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THIRD NATIONAL COMMUNICATION OF THE REPUBLIC OF UZBEKISTAN UNDER THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE

Tashkent 2016

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INTRODUCTION

The United Nations Framework Convention on Climate Change (UNFCCC) is the basis for international actions aimed at climate change combat. The ultimate objective of this agreement is to achieve stabilization of greenhouse gases (GHGs) concentration in atmosphere at the level preventing dangerous anthropogenic impact on climate system.

Uzbekistan signed the UNFCCC in 1993, and ratified the Kyoto Protocol in August 1999. Uzbekistan, as a party to the Convention, pursues the consistent policy aimed at decrease in GHGs emission in the key sectors of economy. The Government has adopted a number of documents associated with regulation of actions and implementation of measures in the area of climate change. The tangible success has been achieved in implementation of the Kyoto Protocol mechanisms. 15 Clean Development Mechanism Projects have been registered in the Executive Council of UNFCCC and 14 million ton of CER (Certified Emission Reductions) were put into practice. Uzbekistan occupies the first place among CIS and Easter Europe countries by number of registered CDM projects.

According to the UNFCCC, members (Parties) to the Convention are obliged to submit periodically their respective National Communications with information regarding the Convention implementation progress.

The Initial National Communication was accomplished in 1999 within the framework of the GEF/UNDP Project "Uzbekistan – Country's Climate Change Study" and submitted to the 5th Conference of the Parties in Bonn. The Initial National Communication included data on GHGs inventory for the period 1990 -1994, materials for calculation of emission trends, assessment of vulnerability of Uzbekistan to climate change and the general description of adaptation and mitigation measures.

The Project "Uzbekistan – country's climate change study, Phase-2" was accomplished in 2001. Amongst the Project's outputs were: GHGs inventory for 1990-1999, identification of technological requirements of various economy sectors, assessment of the potential Projects in terms of decrease in GHGs emission, development of scientific approaches to evaluation of vulnerability of nature systems and sectors of economy, review of the possible adaptation measures to climate change and analysis of compliance of the systematic observations system with requirements of the Global climatic observation system.

The Second National Communication (SNC) was accomplished in 2008 under implementation of the GEF/UNDP Project "Uzbekistan: Preparation of the Second National Communication under the UNFCCC". The following outputs were reflected in the SNC: improved and supplemented GHGs emission database; decreased uncertainty in the national inventory of GHGs emissions; assessment of vulnerability and capacity for mitigation and adaptation capability of various sectors of economy; identified priority strategic directions and adaptation measures; assessment of potential risks and requirements for development of early warning system about dangerous climatic phenomena; analysis of systematic observations compliance with requirements of the Global Climate Observing System (GCOS) and climate monitoring principles.

This publication, the Third National Communication (TNC), is the document that retains succession of the strategic and conceptual provisions reflected in the first two Communications and summarizes the most up-to-date information regarding climate change problems and progress with the UNFCCC implementation. It comprises results of GHGs inventory for 1990-2012; observed changes in climatic features; assessment of vulnerability to climate change; analysis of on-going policy and measures for reduction in GHGs emission and adaptation to climate change.

Framework structure of the TNC has been developed on the basis of UNFCCC methodological recommendations taking into account experience gained in preparation of the previous National Communications. The TNC is a result of multilevel analysis, studies and broad consultations with all the concerned parties, experts and representatives from the governmental and public institutions.

Preparation of the TNC was aimed at deepening and systematizing studies and assessing the following sectors of economy: agriculture; water resources management; population health; dangerous and extreme nature phenomena; terraneous and aquatic ecosystems; forests and forestry; public utilities and infrastructure; some industry sectors.

Vulnerability to climate change impact on various economy sectors has been assessed on the basis of model calculations recommended by the IPCC. Vulnerability has been assessed for base climatic period and current climatic variations, as well as for future climatic scenarios. Evaluation time intervals were corresponded to periods up to 2030, 2050 and 2080. Information presented in the TNC, gives the comprehensive picture about measures that have been implemented, being implemented and planned to be implemented in the country for solution of climate change problems.

SUMMARY

The Third National Communication of the Republic of Uzbekistan under United Nations Framework Convention on Climate Change (UNFCCC) has been prepared by the Centre of Hydro-meteorological Service at the Cabinet of Ministers of the Republic of Uzbekistan under the leadership of National Focal Point jointly with the key ministries and agencies, scientific and research institutions with participation of experts from a number of industrial enterprises, non-governmental non-commercial organizations. It is presented in accordance with Articles 4.1 and 12.1 of the Convention. The Third National Communication has been developed on the basis of the guidelines on National Communications from non-Annex I Parties to FCCC (2004) with support from the United Nations Environment Programme (UNEP).

NATIONAL CIRCUMSTANCES

The Republic of Uzbekistan is located in the Central Asia, within the Amudarya and Syrdarya river basins, between 37° and 45°N, and 56° and 73°E. The north-western part of territory (78.8%) is occupied by steppes and deserts of the Turan depression. The rest of Uzbekistan's territory is located in piedmont area and off spurs of the Tien - Shan and Gissar – Alay mountain system. The total area of the Republic is 448.9 thousand km^2, expanding from north to south by 930 km, and from west to east by 1,425 km.

Climate of Uzbekistan is of continental type. The majority of territory is attributed to moderate climate zone. The southern part of the country is located in the arid subtropical climate zone. Large seasonal and daily variations in air temperature and dry, hot and long summer are typical for climate of Uzbekistan. Minimum precipitation amount (around 100 mm per year) occurs in the western desert part of republic. In the mountainous area precipitation amount increases reaching 800-900 mm per year.

Water resources of the country comprises the surface runoff of Amudarya and Syrdarya rivers (55%), runoff of small rivers (33%), underground waters (around 10%), and collector/drainage waters (2%). All watercourses and water bodies of Uzbekistan are attributed to the Aral Sea basin. The long-term average flow of 38 km^3 and 79 km^3 are formed on the Syrdarya and Amudarya river watersheds respectively. Natural hydrological regime of rivers flows of the Amudraya and Syrdarya river basins is disturbed due to construction of reservoirs, water diversion into canals for irrigation and drainage water disposals.

The main consumer of available water resources is irrigated agriculture, which in some years takes up to 90% from the total water consumption. Around 10% and 8% of the Syrdarya and Amudarya rivers flow respectively are formed on the territory of Uzbekistan. Underground water resources are used mainly for drinking and municipal water supply and for industry. Small portion of underground water is used for land irrigation.

Lakes in Uzbekistan are mainly presented by small water bodies. With development of irrigated agriculture and disposal of drainage water beyond irrigated lands, the large drainage water disposal lakes have been formed, such as Dengizkul, Sarikamysh, Sudochie, Aidar – Arnasay system of lakes, etc. There are 56 artificial reservoirs operating in the country, intended mainly for irrigation and electric energy generation.

The Aral Sea and Priaralie (the Aral Sea littoral zone). Owing to intensive and irrational use of water, area of water surface of the Aral Sea was decreased from 67,000 (1960) to 4,000 km^2, and water mineralization increased by 13-14 times. It losts its ecological and economic value. Currently only western deepwater part of the Aral Sea and separated by dam northern part (Small Aral) on the territory of Kazakhstan are remained. The country applies great efforts for solution of practical tasks aimed at overcoming of the Aral Sea disaster. Therefore, the state "Integrated program on mitigation of the Aral Sea disaster impact, rehabilitation and socio-economic development of Priaralie for 2015-2018"[1] has been adopted and being implemented. It was approved Plan for financing projects and measures in the Priaralie for the total amount equivalent to USD1.3 billion (2013). The Plan comprised creation of small local ponds in the Amudarya river delta, construction of water intake structures with de-salination plants, creation of protective forest plantations on the Aral Sea dried bottom. However, substantial support from the International community (funds and donors) is required for solution of the complicated task to overcome Aral Sea disaster in climate changing conditions.

Biodiversity quality in Uzbekistan is evaluated by expert as high and very high only on 6.8% of territory (specially protected natural territories, natural forests), 50.5% as medium quality (non-irrigated hayfields and pastures). Restricted sizes and spatial dispersion of conservation areas stipulate their ecosystems and biodiversity vulnerability in the long-term perspective. Climate change is the additional pressure factor that enhances threat of biodiversity decrease of the arid ecosystems.

State Structure. Uzbekistan is the sovereign democratic republic, headed by the President. It is full entity of the international law. On 2 March 1992, Uzbekistan became the member of United Nations Organization (UN). The system of state authority is based on

[1] Decree of Cabinet of Ministers of the Republic of Uzbekistan No. 363, dated 24 December 2014, "On measures for implementation of agreement achieved at the International Conference "Development of cooperation in the region of Aral Sea basin for mitigation of the Aral Sea disaster impact"

principle of separation of powers into legislative, executive and judicial ones. Legislative power is exercised by the supreme state representative body - the Oliy Majlis, which consist of the Legislative Chamber and the Senate. The executive power is exercised by the Cabinet of Ministers. The judicial power in the republic belongs to courts.

The system of state administration is based on functional-sectoral and territorial principles, and includes ministries, state committees, agencies and organizations, as well as local bodies of state authority – khokimiyats (local municipalities) in provinces, cities, towns and districts.

Administrative division and population. The Republic of Uzbekistan consists of 12 provinces, 174 districts, 119 cities and towns, 1,085 settlements of urban type, 11,017 rural settlements and the Republic of Karakalpakstan. The capital of Uzbekistan is Tashkent city with population more than 2.3 million people. Size of resident population is steadily increasing and as of 1 January 2016, reached 31,576 million people. Shares of urban and rural population in the total population size are 50.6% and 49.4% respectively. Size of the economically active population on average for 2015 was 13,767.7 thousand people, or 44.0% from the total population.

Structure of economy. Uzbekistan is attributed to the category of countries with rapid-growing economy. Over the past 10 years the average annual rates of the GDP growth were not less than 8%. In 2014 value of the GDP per capita was 4,709,700 Uzbek Soums (or USD2,036.7). Share of services sector in GDP was 54%, industry – 24.1%, and agriculture – 17.2%. Uzbekistan demonstrates its striving towards transition to the resource saving development model. There are currently programs and legally binding legislative acts aimed at ensuring measures by 2020, for decrease in energy consumption, introduction of energy saving technologies in economy sectors and social sphere and development of RES. Measures for mitigation of climate change impacts are being successfully implemented in the republic within framework of CDM projects. Currently, as a result of the governmental policy in area of energy saving and efficiency, the GDP energy consumption has been considerably reduced (more than 2.5 times as compared with 1995).

Based on analysis of development trends, assessments of resources and capabilities, Uzbekistan has identified its target task to achieve twofold GDP increase by 2030, with accelerated industry growth and extensive introduction of energy saving technologies,[2] and reduce GDP energy consumption by 2 times approximately. The following measures were identified as the country's economic priorities: upgrading, technical and technological renewal of the fuel and energy complex and metallurgy; countrywide introduction of the advanced efficient energy saving technologies; development of chemical and light industries, as well as construction materials industry.

Agriculture sector is one of the leading sectors of Uzbekistan's economy. In spite of reduction in agriculture's real contribution to GDP from 34% (in 1990) to 17% (in 2014), volume of agricultural production over this period was doubled. 3.392 million people are employed in agriculture or 27.2% from the total employment in the republic. More than half of the private farms grow cotton and wheat. The rest ones are cattle breeding, vegetables, melons, grapes, fruits growing and apiculture farms. Uzbekistan is one of the world leaders in cotton production and the main producer of fruits and vegetables in the Central Asian region. The national strategy for agriculture development is aimed at structural reformations, including deviation from cotton monoculture, reorientation to diversification of agricultural production, advanced processing of agricultural products, rehabilitation of saline irrigated lands. In 2015 Uzbekistan became one of 14 countries received awards for achievement of the Millennium development goals in ensuring food security.

Fuel and energy complex (FEC) includes electric-power industry, heat power industry and oil and gas sector. Natural gas reserves are the basis for creation and development of oil and gas sector. Uzbekistan is net exporter of natural gas possessing 0.6% of world gas reserves. The considerable part of natural gas is consumed within the country and around 15-18% is exported. Natural gas is transported by the main and field gas pipelines with the total length of more than 13.5 thousand km.

The oil and gas sector of Uzbekistan possesses its own processing base. It comprises such large enterprises as the Mubarek gas processing plant, head structures of the Shurtan gas field and Shurtan gas-chemical processing plant, Navoi chemical works with three oil processing plants.

Electric energy generation is primary economy sector of Uzbekistan, which covers completely electric energy demand in the country. The basis of energy system of Uzbekistan is 10 large thermal electric power stations (TEPP). There are 36 hydro-electric power stations (HEPS) in Uzbekistan with the total installed capacity of 1.83 GW. Length of the JSC "Uzbekenergo" electric grids is more than 250 thousand km that allow involving practically all consumers in the zone of centralized electric power supply. Currently the large scale works for introduction of new technologies for electric power generation on the basis of the advanced gas-vapor

[2] Report of the President of the Republic of Uzbekistan, Mr. I.A. Karimov, at the extended session of the Cabinet of Ministers devoted to the results of social and economic development of the country in 2015, and the most important priority directions of economic program for 2016. 16 January 2016.

and gas turbine power plants are carried out at the large thermal electric power stations (TEPP). Great attention is paid to upgrading and automatization of electric energy metering.

Extensive use of alternative energy sources is one of the country's priorities in development of energy generation sector. The gross potential of renewable energy sources (RES) is estimated in the volume of approximately 51 billion t.o.e. and technical potential in volume of 179 million t.o.e. More than 99% from the total RES potential is solar energy. Pursuant to the Decree of the President No. UP-4512, dated 01 March 2013, "On measures for further development of alternative energy sources" it is envisaged in the mid-term perspective construction of 100MW solar photoelectric power stations in the Samarkand, Namangan and Surkhandarya provinces with attraction of credit resources from the international financial institutions. Biogas plants, hot water supply systems for residential buildings based on solar water heating units, wind electric energy generators and other types of RES became more widely used in Uzbekistan.

Industry sector of Uzbekistan comprises the large machine-building complex, ferrous and non-ferrous metallurgic plants, advanced enterprises for production of gold, silver and palladium, new plants for manufacturing cars and buses, large chemical plants for production of mineral fertilizers, cement plants, diversified light industry complex (cotton ginning, cotton and silk processing), medium and small scale fruits and vegetables processing enterprises, food production.

As compared with 1990, volume of industrial production in the country was increased by more than 3 times. Its annual increment in 2014 was 8%. The main directions of Uzbekistan's economic strategy are: maintenance of high growth rates in export-oriented economy sectors; stimulation of development of enterprises with the advanced processing of domestic raw materials and manufacturing products with high added value; technical modernization of enterprises. Implementation of more than 500 investment projects with the total cost of around USD50.0 billion on modernization of existing and commissioning new production capacities under the Program for development of industry of the Republic of Uzbekistan for 2011-2015[3] ensures retention of the stable growth rates of industrial production, first of all in the hi-tech industry sectors.

Transport sector of Uzbekistan comprises automobile, railroad, air and pipeline transportation. In 2014, volume of freight turnover by all types of transport was 85.7 billion thousand t-km, which by 2 billion thousand t-km more as compared with the previous year. In the total volume of freight turnover share of automobile transport is 37%, pipeline transportation – 36%, railroad transport – 26.9% and air transport – 0.1%.[4]

Waste management. There are 247 sites with the total area of 9,628.98ha for disposal and utilization of wastes. The main method of solid municipal wastes (SMW) disposal is their burial into ground. Currently, there are more than 370 mln. m^3 of SMW are accumulated on the operating waste disposal sites of the republic. This volume is increasing annually by 12-13 mln. m^3 of SMW. Around 100 mln. m^3 of industrial wastes are generated in the republic annually, of which 14% is attributed to toxic category, and around 68% is mining industry wastes. For efficient solution of problems associated with utilization and secondary recycling of wastes it is necessary to introduce widely advanced technologies. As of beginning of 2014, 131 enterprises for utilization and processing of wastes and 66 enterprises dealing with utilization and processing of used containers and packaging are registered in the republic.

Education. One of the main state objectives in Uzbekistan is formation of harmonically advanced, educated, moral and healthy generation. Annual education expenditures in Uzbekistan are around 10-12% from the GDP, which by almost 2 times higher than investments in education recommended by the UNESCO (6-7%), necessary for ensuring the sustainable development of country. Charge-free 12-year education is obligatory in Uzbekistan. It comprises primary, general secondary and specialized secondary education. Coverage of population by general secondary education is estimated at the level 98-99%, that of secondary specialized education is 99.6%. The state ensures possibility to get higher education based on the governmental grants or on payable contractual basis. Measures for strengthening material and technical base of educational institutions and capacity building of teaching staff are carried out on a regular basis.

Development and introduction of information and communication technologies (ICT) in the country is one of the priority directions of governmental policy. It is based on essential regulatory and legal framework. Strategy for ICT technologies development is being implemented in accordance with the Integrated program for development of the national ICT system of the Republic of Uzbekistan for 2013–2020. Nowadays more than 60% of households have access to Internet. In 2014, share of ICT sector in the country's GDP was 1.9%, volume of goods production and services in the ICT sector exceeded 4.1 billion Soum, and export was over USD213.0 million. Development of ICT and electronic mass media creates preconditions for population and decision makers' awareness

[3] Decree of the President of the Republic of Uzbekistan No. PP-1442, dated 15 December 2010 "On priorities for development of industry in the Republic of Uzbekistan in 2011-2015" //Law Book RUz, 2010, No 50 (472)

[4] http://stat.uz/ru/uploads/ekonom/transp/gruz_perevozki14.xls

raising, improves access to information and facilitates involvement of population in solution of tasks associated with climate change problems.

Tourism. Uzbekistan possesses high touristic capacity. There are more than four thousand unique architectural, historical and natural landmarks of various epochs in Uzbekistan, and four of them (Ichan-Kala in Khiva, historical centers of Bukhara, Shakrisyabz and Samarkand cities) are included in the UNESCO World list of heritage landmarks. Currently plan for development of ecological tourism in various regions is being developed. Volume of touristic services grows constantly. Only during last year it was increased by 16%.

Institutional and legal base for implementation of the UNFCCC is ensured by more than 30 environmental laws and around 100 normative legal documents. The important institutions fulfilling commitments, adopted by the republic in regard to UNFCCC, are: the Centre of Hydrometeorological Service at the Cabinet of Ministers of the Republic of Uzbekistan (Uzhydromet) – responsible agency for the implementation of the UNFCCC in Uzbekistan; National Agency on the Clean Development Mechanism under the Ministry of Economy of the Republic of Uzbekistan; sectoral ministries, responsible for development and implementation of the governmental policy for adaptation to and mitigation of climate change impacts; a number of sectoral expert groups, dealing with greenhouse gases inventory, assessment of climate change impacts mitigation, evaluation of vulnerability and adaptation to climate change impacts and integration of climate change issues in the national policy and programs, etc.

GREENHOUSE GAS INVENTORY

Within the framework of preparation of the Third National Communication it has been evaluated and revised the anthropogenic emission and sink of greenhouse gases (GHGs) for the period 1990-2012, in accordance with the IPCC methodology and classification by five sectors of economy: "Energy"; "Industrial processes"; "Agriculture"; "Land use change and forestry"; "Waste". Data on emissions/sinks of the following gases with direct greenhouse effect are presented in the National GHGs cadastre: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (CH_2F_2, C_2HF_5, $C_2H_2F_4$, $C_2H_3F_3$) and gases with indirect greenhouse effect: carbon monoxide (CO), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC), sulphur dioxide (SO_2).

Total GHGs emission without sinks in the Land use change and forestry sector in 2012 was 205.2 Mt CO_2-eq. As compared with the 1990 baseline, the total GHGs emission was increased by 13.7%. The carbon dioxide prevails in the total emissions, with its contribution of 51.4% in 2012. Contribution of methane and nitrous oxide was 43.0% and 5.5% respectively, with insignificant contribution (0.04%) of hydrofluorocarbons. Greenhouse gases sink in the Land use change and forestry sector in 2012 is estimated as 2.86 Mt CO_2, or 1.4% from the total emissions. The GHGs emissions with taking into account sinks in the Land use change and forestry sector was 202.3 Mt CO_2-eq.

There is a decrease in CO_2 emissions for the period 1990-2012, from 113.3 to 105.5 Mt CO_2-eq. or by 6.7% (without sink in the Land use change and forestry sector), and from 111.7 to 102.7 Mt CO_2-eq. or by 8.1% (with sink in the Land use change and forestry sector). Decrease in emission is associated with increase in share of natural gas consumption in the overall pattern of fuel consumption, modernization of energy consumptive enterprises, use of more efficient technologies and renewal of transport vehicles park.

CH_4 emissions were increased in the considered period by 63.1% (from 54.2 to 88.4 Mt CO_2-eq). Increase in methane emission in the "Energy" sector is associated with growth of natural gas extraction and increase in technological leakages as a result of gas transportation volume increasing. Increase in number of animals in the "Agriculture" sector and growth in solid domestic waste volumes had impact on increase in methane emissions.

Emissions of N_2O have been decreased by 13.9% (from 13.0 to 11.2 Mt CO_2-eq.). Decrease in emissions is mainly associated with reduction in use of nitrogen fertilizers in agriculture, as well as implementation of the CDM projects at nitric acid producing enterprises.

In 2012, GHGs emission per capita was 6.9 ton of CO_2-eq./person. As compared with the level of 1990, this index was reduced by 21.6%. The obtained values of CO_2emissions per capita correspond to estimations of the International Energy Agency (IEA).

"Energy" sector is the largest contributor to the total volume of anthropogenic GHGs emissions with 82% (in 2012). Emissions in the sector are mainly associated with fuel combustion (such as oil, natural gas, coal) and technological leakages of methane along with extraction, processing and transportation of natural gas. Share of "Agriculture" sector in the total emission is 10.5%. Share of the "Industrial processes" and "Waste" sectors is 3.8% and 3.7% respectively.

Uncertainty of GHGs cadastre has been evaluated for 99.7% of GHGs emissions, including all key sources.

Emission of gases with indirect greenhouse effect over the period 1990-2012, was decreased as follows: CO – by 47%, NOx, NMVOC – by 25%; SO_2 – by 71%. The main reason for emission decrease is growth in the share of natural gas consumption for energy generation and in transport sector, as well as modernization of industrial enterprises.

CURRENT POLICY AND MESURES ON REDUCTION IN GHGs EMISSIONS

Over the recent years a number of sectoral documents, regulating policy and measures on energy saving and energy efficiency, has been adopted in Uzbekistan. Currently the draft law "On renewable energy sources" is under consideration, and the law "On thermal energy" is refining. The Decree of the First President of the Republic of Uzbekistan "On measures for reduction in energy consumption, introduction of energy saving technologies in various sectors of economy and social sphere for 2015-2019"[5] is of special importance. In fact, this document identifies the national policy and measures on energy efficiency, introduction of energy saving technologies and development of renewable energy sources.

A number of strategic documents regarding decrease in GHGs emissions have been developed in Uzbekistan with support from the UNDP, including: "Transition to the Resource - efficient Growth Model" (UNDP/Center for Economic Studies), "Strategy for Low Carbon Development: Target Indices on Reduction in Energy Consumption/Emission of Greenhouse Gases in the Key Sectors of Uzbekistan's Economy" (UNDP/Ministry of Economy of RUz), "Energy Efficiency in Buildings: Hidden Resource for Sustainable Development of Uzbekistan (UNDP/Ministry of Economy of RUz). Implementation of Measures, Envisaged in these Documents, Will Require Relevant Institutional Capacity Building, Development of Regulatory and Legal Framework, Use of New Financial Mechanisms and Incentive Measures.

Capacity for GHGs emission decrease. In 2013, the total capacity for energy saving in Uzbekistan was estimated to be 22.7 million t.o.e., which correspond to 53.1 Mt CO_2-eq. or 26.6% from the current volume of GHGs emission. Rapid growth of Uzbekistan's economy is not accompanied by significant increase in the total GHGs emissions (+13.7% for the period 1990-2012). Measures on realization of capacity for GHGs emission decrease are carried out in the following economy sectors: oil and gas, energy generation, heat supply, buildings, transport, industry, agriculture and forestry.

The possible energy resources saving in generation and transmission of electric energy, taking into account use of renewable energy sources and introduction of cogeneration technology in energy supply to large industrial enterprises, is estimated to be 10.85 mln. t.o.e./year. Realization of the current capacity for energy efficiency in the energy production sector will allow to reduce GHGs emissions by 25.3 Mt CO_2-eq./year. The main necessary technical measures, facilitating realization of capacity in heat supply sector, are reflected in the "Concept for reformation of heat supply system in the Republic of Uzbekistan for 2010 – 2020". According to this concept, the master plans for development of heat supply systems for period up to 2020, are being prepared for 28 cities/towns of the country. As a result of the state energy saving policy, energy consumption in *buildings* has been reduced over the recent years by 5-10%.

Institutional and technical measures for increasing energy efficiency/reducing GHGs emission in the *transport sector* include: gradual introduction of the standards on fuel consumption and CO_2 emissions; priority development of urban transport, including restrictive measures; further change-over of automobile transport to run on liquefied and compressed natural gas; public transport traffic optimization in large cities of the republic, etc.

Clean Development Mechanism (CDM). Uzbekistan has achieved the tangible success in the CDM Projects implementation. As of 1 January 2016, 15 CDM Projects were registered in the UNFCCC Secretariat, and over 15.2 million ton of CER (Certified Emission Reductions) were put into practice. Another two CDM Projects with the average annual emissions decrease more than 1 Mt CO_2-eq. are in the process of registration. Uzbekistan occupies the first place among CIS and Eastern Europe countries by number of registered CDM projects. Uzbekistan has become the third country in the world, which developed and approved in the UNFCCC Secretariat the standardized emission baseline (GHGs emission factor from electric energy generation) for the national energy system. Participation in the CDM Projects has allowed to attract to the country's budget over USD24 million of private foreign investments. As a result of monitoring and subsequent international audit of the Clean Development Mechanism Projects in oil and gas sector, it was revealed that natural gas saving only on account of elimination of existing gas leakages in check valves and fittings of distribution networks in 9 provinces of the country is approximately estimated in more than 1 billion m^3 of natural gas over three years (or 350.1 million m^3 per year).

Prediction of Greenhouse Gases Emission. Calculation of greenhouse gases emission up to 2030 has been made taking into account economy sectors development and macroeconomic indices. The following materials have been used for selection of assumptions: the national and sectoral development plans, as well as target indices developed in the strategic documents "Transition to the

[5] Decree of the President of the Republic of Uzbekistan No. PP-2343, dated 05 May 2015 "On measures for reduction in energy consumption, introduction of energy saving technologies in various sectors of economy and social sphere for 2015-2019"

Resource-efficient Growth Model", "Strategy for Low Carbon Development: Target Indices on Decrease in Energy". The calculations indicate that by 2030, GHGs emission may reach 277-358 Mt CO_2-eq. depending on the adopted scenario. The maximum and minimum GHGs emission growth is possible with realization of the "Business as usual" and "Realistic scenarios" respectively. The latter scenario envisages implementation of package of mitigation measures in the key sectors of economy, including wide use of RES. All calculation options by the GACMO model demonstrate further growth in GHGs emissions, which is stipulated by rates of the country's economic development.

OBSERVED CHANGES, VULNERABILITY TO CLIMATE CHANGE, POLICY AND ADAPTATION MEASURES

The approaches, methods and tools of UNFCCC and UNEP, CropWat model and etc., as well as the regional assessment methodologies have been used for assessment of vulnerability of natural resources and economy sectors of Uzbekistan. The assessment has been made taking into account socio-economic and demographic indices, information on land fund, agriculture and water management sectors. For assessment of natural resources vulnerability various factors have been summarized and aggregated factor of vulnerability formed. According to the aggregated factor, the Republic of Karakalpastan, Khorezm and Syrdarya provinces are attributed to the most vulnerable ones to climate change. Navoi, Djizak, Bukhara, Surkhandarya, Namangan, Kashkadarya and Tashkent provinces are attributed to the medium vulnerable ones. Andijan, Fergana and Samarkand provinces are included in the group of low vulnerable to climate change.

Uzbekistan is among the countries most vulnerable to climate change. Increase in average annual air temperatures in Uzbekistan occurs on background of high natural variability, which is stipulated by considerable inter annual variations. Warming rates exceed the average rate observed on the global scale. The most considerable increase in average annual air temperatures has been observed in Tashkent and Fergana meteorological stations (1.8ºC and 1.6 ºC respectively). On average by Uzbekistan warming rate is 0.27ºC per10 years.

Analysis of changes in the total annual precipitation amount averaged by various parts of Uzbekistan for the period 1950-2013 indicates very low trends towards decrease. The most significant trend towards decrease in total annual precipitation amount is observed in the southern plains of Uzbekistan (Bukhara and Kashkadarya provinces).

Increase in number of significant positive temperature anomalies is observed by all territory of Uzbekistan and in all year seasons. The highest rates of increase in number of days with "heat waves" have been registered in the Priaralie (Aral Sea littoral zone) and lower reaches of Amudarya river.

Adopted scenarios. For assessment of climate change impact in Uzbekistan it was considered three scenarios of greenhouse gases (GHGs) emissions. Soft scenario reflects global warming within range of 2°C against pre-industrial period. It is scenario of CO_2 stabilization in near the ground atmosphere at the level of 450ppm (WRE450). Moderate scenario assumes CO_2 stabilization at the level of 750ppm (WRE750), which will lead to increase in global temperature by 3°C by year 2100. According to the extreme scenario (A1FI), by the end of century, increase in global temperatures will reach 4.9°C, and concentration of CO_2 will approach to 990ppm.

Climate change scenarios for the whole Uzbekistan and for upper watersheds of the Syrdarya and Amudarya river basins have been built upon basis of averaged outputs from 8 Global Climate Models (GCM) with use of model MAGICC/SCENGEN5.3 (Climate Scenario Generator for Vulnerability and Adaptation Assessments). Calculations indicate that air temperature in Uzbekistan will continue increasing in accordance with the already observed trends and by 2030 it will be increased by 1.0-1.4ºC. With the general climate warming, in future probability of the intensive "heat waves" will be increased along with retention of cold waves probability.

The total annual precipitation amounts in the upper watersheds of Syrdarya river are changing insignificantly in time and by GHGs emission scenarios. Decrease in precipitation amount by 13% is possible in the Amudarya river basin with realization of the extreme GHGs emission scenario. In general, trend towards decrease in watering level of the Central Asian region is observed by all scenarios.

Climate change impact on water resources. Glaciation of the mountainous area in the whole Aral Sea basin has great importance for the water resources of Uzbekistan. However, within the country's territory glaciations area is not too large. Rates of glaciation area decrease vary by territory and time periods from 0.1 to 1.65% per year. Assessments have indicated that already in the nearest 30-50 years glaciation area e.g. in the Pskem river basin may be decreased by more than two times even with realization of soft scenario of GHGs emission.

Results, obtained with use of various methodological approaches for moderate scenario of increase in the global GHGs emissions indicate that insignificant decrease in norms of vegetation river flow will be a consequence of climate warming in the nearest 40-50 years. In the long-term perspective with realization of extreme scenario of GHGs emissions it is possible decrease in runoff of some rivers in the Amudarya and Syrdarya river basins by 7-22% and 5-42% respectively. Minimum changes in runoff are expected in the large rivers and maximum ones in the small rivers of piedmont zone.

Evaluation of future demands for water with use of WEAP model has indicated that already now water demands for irrigation and ecology are not covered. Deficiency of water resources will be increased considerably in the conditions of climate change. According to assessments, by 2040s even with increase in runoff of the Amudarya and Syrdarya rivers, the total deficiency of water for irrigation in Uzbekistan may be 8.0%. With the unchanged and decreased rivers runoff water deficiency may reach 15.4% and 33.5% respectively.

The essential adaptation measures are: increase in efficiency of available water resources use; broad introduction of water saving technologies in agriculture, industry and housing and public utilities sectors; improvement of irrigation infrastructure in aid of decrease in water losses and reduction in its consumption per unit of production; transition to use of irrigation water with increased mineralization; improvement of level of mechanization and automatization of water distribution in river basins and irrigation districts; transition to flexible system for planning optimal volume of agricultural production. These measures may be a basis for the National plan for adaptation of agriculture and water management sector to climate change.

Climate change impact on agro-climatic resources. Carried out in the Third National Communication current estimates of vulnerability of agro-climatic resources of the republic in changing climate conditions and expected trends confirm the adverse effects of climate change on agriculture of the republic, which indicates necessity to adopt adaptation measures.

Observation data for period from 1950 to 2013 indicate shifts in dates of average daily air temperature stable transfer over the 5°C, 10°C and 15°C in spring, and in autumn towards winter by all territory of Uzbekistan, i.e. increase in duration of vegetation period (on average by Uzbekistan rates of such increase is 3 days per 10 years).

The statistically significant increase in sum of effective air temperatures has been revealed, which by 2030s may exceed the currently observed variability by 1.5-2 times. Such changes will not affect yield of present-day crop varieties. This will require changes in crop varieties composition and redistribution of agricultural crops by territory.

Increase in water deficiency occurs by all scenarios of GHGs emissions by all territory, and in general repeats rates of increase in sum of effective air temperatures. According to all scenarios, by 2021-2040 it is expected increase in water deficiency by 11-14% on average by Uzbekistan against base period. According to evaluation by the CropWat model, it is expected increase in moisture evaporation from fields of cotton, vegetables, melons, alfalfa and tree plantations in desert and steppe zones by 5-7% by 2030 and by 8-15% by 2050 against climatic norm. In piedmont areas increase in moisture evaporation rates is less intensive. Growth in moisture evaporation rates requires increase in irrigation norms. Calculations have indicated that irrigation norms for majority of crops (cotton, vegetables, melons, alfalfa and tree plantations) growing on main arable lands in desert and piedmont zones will require increase in irrigation norms by 5.8-7.3% by 2030 and by 9.7-15.0% by 2050.

Increase in number of days with the abnormally high air temperatures may also entail decrease in cotton yields in a number of districts of the Bukhara, Kashkadarya, Tashkent and other provinces. Yield losses due to impact of the ballast temperatures (above biological minimums) may reach 10-12% in the southern cotton growing districts. For rainfed areas with lack of precipitations it is possible decrease in cereals yield up to 15-20%.

Increase in air temperatures by 2050 will lead to formation of vegetation winter for pastures facilitating better vegetation development in spring, however productivity of ephemeral pastures may be decreased. Air temperature increase in warm six months along with decrease in water availability will worsen conditions for formation of forage supply and create difficulties in the cattle breeding sector. Increase in frequency of hot days occurrence will enhance thermal stress for animals grazing in summer period. This may entail decrease in weight gain or even weight loss by animals.

The essential measures for agriculture adaptation are: diversification of agricultural crops and decline in crop moisture capacity; use of more efficient crop varieties and animal breeds; broad introduction of advanced agro-technologies and efficient irrigation methods; maintenance of irrigation and drainage infrastructure at proper level; reuse of drainage water; private farms size optimization; ensuring more freedom to farmers in crops selection; improvement of irrigation systems efficiency; creation of incentives for long-term investments and others.

Dangerous hydrometeorological phenomena. Such dangerous hydro-meteorological phenomena as droughts, high air temperatures, “heat waves”, frosts, mudflows, avalanches have been considered within the framework of the Third National Communication.

Drought. Owing to possible rivers runoff decrease during vegetation period and increase in water consumption by all economy sectors due to climate change and intensive population growth, risks of occurrence of extremely dry years and droughts in Uzbekistan grow up considerably, especially in the downstream reaches of rivers in the Amudarya river basin (Republic of Karakalpakstan, Khorezm and Bukhara provinces). Also the most vulnerable districts will turn to be those ones, which depend on water supply from small rivers. Risks of atmospheric drought occurrence have been considered in regard to arable lands, meadows and pastures. According to moderate greenhouse gases emission scenario (WRE750), share of meadows and pastures, and arable lands subjected to high risk of atmospheric drought occurrence (40 and more days per year with air humidity deficiency over 50hPa) may reach 28% and 35% respectively. Droughts prediction, development of early warning system and ensuring readiness to drought are the main strategy for adaptation to climate change.

"Heat waves". Increase in number of days with "heat waves" is observed by all territory of Uzbekistan, and especially in the Aral Sea littoral zone, Fergana valley and piedmonts of Western Tien Shan. Index of risk of the dangerous "heat waves" occurrence is a number of days with high air temperature. Assessments of variations in frequency of occurrence of days with high air temperatures indicate that even with realization of the soft greenhouse gases emission scenario (WRE450), by territory of Uzbekistan it is possible increase in frequency of air temperatures above 39°C by 1.5-2 times against base period, already by 2050s.

Dangerous hydrometeorological phenomena. Owing to climate warming, boundaries of dates with last spring frosts will be shifted towards more northern areas of the republic, reducing risk of adverse impact on agriculture sector.

Due to anticipated increase in general variability of precipitations and their daily maximum, it is possible to expect also increase in frequency of heavy rains and hail occurrence. The main measures for diminishing impact of infrequent local dangerous meteorological phenomena (heavy rains, hail, frosts, high air temperatures) are associated with improvement and wide use of insurance practice both at the present time and in future.

In general, the available assessments of climate change and observation data for the low mountain zone of Uzbekistan (below 2000-2300 mamsl) indicate probable decrease in frequency of avalanche occurrence and duration of avalanche dangerous period, associated with the predicted further increase in air temperatures and elevation of seasonal snow cover boundary. However, taking into account the intensive population growth, expansion of economic activities and development of tourism and recreation zones, the avalanche occurrence risks for perspective up to 2050, will remain very high.

Adaptation measures for reduction in risks and negative impacts of dangerous weather phenomena include: development and improvement of monitoring and warning system; capacity building for prompt response and protection, including expansion of ground-based network of hydro-meteorological observation stations, especially in mountainous zone; monitoring of breakthrough dangerous lakes; maintaining databases; regular updating of reference materials; development and use of remote monitoring methods.

Climate change impact on population health. Climate change affects human health through complicated systems of factors. Direct impact is associated with people death and injury as a result of mudflows, floods, "heat waves", frequency of which increases. Indirect impact is associated with increase in incidence of infectious and meteotropic diseases, as well as diseases related to change in habitat of infection carrying agents (insects and rodents) and lack of safe drinking water. Uzbekistan has identified priorities of the National strategy for adaptation of public healthcare system to climate change. The following measures have been selected as *priority ones*: implementation of reforms and capacity building of healthcare system; development of the Early Warning System (EWS) about risks of diseases, sensitive to climate change.

Measures for adaptation to climate change of healthcare sector of Uzbekistan also include: development of legal framework and strengthening material and technical base of healthcare sector; development of electronic database on conditions of population health, covering all regions of the republic; introduction of medical warning system about heat waves as additional stress to human organism; stiffening procedures for control over quality of drinking water and foodstuff during hot year period; improvement of public awareness regarding climate change impact on human health, especially for the most vulnerable to disease risk groups of population (i.e. children, women, elderly age people); expansion of studies on assessment of climate change impact on population health.

Climate change impact on biodiversity. The distinctive feature of majority of natural terrestrial ecosystems in Uzbekistan is their enhanced fragility, associated with climate aridity and high anthropogenic pressure. Climate change intensifies processes of land degradation and desertification and, thereby, affects conditions of biodiversity. Very intensively these processes go on in the Priaralie (Aral Sea littoral zone), on Ustyurt plateau, in Kyzylkum desert and piedmont areas. Such trends in future will enhance transformation and fragmentation of desert, piedmont and low mountain ecosystems throughout the territory of republic.

Climatic factors affect functioning aquatic and terrestrial ecosystems through change in surface runoff, which vary considerably depending on water availability in particular year. Change in rivers high water regime and flow decrease lead to decrease in area of tugai vegetation and further degradation of inundable river ecosystems.

National strategy and Action plan for biodiversity conservation have been developed and being implemented in the republic. They include improvement of regulatory and legal framework for protection of ecosystems, development of system of protected nature territories; carrying out state ecological expertise and environmental impact assessment of designed objects of economic and other activities; introduction of economic mechanisms for incentives; maintenance of flora and fauna cadastres and the National Red Book.

Aquatic ecosystems are the most vulnerable ones in the conditions of water deficiency, especially in the Amudarya river delta. Creation of controlled wetlands is the most efficient way for adaptation to climate change. Priority should be given to stable wetlands, which in dry years may preserve biodiversity. Ecosystems of unstable wetlands are completely vanishing during periods of low water availability. In particular, in the Southern Priaralie status of stable may be assigned to the Sudochie and Djiltyrbas wetlands, and Rybachiy and Muinak bays, as well as Karadjar lake system.

The following measures will be required for stabilization of ecological situation, reduction in ecological and social impacts of climate change on biodiversity conservation: improvement of the regional cooperation in water resources management; establishment of norms for sanitary and ecological water releases under introduction of IWRM; development of system for ecological monitoring of water resources and coastal ecosystems; integrated management of aquatic ecosystems, including management programs for separate river basins and especially valuable ecosystem complexes; improvement of norms and rules for operation of aquatic ecosystems; rehabilitation of commercial capacity and main components of aquatic ecosystems biodiversity.

Forests in Uzbekistan differ substantially by their composition and comprise desert, mountain, tugai (flood-plain forests) and artificial forest plantations in oases. The total land area of the State Forest Fund of Uzbekistan is around 21.5% of the country's territory. It is characterized by low percentage of woodland (woodiness) - 6.7%. All forests of Uzbekistan have great protecting and habitat forming importance. The forests are also the most important factor for maintenance of biodiversity, carbon dioxide sequestration and deposition. Capacity for GHGs emissions sink by forests of Uzbekistan is estimated in 2.53 mln ton per year, of which 0.58 mln ton per year is provided as a result of afforestation measures on lands of the State forest fund. On account of creation of field-protective belt on agricultural lands, carbon dioxide sink may be around 1.95 mln ton per year.

The country has certain capacity for afforestation by establishment of commercial plantations, however, currently it is limited due to lack of water quota for forestry. The main direction in mitigation of climate change impact on forestry is ensuring continuous increase in area of forest plantations, which may be achieved by forests planting on non-forest territories, rehabilitation of degraded forest plantations, increase in density of open forests on account of artificial planting of tree seedlings.

Climate change impact on economy sectors

Buildings. Over the period 1950-2013, actual demand for energy resources for buildings heating was reduced by all territory of Uzbekistan. Owing to climate warming this trend will be continued. For the moderate and extreme GHGs emission scenarios the possible reduction in energy resources demands for buildings heating by 2071-2090 is estimated as 28% and 40% respectively.

Demand for energy resources for cooling in summer grows up not only due to rise in air temperatures, but also owing to population growth and improvement of living standards. The considerable increase in demand for energy resources for buildings cooling is expected on account of increase in air temperatures by various GHGs emission scenarios. For the soft scenario increase in demand for energy resources may be 56% already by 2030, and by 2080, the current values may be doubled. Analysis has indicated that increase in demand for energy resources for buildings cooling during hot year period will be compensated by decrease in energy demand for heating in cold year period.

Agriculture. Share of agriculture in electric energy consumption pattern by sectors of Uzbekistan's economy was 21.9% (2013). Out of this percentage around 70% of electric energy is used by irrigation pumping stations. Increase in irrigated land area in Uzbekistan is limited, therefore growth of electric energy demand in the sector, stipulated by climate change, will be in proportion to increasing demand for irrigation water due to increasing crops evapotranspiration.

Transport. Temperature indices identify values of summer and winter supplements to fuel consumption rates in the motor transport sector. Due to climate warming, it is expected decrease in winter supplements to fuel consumption norms and their increase in summer period. The main strategy for adaptation to climate change in various sectors of economy, being at the same time the mitigation strategy, is more rational use of energy resources in the climate change conditions. Relevant sectoral normative documents, construction norms and rules, comprising climatic information, should be updated regularly with use of advanced international methodological approaches and standards.

DEVELOPMENT AND TRANSFER OF ECOLOGICALLY CLEAN TECHNOLOGIES

Introduction of new ecologically sound technologies (EST) is essential in the conditions of economy modernization to support "green development". Therefore, analysis and evaluation of situation with development and transfer of EST, carried out in the TNC, have considered such issues as: creation of favorable conditions for technologies transfer; encouragement of direct foreign investments; formation of innovative infrastructure; strengthening of the national scientific and research institutions and networks; assessment of technological requirements for mitigation of and adaptation to climate change impact; technologies transfer arrangements; capacity building and development for broad expansion and application of ecologically sound technologies and know-how; assessment of gaps and needs.

Private business and scientific and production associations are involved in activities associated with the EST. The Association "Enterprises of Alternative Fuels and Energy" (such as solar and wind energy, biological fuel, development of small scale hydropower industry, etc.) has been established to support all types of relevant activities, from scientific researches and design preparation to their practical implementation. The Government of Uzbekistan supports development of innovative infrastructure, the main elements of which are free economic zones (FEZs) and special industrial economic zones (SIEZs), technological parks, and business incubators. Tax exemptions are provided to scientific institutions dealing with development of innovative projects. Innovative transformations of the national economy require large technical, financial and intellectual inputs, which can be provided by the state only.

From 2013, Uzbekistan is a member of the Climate Technology Centre and Network. The Centre of Hydrometeorological Service at Cabinet of Ministers of the Republic of Uzbekistan (Uzhydromet) is the National Agency that appointed for development and transfer of technologies. The WOCAT global network approaches and criteria are used in Uzbekistan for dissemination of experience in adaptation to climate change and sustainable land management. It comprises documenting technologies and approaches with their scientific validation, combining capability of scientists, local technical experts and institutions. As of today, 4 unique technologies and 2 approaches from Uzbekistan have been included in the WOCAT database.

The main tools for EST transfer in Uzbekistan are: sectoral development and investment programs; projects being implemented with support from development partners (ADB, WB, GEF, UNDP, GIZ); CDM Projects; innovative fairs, international, territorial and sectoral industrial fairs, forums, exhibitions, cooperative stock exchanges. The ICT technologies play special role in capacity building for the EST transfer through introduction of more efficient equipment and networks, replacement of physical objects with electronic ones, application of IT-based systems for weather and environment monitoring, provision of population with all information types.

In all in Uzbekistan the favorable conditions for development and introduction of technologies facilitating mitigation of and adaptation to climate change impact have been created. There is a relevant capacity in the country and NGOs are involved in this process. Nevertheless, there is a need for capacity building in the following areas: mobilization of local and external sources of financing, including innovative climatic financing; capacity building and increase in awareness of decision makers and society, improvement of tool for dissemination and transfer of information about ESTs; detailed assessment of technological requirements; improvement of institutional, and regulatory and legal framework and innovation infrastructure.

The existing barriers on the way to broad introduction of EST include: high cost of equipment and technologies; problems, associated with objects of intellectual property; insufficient degree of commercialization of existing and developing local ESTs; lack of specialists in the area of technologies transfer.

RESEARCHES AND SYSTEMATIC OBSERVATIONS

Conditions and development of hydro-meteorological observation network. Current observation network of the national hydro-meteorological service of Uzbekistan combines functions of climatic, synoptic and ecological networks. The reference climate network (50 stations) includes representative stations with full program of observation, including stations of international data exchange (21 stations) and stations of the Global climate observation network (3 stations).

Uzhydromet is the Regional Telecommunication Center (RTC) for collection, processing and dissemination of hydro-meteorological and satellite information in the global telecommunication network (GTN) of the WMO's World Weather Watch. The Regional telecommunication center ensures twenty-four-hour reception and processing satellite data from the US NOAA earth satellites and geostationary earth satellites of the European Space Agency (MeteoSat-7, MeteoSat-9), Chinese satellites FengYun-2C and FengYun-2D. The data being received are archived and used for weather forecasting and monitoring of snow cover in the mountains of Central Asia and Afghanistan. Equipment for reception of data from the MODIS type satellites allows getting information for assessment of conditions of snow cover, agricultural crop areas, dust storms, the Aral Sea aquatory, etc.

Based on information from the observation network, the state authority and administration bodies, sectors of economy and population receive regularly the confidential, forecasting and climatic information. Hydro-meteorological and agro-meteorological bulletins, reviews, references, daily and 5 day forecasts are prepared for common and specialized users. Problems, associated with deteriorating network equipment, Uzhydromet resolves with attraction of the international investments and efforts of national specialists. Modernization and development of network envisage increase in number of stations in accordance with the WMO recommendations (up to 130-150 stations) and their equipping with the advanced automated observation tools, instruments, analytical equipment and reliable communication systems.

Climate Change Studies. The departments of Uzhydromet carry out extensive volume of studies and practical application of climatic knowledge, including organization of system for monitoring climate features and factors of its formation, fundamental studies of climatic system and solution of wide scope of application tasks. During more than a hundred year history, the hydro-meteorological service of Uzbekistan gained research and methodological instruments allowing to assess the occurred climate changes and to use these results in practical activities.

Studies, associated with evaluation of the global warming impact, have been carried out within the framework of compliance with commitments to UNFCCC and preparation of the National Communications. This has allowed to involve large group of scientists in solution of this new problem and give a kick to development of studies in the following directions: development of methodological approaches to evaluation of water resources vulnerability; assessment of climate change impact on water requirements and productivity of various crops; elaboration of methods for development of climatic scenarios; study of various climatic features of the region associated with the on-going global climate warming. As a result of researches carried out over the recent years by the Scientific research hydrometeorological institute (NIGMI) under the state scientific and technological programs, the following tasks have been accomplished: evaluation of climate change in the country for perspective in accordance with the scenarios of global GHGs emissions; study of climate change impact on the key sectors of economy; preparation of climatic and agroclimatic zoning and set of bioclimatic maps of Uzbekistan's territory; development of solar and wind energy cadastres; adaptation measures proposed.

At the international level Uzbekistan cooperates with the UNFCCC, UNESCO, GEOS, EUMETSAT, IAEA, IFAS, WHO, GEF, UNDP, UNEP, UNIDO, etc, in area of studies, systematic observations and creation of databases, associated with climatic system, environment conservation and life safety.

EDUCATION AND PUBLIC AWAEWNESS RAISING IN CLIMATE CHANGE ISSUES

Great attention is paid in the country to ecological education, as one of the most important factors of sustainable development. Development of ecological education is carried out in accordance with the Concept "On development of ecological education, staff training and retraining, as well as perspectives for improvement of advanced training system in the Republic of Uzbekistan" and "Concept of education in aid of sustainable development of the Republic of Uzbekistan (ESD)" (2011). Within the framework of these documents implementation, training manuals on environmental issues and sustainable development for schools, colleges, lyceums and higher education institutes have been published, training programs in climate change issues improved and training and retraining of teaching staff of educational institutions carried out. However, problem with availability of highly qualified specialists, required for scientific researches, training of teachers and engineers in area of climate change is not resolved completely.

Informational and outreach activities carried out during the recent years in Uzbekistan in area of climate change allowed to various groups of population to improve significantly level of their knowledge in issues associated with risks of climate change, adaptation to and mitigation of its impacts. The following publications have been prepared "Profile of Climate Risks", "Manual for Evaluation of Climate Risks in Uzbekistan", "Approaches to Assessment of Water Availability and Water Consumption in Uzbekistan in the Conditions of Climate Change" and practical trainings provided. It has also been developed training course "Climate change and climate risks management" for students of higher educational institutes. Electronic training course on climate change intended for participants of the international climate negotiations, students and public at large has been developed within the framework of the UNDP Project "Support to Uzbekistan in Transition to Low Carbon Development of National Economy".

Under the WHO/UNDP pilot Project "Adaptation of healthcare system to climate change" it has been developed informative and practical site www.meteomed.uz, presenting booklets and brochures with popular information on topic "Climate change and its impact on environment and population health", prepared and approved training program for general practice doctors "Climate change impact on health conditions of Uzbekistan's population"

The State committee on nature protection in cooperation with the key ministries, agencies and NGOs (in particular, the Ecological movement – public association that has permanent representatives in the Legislative Chamber of Oliy Majlis, and Ecological forum of NGOs of Uzbekistan) play important role in ecological education.

Development in Uzbekistan of ICT technologies and electronic mass media also creates preconditions for population and decision makers' awareness raising, improving access to information and facilitating involvement of population in solution of priority tasks, associated with climate change problems. There are many Internet resources, where up-to-date information is posted (amongst the most frequently accessed resources are: www.econews.uz, www.meteo.uz, www.ekomaktab.uz, and others). Wide population coverage by mobile communication allows to the Ministry of Emergency Situation to warn timely about possible occurrence of dangerous hydro-meteorological phenomena and other risks.

Capacity Building Requirements. Assessments of climate change impact on various sectors of economy and ecosystems of Uzbekistan, carried out in TNC, have indicated existence of the serious adverse impacts, such as:

- enhancement of general aridity of climate that has adverse impact on all ecosystems, increases evaporation rate, deteriorates quality of surface water and increases water losses from irrigated lands;
- reduction in volume of snow/glacial resources in the upper watersheds of Amudarya and Syrdarya rivers, which assume decrease in surface runoff for perspective, especially during vegetation period;
- increase in variation of precipitation amount that entail growth in runoff variations and as a consequence, increase in frequency of dangerous phenomena occurrence (droughts, mudflows, floods, breakthrough of high mountain lakes);
- enhancement of water stress on crops, increase in water demands, land salinity increase and decrease in irrigated lands productivity;
- increase in frequency and severity of droughts that additionally aggravating by practically complete vanishing of the Aral Sea, degradation and danger of extinction of coastal and aquatic ecosystems in delta and low reaches of the Amudarya river;
- additional losses of crop yields due to increase in water deficiency, frequency of high air temperatures, atmospheric droughts, dry hot winds, heavy rains;
- decrease in productivity of cattle breeding due to increase in heat stress on animals and deterioration of fodder base;
- growth in frequency of high air temperatures and "heat waves", which in turn increase risk of cardiovascular, transmissible and infectious diseases;
- growth in duration and tension of hot year period, which lead to increase in energy consumption for ventilation and air conditioning, and load on electric grids;

In aid of adaptation to and mitigation of the abovementioned impacts it will be required, first of all, development and implementation of long-term national plans for adaptation and low carbon development (NAMA, NAPA/NAP) and/or integration of measures and actions on climate change control into on-going and developing national strategies and sectoral development plans, as well as substantial technical and financial assistance from the international funds and donors.

Considerable strengthening of specialists capacity is required for preparation and implementation of efficient and target projects and widening international cooperation with financial institutions supporting the UNFCCC implementation.

There is an obvious need to continue and develop studies for assessment of vulnerability and possibility for adaptation to climate change of ecosystems and economy sectors. This will require collection and analysis of large information volume and therefore improvement of the state statistics system, as well as enhancement of cooperation and interaction with the ministries and agencies concerned.

Requirements for capacity building in area of adaptation also include: improvement of hydro-meteorological monitoring and expansion of snow cover observation network in the upper watersheds of transboundary rivers; refinement of droughts early warning system for separate river basins; development of plans aimed at preparation of population and administration bodies to actions in threat of dangerous hydro-meteorological phenomena.

Climate change affects all sectors of the population. In this regard, urgent is the task of regular education and broad information on the causes and consequences of climate change, measures and activities to prevent its negative consequences, information on energy-saving technologies, policies, measures that reduce GHG emissions, hazardous weather phenomena. There is a need to integrate climate change issues, along with environmental knowledge in educational programs and development plans of the various sectors of the economy on the basis of information platform created by this direction.

NATIONAL CIRCUMSTANCES

1 NATIONAL CIRCUMSTANCES

1.1 Geographic Location and Climate

The Republic of Uzbekistan is located in the central part of Eurasian continent, within the Amudarya and Syrdarya river basins, between 37° and 45°N, and 56° and 73°E, and far away from seas and oceans (Figure 1.1).

Figure 1.1 | *Geographic Location of Uzbekistan*

The total area of the Republic is 448.9 thousand km^2, expanding from north to south by 930km, and from west to east by 1,425 km.

Boundaries. The total length of the Republic's boundaries is 6,224 km. The Republic of Uzbekistan borders on Kyrgyzstan in the north-east and east (with the total border length of 1,099 km), on Kazakhstan in the north and north-west (with the total border length of 2,206 km), on Tajikistan in the south-east (with the total border length of 1,161 km), on Turkmenistan in the south-west (with the total border length of 1,621 km), and on Afghanistan in the south (with the total border length of 137 km).

Relief. The majority of Uzbekistan's territory (78.8%) is plains stretching from the north-west to south-east, which are parts of the Turan depression. The plain area is presented by steppes, Kyzylkum and Karakum desert and the newly formed Aralkum desert.

The south-eastern part (21.2%) of the territory is presented by piedmont and mountaineous areas, attributed to the Tien - Shan and Gissar – Alay mountain systems.[1] Fragments of mountain relief can be seen within plain lands, as well as quite significant flat land areas may be located within the mountainous areas. The mount Khazret Sultan (in the Gissar mountain ridge) with elevation above sea level of 4,643 m is the highest point in Uzbekistan. The lowest point of 12.8 m below sea level is located in the Mingbulak depression in Kyzylkum desert.

Climate. The southern part of Uzbekistan is located in subtropical climatic zone, and the northern one in moderate climatic zone. Climate formation depends on three main factors: general air circulation, inflow of solar radiation (stipulated by geographic location) and orography of terrain. Climate of Uzbekistan is of continental and subtropical type with large seasonal and daily variations in air temperature.

Extended summer season is the one of climate features. Thermal depression is quite often located over Uzbekistan in summer, which consists of front free non-mobile area of low air pressure with distinctive fair dry and hot weather. The vast Karakum and Kyzylkum deserts are sources of intensive air transforming in warm year season. The hottest month generally is July with average mean monthly air temperature ranges from 37ºC in the south (Termez) to 32-33ºC in the north (Ustyurt Plateau). The absolute maximum air temperature reaches 48-50ºC, and 44-46ºC in the southern and northern districts respectively. That of in piedmont areas with elevation up to 800-900m above mean sea level (mamsl) is over 42ºC.

In winter cold air mass from Arctic and Siberia regions accompanied by winds and heavy precipitations penetrates freely to far south of the Central Asia. Along with invasion of arctic air mass temperature continues to decrease sometimes to very low levels. The average temperature for the coldest month of January on Ustyurt Plateau and lower reaches of Amudarya river is -8C, -10ºC, that of in the south is +2, +3ºC. The absolute minimum winter air temperature of -40ºC was observed on the north of Ustyurt Plateau. The absolute minimum winter air temperature in the far south of Uzbekistan is -20ºC. In the Kyzylkum desert, piedmont area and mountains air temperature never drops below -25, -34ºC.

Generally, the territory of Uzbekistan is attributed to the arid zone. Precipitation is mainly brought about by humid air mass. Distribution of precipitation across the territory is extremely uneven and closely associated with terrain elevation, disposition of mountain systems, direction of mountain slopes and other features of orography. As a rule the significant amount of precipitation falls in autumn, winter and spring periods. Minimum precipitation amount (less than 100 mm per year) occurs in the western part of

[1] Geographic Atlas of Uzbekistan, Goskomzemgeosezkadastr, Tashkent - 2012

republic (Ustyurt Plateau, lower reaches of Amudarya river and Kyzylkum desert). Towards south-east and east with approaching to mountains and terrain elevation increase, the precipitation amount is increasing reaching 800-900 mm per year.[2,3]

Analysis of variations of an average annual precipitation amount by various regions of Uzbekistan data from 1950 to 2013, indicates in majority of cases very low trends to its decrease. Only in some mountain regions slight increase in precipitation amount is observed in winter season.

On average by Uzbekistan, from 1950 to 2013, the rate of temperature increase was 0.27°C for every 10 years, which is more than 2 times higher than the global rate. The highest warming rates are observed in the north of republic and in large cities/towns (0.3 – 0.43°C over every 10 years), the lowest ones – in mountain areas (0.10- 0.14°C over every 10 years).

Air temperature increases both during cold and warm seasons of a year. Number of days with frost is being decreased significantly (by 4-5 days on average every 10 years). It is observed increase in number of days with high air temperatures, especially in the south of country and in deserts. For example, if number of days with maximum air temperature above 40°C in the central part of Kyzylkum desert (Tamdy meteorological station) was around 10 in 1950s, then currently it is more than 20 days. Therewith, increase in air temperature variations is observed throughout the territory of republic.

Intensive warming in Uzbekistan aggravates climate aridity. Significant increase in deficiency of air humidity during warm half of a year (28%) is observed in the Aral Sea littoral zone and lower reaches of Amudarya river, due to combined impact of air temperature increase and actual disappearance of the vast Aral Sea water area.[4]

1.2 Natural Resources

Uzbekistan possesses great production capacity, large supply of fossil minerals and raw materials, unique agricultural raw materials and rich natural resources.

Table 1.1 | *Land Fund Categories of Uzbekistan*

Land Fund Categories		Total Land Area	
		thous. ha	%
1.	Agricultural lands	20481.1	46.1
2.	Cities/towns/settlements	214.1	0.5
3.	Industry. transport. communication. defence	914.5	2.1
4.	Nature protection. resorts and recreation	75.9	0.2
5.	Historic and cultural landmarks	6.2	0
6.	Forest fund	9636.9	21.7
7.	Water fund	831.4	1.9
8.	Reserve lands	12250.2	27.6
Total		44410.3	100.0

Source: Inventory of land resources of the Republic of Uzbekistan

The total land area of Uzbekistan is 448,97 thousand km^2. Some 44,410.3 thousand ha are in use by various enterprises, organizations, institutions and population. There are eight main categories in the land fund use pattern. Share of agricultural lands is 46.1%, including 9.5% of irrigated lands (See Table 1.1).

Around 100 types of fossil minerals have been explored on the territory of Uzbekistan. Out of which 60 types are already used in national economy. Among the main types of fossil minerals found out in the republic are natural gas, gold, oil, coal, copper, lead, zinc, silver, wolframite, bismuth, graphite, potassium and mineral salts, talc and cement raw material. By supply of copper, wolframite, silver, lead and zinc Uzbekistan occupies one of the leading places in the world. Deposits of nonferrous metals have a special value due to possibility to extract of ore by open-cut mining, which significantly increases profitability of ore extraction.

Uzbekistan possesses the considerably supply of hydrocarbon fuel, including 211 natural gas fields, deposits of coal, oil and oil condensate.[5] Oil, gas and gas condensate fields are located in the Ustyurt, Bukhara-Khiva, South-western Gissar, Surhkandarya and Fergana regions. Oil and natural gas extraction is carried out on the developed fields: Gasli, Shurtan, Kokdumalak, Surgil, Zevardy, Kandym and others.[2] Production of oil processing products (petrol, diesel fuel, mazut, technical hydrocarbon oils, etc.) is rapidly developing in the country.

Explored reserves of coal is 1.9 billion ton. Coal deposits are located in Tashkent and Surkhandarya provinces.[6] The main supply of coal is concentrated in Angren deposit, with 80% from the total coal extraction in the republic. This is a low-calorie brown coal with high ash content.

[2] Geographic Atlas of Uzbekistan, Goskomzemgeosezkadastr, Tashkent - 2012.
[3] G.N. Leukhina, O.A. Lyapina, T.L. Veremeeva / under the editorship of S.G.Chanysheva, Climate of Uzbekistan, NIGMI, Tashkent -1996 –p,71.
[4] V.E. Chub, T.Yu. Spectorman Climate Trends in Uzbekistan // Climate Change, Reasons, Impacts and Response Measures. Bulletin No. 10, Tashkent, 2016 – p. 5-16.
[5] http://www. uzneftegaz.uz
[6] http://www.review.uz/

Uzbekistan is rich by its reserves of nonferrous metals and by copper reserves first of all. In the current conditions three copper deposits are suitable for development: Kalmakir, Dalneye and Sarycheku, all located in Almalyk district of Tashkent province. Another several perspective copper ore deposits were found in the Kyzylkum desert and Karakalpakstan.[9]

By reserves of gold and its production, Uzbekistan occupies 4-th and 7-th places in the world. The largest center of gold extraction is the Muruntau district. Some gold deposits are located within Tashkent, Djizak and Namangan (Mardjanbulak, Zarmitan and Chadakh) provinces.

The significant supply of uranium ore has been explored in the country. According to IAEA data, Uzbekistan occupies 7-th place in the world by its reserves of uranium[7] Wolframite deposits have been developed for production in the Ingichki (Samarkand province) and Koytasha (Djizak province) districts.

Some small deposits of ferrous metals such as iron, manganese and chrome have been explored in the country. The Dautash, Kyzylbairak and Takhtakarachin deposits of manganese are located in the Kashkadarya province. There are large supplies of kaolin clays, ozocerite, sand, gravel and cladding stones in the republic used in construction of buildings. Some ornamental, semiprecious and precious stone are also available.[9]

1.3 Water Resources

The total water resources of the country comprises the surface runoff of Amudarya and Syrdarya rivers (55%), runoff of small rivers (33%), underground waters (around 10%), and collector/drainage waters (2%).[8] There are more than 17 thousand natural watercourses in Uzbekistan. The major part of these rivers are watercourses less than 10km long. These rivers have intermittent flow throughout a year and in dry years no flow is formed at all.

The Main Transboundary Rivers. The Amudarya and Syrdarya rivers are mainly formed in the neighboring countries of Tajikistan and Kyrgyzstan. The long-term average flow of 38 km^3 and 79 km^3 are formed on the Syrdarya and Amudarya river watersheds respectively. Around 10% and 8% of the Syrdarya and Amudarya rivers flow respectively are formed on the territory of Uzbekistan.[9]

The Amudarya river runoff is regulated by water reservoirs. The complicated irrigation system comprises large number of canals, pumping stations, drains and drainage collectors. Among the large canals are Karakum main canal, Karshi main canal with cascade of 6 pumping stations and Amubukhara main canal.

Runoff of the Syrdarya river is also regulated by the large reservoirs: Kairakkum reservoir in Tajikistan (the designed volume is 3.4 km^3) and Chardara reservoir in Kazakhstan (the designed volume is 5.2 km^3). Besides, there is the largest Toktogul reservoir on the Naryn river, one of the largest tributaries of Syrdarya river with the total and available volumes of 19.5 km^3 and 14 km^3 respectively. From 1993, operational mode of the Toktogul reservoir was changed from irrigation to electric power generation mode. Therefore, the annual distribution of river runoff was changed accordingly with peak of high water in autumn-spring. This entails deficiency of water during vegetation period.[10]

Surface water in mountains is of a high quality with mineralization ranging from 60 to 400 mg/l.[11] Specific pollutants, such as heavy metals, phenol, oil products (natural hydrocarbons), are presented within background limits. On the plain land in the zone of river flow consumption and in the river estuaries water has increased mineralization (from 1,070 to 2,500 mg/l). Water within zone of industrial and urban agglomerations is characterized by increased content of nitrite nitrogen, organic matter and heavy metals.

Figure 1.2 | *Aidar-Arnasay Lakes System*

Lakes and Reservoirs. Lakes in Uzbekistan are of large variety in forms, dimensions and shapes. Lakes have various origin and unevenly distributed throughout the territory of republic. There are in total more than 520 lakes in Uzbekistan. The vast majority of these lakes are small water bodies with the area less than 1 km^2. They represent 95% from the total lakes number.[12]

[7] http://worldofscience.ru/geografija-mira/23-geografija-uzbekistana/583-prirodnye-resursy-uzbekistana.html
[8] State Water Cadastre, Uzhydromet, Tashkent, 2015.
[9] Geographic Atlas of Uzbekistan, Goskomzemgeosezkadastr, Tashkent - 2012.
[10] UNDP. Water – critical resource for Uzbekistan's future. – Tashkent, 2007.
[11] Uzhydromet. Annual data on quality of surface waters. – Tashkent, 2015.
[12] Geographic Atlas of Uzbekistan, Goskomzemgeosezkadastr, Tashkent - 2012.

The mountainous lakes are mainly of tectonic, moraine and rock-dammed origin with small surface ares and water volumes, located within elevation range from 1700 to 4000 mamsl. Large number of mountainous lakes is concentrated in the Pskem river basin. Being located in high mountains these lakes are potential sources of clean fresh and extremely fresh water.

Plain lakes are located within elevation range from 50 to 300 mamsl and presented by the following genetic types: oxbow lakes, backwater lakes, intra-delta lakes and tail water escape lakes. As opposed to the mountainous lakes, the plain ones are subjected to intensive dynamic transformations and more sensitive to climate change impact.

With development of irrigated agriculture and disposal of drainage water beyond irrigated lands, new water bodies are being formed along circumference of irrigated zones, which are classified as separate type - drainage water disposal lakes. Total return water volume from various water consumers and water users ranges within 28-33 km^3/year. Their total volume in the Aral Sea basin already exceeds the volume of all reservoirs. The largest lakes of this type are Sarykamysh, Dengizkul, Sudochye in the Amudarya river basin and Aidar – Arnasay system of lakes in the middle reaches of Syrdarya river. Being located on the way of seasonal waterfowl birds migration drainage water disposal lakes serve as their resting and feeding place. So, Dengizkul and Aidar – Arnasay system of lakes are included in the Ramsar list of protected wetlands.

There are 56 reservoirs operating in the country with the active storage capacity of 14.54 km^3. The largest ones are Charvak, Andijan, Kattakurgan, Tudakul, Tuyamuyun and South-Surkhan reservoirs. By mode of filling the reservoirs are subdivided into impounding reservoirs, created by dam construction in river channel and off-channel reservoirs, which get water through intake channels. Out the total number of reservoirs 27 ones are off-channel types.

Reservoirs of Uzbekistan are carried out seasonal flow regulation, and by type of water use are subdivided into reservoirs operated in irrigation and integrated mode. Reservoirs with integrated operational mode are designed for irrigation, energy generation and fishery.

Underground Waters. Underground water forms a significant part of Uzbekistan's water resources. In mountains underground water comes from rock fractures and karsts, and in plains – from artesian basins (aquifers). Underground waters are fed and formed by filtration channel losses from watercourses, infiltration of irrigation water and precipitation. As of 01 January 2015, the available supplies of fresh and brackish underground waters are proven in the volume of 6.147 km^3/year.[13] On average underground water covers 10% from the total water consumption in the country. It is used as the main source of drinking and municipal water supply, for industry and pasture watering, and partly for land irrigation. Use of underground waters in 2014, is estimated in the volume of 5.319 km^3/year.

Aral Sea. The Aral Sea, located between two Central Asian deserts – Karakum and Kyzylkum, belongs to two republics – Uzbekistan and Kazakhstan.[14,15]

Figure 1.3 | *Aral Sea (western part)*

The Aral Sea drying is one of the most serious anthropogenic environmental crises of XX century. During notionally natural period (before 1960s) the Aral Sea was fourth lake in the world by its size (with open water surface area of 66.1 thousand km^2, and elevation around 53 mamsl), with annual water inflow of around 60 km^3 on average. In 1987, water level of the Aral Sea was dropped down to the critical elevation of 40 mamsl, and it was subdivided into two parts: Small and Large Aral. Further decrease in water level of Large Aral has led in the mid of 1990s to merger of the Komsomol, Vozrojdeniye and Lazarev islands. In 2001, these islands were merged with the southern shore part of sea. After drying of south channel the Large Sea is presented by two depressions stretched in longitudinal directions and connected by narrow channel in the north. As a result water circulation between western and eastern parts of Large Sea was reduced significantly.

Complete disappearance of eastern part of Large Sea was observed on satellite images in autumn of 2009. During last six years water in eastern part is appeared for short time after water releases from Small Sea and passing of large water discharges through Amudarya river channel downstream from the Takhiatash waterworks. Currently only western deep-water part of Large Sea and part of Small Aral on Kazakhstan's territory separated by dam constructed along the Berg channel, were retained.

[13] State Water Cadastre, Uzhydromet, Tashkent, 2015.
[14] Large Aral Sea at the beginning of XXI century. Physics, biology, chemistry. – Moscow.: Science, 2012.
[15] National Communication on Environment Conditions and Use of Natural Resources in the Republic of Uzbekistan (for 2008-2011), Edited by N.M. Umarov, State Committee fo Nature Protectiotion (Goskompriroda), Tashkent, Chinor ENK, 2013. – 260 p.

As of 1.01.2014, sea water volume was reduced from 1,064 km^3 (during notionally natural period at the end of 1961) to 52.1 km^3. Area of water surface has reduced correspondingly from 66,000 to 4,000 km^2, and water mineralization was increased by 14-15 times.[16] Changes in water surface area of Aral Sea for period from 2000 to 2015 are shown in Figure 1.4.

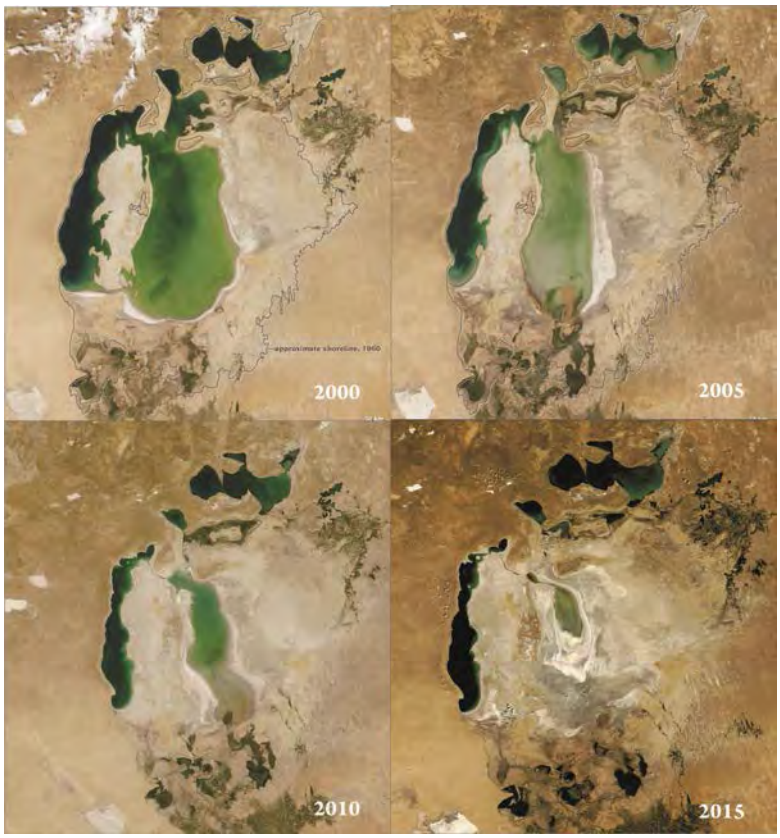


Figure 1.5 | *Change in Area of Water Surface of Aral Sea from 2000 to 2015*

Glaciers. Mountain glaciers in Uzbekistan are located in the upper reaches of Pskem, Kashkadarya and Surkhandarya river basin. Based on the inventory for 2010, there are 613 glaciers within these river basins with the total area of 158.19 km^2. Out of this number, 411 glaciers with the total area of 99.69 km^2 are located within the boundaries of Uzbekistan. The total volume of ice in glaciers is 3.554 km^3, or 3.021 km ^{3} of water equivalent (with ice density of 0.85g/cm^3). The total volume of ice in glaciers located within territory of Uzbekistan equals to 2.106 km^3, or 1.790 km^3 in water equivalent.[17]

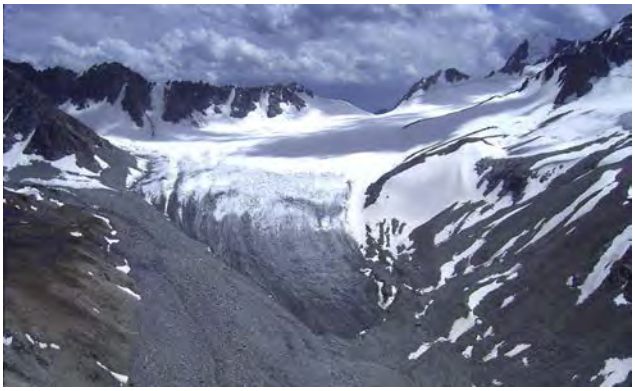


Figure 1.4 | *Kalesnik Glacier*

Decrease in area of glaciers over period from 1957 to 2010, was observed in all three river basins: Pskem, Kashkadaraya and Surkhandarya. Decrease in glaciations area in these river basins was around 50.12 km^2 or 24.1% from the initial glacier area (in 1957). Decrease in glacier area on the territory of Uzbekistan for the same period was 41.63 km^2 or 29,5% from the initial glacier area.

[16] Based on Uzhydromet data as of 01 January 2014.
[17] Report on Grant from State Committee on Science and Technology "Assessment of Current Conditions of Glaciation in Mountains of Uzbekistan", NIGMI, Uzhydromet, Tashkent 2014.

1.4 Social and Economic Conditions

Table 1.2 | *Main Social and Economic Characteristics of the Republic of Uzbekistan*

Categories	Description
Territory	448.9 thousand km^2, 55-th place in the world by land area
Population	- population size as of end of 2014[18] - 30 492 800 people. - average annual increase 1,4% (41-t place in the world by population size) - male population – 49,7% - female population – 50,3% - urban population – 51% - rural population – 49%
Administrative Division	- Autonomous Republic of Karakalpakstan - 1 city of central subordination (Tashkent) - 12 provinces - 174 districts - 119 cities/towns - 1085 urban type settlements
Unit of National Currency	Soun (UDS1 = 2,422.4 Soum as of 30 December 2014)[19]
Gross Domestic Product (GDP)[20]	GDP as of end of 2014 – 144,867.1 billion Soum GDP Production Pattern (2014): - industry – 34,841.3 billion Soum - agriculture – 24,938.3 billion Soum - construction sector – 9,805.4 billion Soum - transport and communications – 16,488.7 billion Soum - trade – 12,480.1 billion Soum - other – 34,111.1 billion Soum - net taxes for products and export – import operations – 12,203 billion Soum
GDP per capita[21]	USD2,036.7 (4,709,700 Soum)[22] (2014)
Industry [23]	Volume of Production 75,194.2 billion Soum (2014)
Leading Industry Sectors[24]	By Industry Sectors (2014): - electric power industry – 5,472.9 billion Soum - fuel industry – 10,023.8 billion Soum - ferrous metallurgy – 2,063.5 billion Soum - nonferrous metallurgy – 6,725.7 billion Soum - chemical and petrochemical industry – 3,970.7 billion Soum - machinery and metal working industry– 14,471.4 billion Soum - timber, woodworking and paper-pulp industry – 1,341.7 billion Soum - construction materials industry – 4,814.8 billion Soum - light industry – 10,570.5 billion Soum - food-processing industry – 11,389.4 billion Soum - other – 4,349.8 billion Soum
Agricultural Production[25]	Volume of Agricultural Production – 41,261.4 billion Soum (2014), *including:* – crop production – 25,152.6 billion Soum – livestock production – 16 108,8 billion Soum

[18] http://stat.uz/demographic/
[19] http://www.nbu.com/exchange_rates
[20] http://stat.uz/ru/141-otkrytye-dannye/989-valovoj-vnutrennij-produkt
[21] http://data.worldbank.org/indicator/NY.GDP.PCAP.CD/countries/UZ?display=default
[22] http://stat.uz/ru/141-otkrytye-dannye/1095-uroven-zhizni-i-sotsialnaya-zashchita-naseleniya
[23] http://stat.uz/ru/141-otkrytye-dannye/996-promyshlennaya-produktsiya
[24] http://stat.uz/ru/141-otkrytye-dannye/996-promyshlennaya-produktsiya
[25] http://stat.uz/ru/141-otkrytye-dannye/995-produktsiya-selskogo-khozyajstva

Table 1.2 Continued

Categories	Description	
Main Sectors of Agriculture	*Growing:* – cotton, – wheat, – vegetables, – fruits, – grapes, – melons.	*Production:* – raw silk, – carakul, – meat, – eggs, – milk.
Fossil Minerals	Total reserves of more that 100 types of mineral raw materials – USD3.5 trillion, including: gold, molybdenum, uranium, copper, natural gas, oil, coal, nonferrous metals and construction materials	
Transport[26]	– length of public railway tracks – 4,201.7 km, – length of public motor roads – 42,654 km, – length of main pipelines – 14,201.3 km. – freight turnover – 85.7 billion ton-km, – passenger turnover – 100.1 billion passenger-km (2014)	
External Trade[27]	– export – USD11,098 million. – import - USD10,179.5 million (over 9 months of 2014) – positive balance in foreign trade turnover – USD918.5 million	
Leading Import Items[28]	Data as of the end of 2014 – machinery and equipment – 39.7%, – chemical production – 16.0%, – services – 7.5%, – nonferrous and ferrous metals – 8.0%,	– energy products and petrochemicals – 6.2%, – food commodities – 10.9%, – other – 11.7%.
Positions in the World Economy	*By explored reserves of:* – gold – on 4-th place, – uranium – on 7-th place, – molybdenum – on 8-th place, *By proven reserves of:* – copper - on 10-th place, – natural gas – on 14-th place, *By extraction of:* – cadmium - on 3-d place, – uranium – on 6-th place, – gold- on 7-th place, – natural gas – on 11-th place, – amongst 15 largest countries in the world by extraction of molybdenum, field spar, etc.	*By production of:* – carakul - on 2-d place, – cotton – on 5-th place, – raw silk – on 6-th place; – in second tens of countries leading in production of sulphuric acid, nitrogen fertilizers, mineral lubricants and paraffine, cotton yarn and textile, tomato paste, dried fruits, production of melons and grapes, wool production, railroad transport freight turnover; *By export of:* – cotton fiber - on 2-d place, – uranium – on 3-d place *By area of irrigated land* - on 11 -th place.

State Structure. The Republic of Uzbekistan is full entity of international law. On 2 March 1992, Uzbekistan became the member of United Nations Organization (UN).

Fundamental law of the Republic of Uzbekistan - Constitution – was adopted on 8 December 1992. According to the Constitution, Uzbekistan is the legal democratic republic headed by the President of the Republic of Uzbekistan. Legislative power is exercised by the supreme state representative body - the Oliy Majlis of the Republic of Uzbekistan, which consists of two chambers – the Legislative Chamber (the lower chamber) and the Senate (the upper chamber).

The system of state administration is based on functional – sectoral and territorial principles, including sectorl ministries, state committees, state inspections, agencies and bodies, as well as local bodies of state authority – khokimiyats (local municipalities) in provinces, cities, towns and districts.[29]

Ministries, state committees, agencies and bodies through their territorial departments deal with issues of social and economic development of their respective territories.

[26] http://stat.uz/ru/90-interaktivnye-uslugi/ekonomika-v-tsifrakh/774-statisticheskaya-informatsiya-o-sostoyanii-transportnykh-kommunikatsij
[27] http://finance.uz/index.php/ru/rum-analitika/789-vneshnyaya-torgovlya-v-uzbekistane-yanvar-sentyabr-2014-goda
[28] http://www.mfer.uz/ru/export/statistics/
[29] https://www.gov.uz/ru/organizations/kind/admin

The Oliy Majlis and President of the Republic of Uzbekistan, elected by the people, have the exclusive right to act on behalf of the people of Uzbekistan. The system of state authority of the Republic of Uzbekistan is based on principle of separation of powers into the legislative, executive and judicial.

The executive power is exercised by the Cabinet of Ministers of the Republic of Uzbekistan, which is the central body of the state administration. The judicial power in the republic belongs to courts.

Administrative and Territorial Structure. The Republic of Uzbekistan consists of 12 provinces, 174 districts, 119 cities and towns and the Republic of Karakalpakstan. The capital of Uzbekistan is Tashkent city with population more than 2.3 million people. The Republic of Karakalpakstan has its own Constitution. Mutual relationships between the Republic of Uzbekistan and the Republic of Karakalpakstan, within the framework of the Constitution of the Republic of Uzbekistan, are regulated by treaties and agreements negotiated by the Republic of Uzbekistan and the Republic of Karakalpakstan.[29]

Population. Population is steadily increasing and as of December 2015, reached 31,575 million people.[30] In 2015, share of urban population in the total population size was 50.8%, and share of rural population was 49.2%. In 2006, these numbers were 64% and 36% respectively.

Legal and institutional framework is formed in the country for ensuring population employment. Issues of population employment are reflected in the Constitution of the Republic of Uzbekistan. The state policy on population employment, ensuring guarantee of rights to work, employment, professional education and advance training, social assistance to unemployed people and interaction between trade unions and governmental management bodies, and employers are identified in the Law of the Republic of Uzbekistan "On population employment" (1998) and "Labor code". The Conventions of International Labor Organization "On employment policy", "On protection of labors rights in enterprises and their possibilities", "On equal fee for men and women for work" and other international agreements and acts in the area of employment and labor have been ratified by Uzbekistan. The Ministry of labor and social security of population is the governmental body responsible for development and implementation of employment policy.

The main tool, identifying scale of working places creation, is the annual Program for creation of working places and ensuring population employment, being approved by the Government and Oliy Majlis of the Republic of Uzbekistan.[31]

The Program is developed by sectors of economy and provinces. It reflects efforts of all public institutions, such as governmental bodies, business, and civil society institutions, thoroughly supports targeted measures for arrangement of working places and increase in level of employment of working population, facilitates employment for around one million of people annually.[32]

In 2015, under this Program more than 980 thousand working places, including over 60% in rural areas, were established. As a result of implemented measures aimed at further improvement of integrated system for arrangement of employment for graduates from professional colleges and higher educational institutes, and on-the-job training for students, 480 thousand graduates from professional colleges and 61.2 thousand graduates from higher educational institutes got their jobs in 2015.[33]

In January-December 2015, number of economically active people in Uzbekistan was 13 million and 767.7 thousand people or 44% from the total population size, and number of employed people, according to the preliminary data from the State Statistics Committee, was 13 million and 58.3 thousand people. Thus, level of employment of economically active population (ratio between number of people employed in economy sectors and number of economically active people) in January-December 2015 was 94.8%.

Increase in the number of employed people in 2015 as compared with 2014 was 1.9%. Considerable growth in employment is observed in transport and communication sectors (by 3.8%), housing and utilities sector and in non-productive types of consumer services (by 3.6%), trade and public catering sector, marketing and procuring goods sector (by 3.5%), in construction sector (by 3.3%). Share people employed by non-governmental sector reached 82.2% versus 81.9% over January-December 2014.

Education. System of education comprises the governmental and non-governmental educational institutions implementing educational programs in accordance with governmental educational standards; scientific - pedagogical institutions carrying out research works required for functioning and developing education system; state administration bodies in education area, as well as their subordinated enterprises, institutions and organizations.

The Republic's system of education is unified and sequential. Education is provided in the following forms: preschool education; general secondary education; secondary specialized professional education; out-of-school education; higher education; postgraduate study; advanced training and staff retraining.

[30] http://stat.uz/demographic/
[31] Center for Economic Studies. Analitical report 2013/05. Employment in Uzbekisatn: challenges and perspectives. – Tashkent, 2013. – 45 p.
[32] People's Democratic Party of Uzbekistan: population employment — optimal way for social security. http://www.mfa.uz/ru/press/elections/2014/12/3165/
[33] On results of social and economic development of the Republic of Uzbekistan in 2015. https://mineconomy.uz/ru/node/1098

As a result of educational system reformation the improved system for enrolment of students in higher educational institutions was introduced in the republic, allowing to select the most knowledgeable applicants.

Over the period from 2001 to 2013, 98-99.8% of school-aged children were covered by the general secondary education.

As a result of transition to the obligatory system of general free of charge 12-year education, coverage of secondary specialized professional education was increased by 68.4% during the period from 2001 to 2013.

As of 2014, there are 144 academic lyceums, 1412 professional colleges, 58 Higher Educational Institutes, 15 regional departments of central Higher Educational Institutes and 7 departments of the foreign leading Higher Educational Institutes.

For strengthening integration of science and production it was established the Institute of mathematics and Center on philosophy under the National University of Uzbekistan, Center on justice under the Tashkent state juridical university, Center on development of software products and hardware-software complexes under the Tashkent University of information technologies, ecological laboratory under the Samarkand state university.

Great attention is paid to training and certification of scientific and pedagogical staff of higher qualification and post-graduate education. The head scientific and methodological center, 10 sectoral and 5 regional centers have been established for retraining and advanced training of pedagogical and managerial personnel of higher educational institutes.

The current problems associated with the state and social construction, economy, culture and technology are being resolved within the framework of scientific and research works. Instead of base financing the grant system for financing of scientific researches was introduced from 2002. This allows ensuring selective approach for choosing projects for financing and improving their efficiency.

In the area of primary and secondary education gender equality is being retained. Some gender distinctions are retained in academic lyceums and higher educational institutions: e.g. in 2013, ratio between girls and boys was 0.94 in schools, 0.74 in academic lyceums and 0.96 in professional colleges.[34]

1.5 Structure of Economy

Accordinf to the international expert assessments Uzbekistan is attributed to the category of countries with rapid-growing economy.[35] The rapid growth of economy is stipulated first of all by application of the own "uzbek" model of economic development. Over short period of time the country managed not only to stop production decline, observed during first years of independence, but to achieve positive dynamics in the main macro-economic processes, ensure annual growth of GDP and industrial production, as well as to stabilize situation on internal consumer's market, achieve grain and energy independence, establish new market infrastructure for agriculture. As a result, during recent years annual index of Uzbekistan's GDP growth was over 8% (see Table 1.3).

In 2014, GDP in Uzbekistan was estimated at the level 144,867.9 billion Soum or 108.1% against previous year. In 2014, value of GDP per capita was 4,709,700 Soum (USD2,036.7).[36]

Structural economic changes can be traced through changes in GDP content by sectors of economy. In 2014 as compared with the previous year, the volumes of industrial production have been increased by 8.3%, agriculture by 6.9%, capital construction works by 10.9%, services by 13.5%, retail commodity turnover by 14.3% (Table 1.3). Share of small business in GDP has been increase up to 51.0%, that of in industrial production - up to 31%. Share of services in GDP structure has been increased up to 54%, communication and ICT services – by 24.5%.[37]

The state budget has been utilized with surplus (0.2% to GDP). Inflation rate turned out to be less than predicted and was at the level of 6.1%. Growth rates of the disbursed investments were equal to 10.9% (USD14.6 billion). Volume of export has been increased by 10.9%. Positive balance of foreign trade turnover in the amount of USD1.3 billion has been achieved.

As the economic priorities up to 2020, it was identified modernization, technical and technological upgrading production of strategically important sectors of industry (fuel-and-power sector and metallurgy on account of developing new raw mineral resources and introducing advanced efficient energy-saving technologies for extraction and processing mineral resources); developing of chemical and light industries, construction materials industry, and others.

[34] Report on Millennium Development Goals for Uzbekistan, 2015. Edited by G. Saidova, Center of Economic Studies, Tashkent - 2015. – 100 p.
[35] http://www.norma.uz/nashi_obzori/uzbekistan_v_reytinge_stran_imeyushchih_samye_bystrorastushchie_ekonomiki
[36] http://stat.uz/ru/141-otkrytye-dannye/1095-uroven-zhizni-i-sotsialnaya-zashchita-naseleniya
[37] http://www.press-service.uz/ru/news/5079/

Table 1.3 | *Dynamisc of Main Macroeconomic Indices of Republic of Uzbekistan*

Indices, billion Soum, %	Years									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
GDP	15923.4	21124.9	28190	38969.8	49375.6	62388.3	78764.2	97929.3	120861.5	144867.9
Industry	3370.9	4597.2	5906.5	9148.2	11651.1	14882.5	18864.1	23456.6	29069.5	34841.3
in % to GDP	21.2	21.8	21.0	23.5	23.6	23.9	24.0	24.0	24.1	24.1
Agriculture	4192.8	5298	6550.2	7673	9200	11226	14018.2	17283.8	21060.8	24938.3
in % to GDP	26.3	25.1	23.2	19.7	18.6	18.0	17.8	17.6	17.4	17.2
Construction works	771.1	1072.4	1666.1	2178.4	3335.7	4033.5	4798.6	6168.6	7816	9805.4
in % to GDP	4.8	5.1	5.9	5.6	6.8	6.5	6.1	6.3	6.5	6.8
Transport and comminication	1676.7	2329.7	3185.6	4866	5721.9	7181.9	9223.7	11624.7	14202.4	16488.7
in % to GDP	10.5	11.0	11.3	12.5	11.6	11.5	11.7	11.9	11.8	11.4
Trade	1400.2	1892.1	2660	3369.7	4381.1	5781.4	7348.6	8618	10631.4	12480.1
in % to GDP	8.8	9.0	9.4	8.6	8.9	9.3	9.3	8.8	8.8	8.6
Others	2821.6	3796.9	5362.5	7879.9	10321.6	13566.1	17699.6	22681.3	28160.2	34111.1
in % to GDP	17.7	18.0	19.0	20.2	20.9	21.7	22.5	23.2	23.3	23.5
Net taxes on productis and export/import operations	1690.1	2138.6	2859.1	3854.6	4764.2	5716.9	6811.4	8096.3	9921.2	12203
in % to GDP	10.6	10.1	10.1	9.9	9.6	9.2	8.6	8.3	8.2	8.4
Investments in fixed capital	3165.2	4041	5903.5	9555.9	12531.9	15338.7	17953.4	22797.3	28694.6	35233.3
in % to GDP	19.9	19.1	20.9	24.5	25.4	24.6	23.1	23.5	24.1	24.3

Source: http://stat.uz/

1.5.1 Agriculture

Agriculture traditionally remains one of the leading sectors of Uzbekistan's economy. In spite of reduction of agriculture's real contribution to GDP from 30% (in 2000) to 17% (in 2014), volume of agricultural production over this period was increased on account of intensive development of other economy sectors. Total value of gross agricultural production produced in 2014, was 41,261.4 billion Soum, out of which 61% is crop production and the rest 39% is livestock production.[38]

3.392 million people are employed in agriculture or 27.2% from the total employment in the republic.[39] Incomes of 14.94 million people living in rural areas (or 49.0% from the total population of the country) to great extent depend on agricultural activities. In the cumulative income of people, share of income from agriculture in various regions equals to 35 - 60%, and in rural areas this index exceeds 70% everywhere in the country.

Agricultural production is concentrated on the land area of 20,469.1 thousand ha (or 54.4% from land fund of the country). Agricultural lands include: i) 11,143.8 thousand ha of pastures and hayfields, ii) 4,035.5 thousand ha of arable lands, iii) 354 thousand ha of tree plantations, and iv) 4,935.8 thousand ha of other plantations.

Mainly land is used for irrigated and rainfed crops husbandry and pastures for cattle breeding.

Pasture-based cattle breeding occupies land area of 11.1 million ha in regions with low natural resources capacity. Out of entire pasture area, 81.3% are located in deserts, 11,8% - in piedmont and semi-desert areas, 5% - in mountains and 1.9% - in high mountains. Productivity of desert pastures with all year round grazing is 0.1-0.27 t/ha of dry matter. Yield of high mountain pastures with spring-summer grazing and low mountain pastures with all year round grazing is higher to some extent and may reach 0.73 t/ha of dry matter.

[38]http://stat.uz/ru/90-interaktivnye-uslugi/ekonomika-v-tsifrakh/771-makroekonomicheskie-pokazateli-respubliki-uzbekistan
[39] Uzbekistan in Numbers, State Statistics Committee, Tashkent -2014.

Pasture-based cattle breeding sector continues to develop rapidly. As of 2013, number of large cattle heads was 9,394.5 thousand, that of small cattle heads was 15,340.9 thousand, out of which 80-90% belong to dekhkan farms. However in some regions exceeding of regulatory burden on pasture leads to pasture overgrazing, degradation of pasture vegetation, initiating development of erosion and desertification processes.

Crop husbandry is concentrated in plain lands and piedmont areas of the republic, which stipulate development of soil formation processes, level of crop husbandry culture, its intensity and difference in quality of agricultural lands. The total irrigated land area is more than 4.3 million ha, which is the main asset of agricultural production. Irrigated arable land occupies 81.4% from the total irrigated land. The main irrigated crops are winter wheat and cotton, covering around 68% from the total irrigated land area. Potato, forage crops, vegetables, melons and other crops are grown on the rest of irrigated land area. Perennial plantations include various fruit trees; apples, pears, cherries, plums, peaches, apricots, grapes, pomegranates, persimmon, figs (see Figure 1.6).

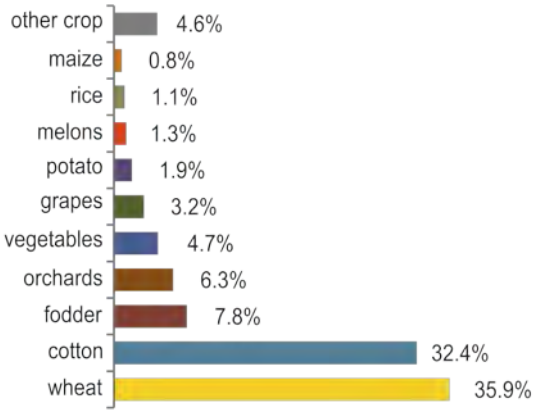


Figure 1.6 | *Cropping Pattern on Irrigated Lands in All Farm Categories in 2013*

Water for land irrigation is supplied by extensive system of canals, dams, reservoirs pumping stations and other waterworks. Currently for irrigation is used around 90% from the total water withdrawal for all sectors of economy. Demand for water will be increasing in order to provide food for rapidly growing population of the republic, and global warming and climate aridization will aggravate disproportion between available water resources and demand for water.

Rainfed agriculture is concentrated in piedmont plains, foothill belts and low mountains of Tien Shan and Pamir-Alay on the area of 753.6 thousand ha (or 18.6% from the total area of arable lands). More than 80% of rainfed lands are located in the zone with insufficient natural moisture supply, with annual precipitation of around 250-350 mm per year. This circumstance stipulates low productivity of these lands and unstable yields of rainfed crops.

National strategy for agriculture development envisages institutional and structural reformations, introduction of new principles in agrarian law, deviation from cotton monoculture and reorientation to diversification of agricultural production, agricultural products processing and self-sufficiency in foodstuffs supply. The main direction of reforms was reorganization of shirkats into private farms, expansion of household plots and dekhkan farms. Currently share of dekhkan farms/household plots and private farms is 52.3% and 46.4% respectively. The rest 1.3% is other agricultural enterprises.[40] Around 13% from the total irrigated arable lands belongs to small dekhkan farms, which produce 64% of gross crop production and 92% of gross livestock production.[41,42] More than half of private farms (37.6 thousand) are specialized on production of cotton and winter wheat, the rest of private farms produce vegetables, melons, grapes, fruits, livestock products and honey (apiculture farms), and other crops.

Ensured grain independence on account of expansion of land area for winter wheat growing and its yields increase became one of the significant achievements of the on-going reforms in agriculture. Currently winter wheat occupies land area of 1,449.6 thousand ha with yield of 4.76 t/ha (on average versus 1.1 t/ha in 1990).[43]

Uzbekistan is one of the leading countries in the world by cotton production, occupying 2nd place in the world's cotton export, and it is among 20 largest wheat producers (see Table 1.4). Uzbekistan is the main producer of fruit and vegetable in the Central Asian region. Over the recent years these sectors of crop production demonstrate stable increase in yields. In 2013, yield of fruits and grapes was 10 t/ha, i.e. increased by 2 t/ha on average versus 2008. Yield of vegetables for the same period was also increased from 24.5 t/ha to 27 t/ha. In 2013, it was produced 8.515 million ton of vegetables, 3.58 million ton of fruits and grapes, 2.25 million ton of potato, 1.56 million ton of melons.[43]

As a result of implementation of strategy for development of cattle breeding, as well as rational use of land resources, trends towards growth in agricultural production at the level of 6.1% (in 2005-2012) and 6.9% (in 2014) are permanently retained in Uzbekistan (Table 1.5).

Achievement of food security is the important social and economic task. Therefore, it is the most vital direction of the governmental policy for retention of its nationhood, sovereignty and national security. In 2015, the Republic of Uzbekistan (one of 14 world countries) received award for achievement of the Millennium Development Goals in the area of food security.

[40] Statistics Year Book: Agriculture of Uzbekistan, State Statistics Committee, Tashkent -2014.
[41] Center for Economic Studies. Uzbekistan towards 2030: Transition to resources efficient development model. Tashkent, 2015.-16p.
[42] Information and Analytical Bulletin for 2013. Economy of Uzbekistan. Center for Economic Studies. Tashkent, 2014.- 87p.
[43] Statistics Year Book: Agriculture of Uzbekistan, State Statistics Committee, Tashkent -2014.

Nevertheless, there are a number of problems in agriculture, associated, first of all, with growing deficiency of land and water resources, irrational use of irrigation water, secondary soil salinization and high anthropogenic pressure on environment.

Table 1.4 | *Agricultural Production for Period 1991-2013, thous. ton*

Product type	1991	2000	2005	2010	2011	2012	2013	2013 (in % to 1991)
Raw cotton	5057.7	3002.4	3778.4	3404	3501	3460.1	3400.2	67.2
Grain	1908.2	4101.4	6541	7504.3	7140.7	7515.2	7804.8	409.0
Vegetables and potato	4249.9	3002.2	4104.1	8039.3	8856.6	9822.6	10766	253.3
Melons	355.7	730.7	916.8	1182.4	1294.7	1418.4	1558	438.0
Fruits	516.5	790.9	949.3	1710.4	1871.1	2052.6	2260.9	437.7
Grapes	480.5	624.2	641.6	987.4	1090.2	1204.6	1322.1	275.2
Meat	800.2	841.8	1061.2	1460.7	1564.2	1672.9	1787.5	223.4
Milk	3322	3632.5	4554.9	6168.6	6766.2	7310.9	7884.7	237.3
Eggs	2347	1254.4	1966.7	3058.4	3441.7	3873.7	4379.1	186.6

Source: UNDP. Food security in Uzbekistan. – Tashkent, 2010
Economy of Uzbekistan. Information and analytical bulletin for 2013 – Tashkent, 2014

Table 1.5 | *Dynamics of GDP Growth and Share of Agricultural Production*

Indices	2000	2005	2010	2012	2013	2014
Growth in gross dpmestic agricultural product (in % to previous year)	103.2	105.4	106.8	107.0	107.4	106.9
Share of agriculture in GDP, %	30.4	26.3	18.0	17.6	17.4	17.2
Share of population imployed in agriculture,%	34.1	29.4	25.2	27.2	27.2	31.1

Source: data from the State Statistics Committee

1.5.2 Energy

Figure 1.7 | *Slate oil field Sangruntau*

Favorable climate conditions, a lot of mineral resources, developed agriculture and high labor potential have served as a basis for establishment of diversified national economy with priority development not only agriculture, but also powerful industry. Energy independence, as one of the first achievements of young Republic of Uzbekistan, allowed to the country to be among the ones with rapidly growing economy during rather short period of time.

Heart of Uzbekistan's economy is fuel and energy complex (FEC), comprising electric-power industry, thermal power industry, oil and gas and coal sectors. As one of the strategic economy part, FEC is under special control by the Government. According to the World Bank estimation, in 2012, energy consumption of Gross Domestic Product (GDP) was 0.34 t.o.e./$1000, which is by 2.5 less than 0.85 t.o.e./$1000 in 1995.[44] At the same time, in spite of constantly strengthening policy for energy saving and efficient use, energy consumption in Uzbekistan, as in other gas and oil producing countries, still remains quite high. I.e. with use of 1 ton of oil equivalent (t.o.e.) the republic produces smaller volume of commodity and services as compared with many other countries.

[44] http://data.worldbank.org/data-catalog/world-development-indicators

Oil and Gas Sector. Uzbekistan possesses huge supply of hydrocarbon raw materials. This economy sector is represented by the National Holding Company (NHC) "Uzbekneftegaz". It comprises 6 main joint stock companies: JSC "Uzgeoburneftegaz" (dealing with oil and gas extraction), JSC "Uztransgas" (gas transportation), "Uznefteproduct" (processing), "Uzneftegasmash" (manufacturing technological equipment for the sector), Shurtan gas-chemical processing plant (production of polyethylene, liquefied gas, sulphur, marketable gas).[45]

Out of 211 explored hydrocarbon material deposits, 108 ones are gas and gas condensate fields, 103 – oil and gas fields.[45]

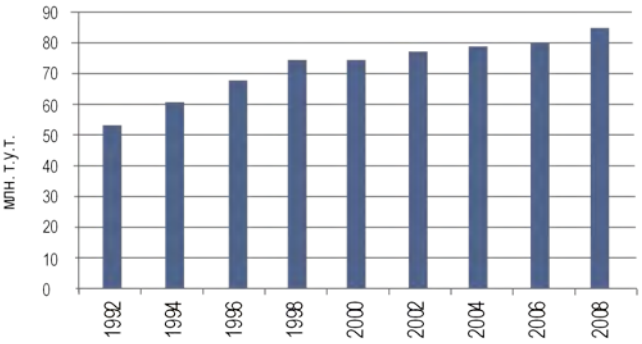
In 2014, by natural gas production Uzbekistan occupied 11th place in the world.[46] Currently over 60% of polyethylene produced by the Shurtan gas-chemical processing plant is exported to European countries (Poland, Hungary, Lithuania, Latvia, Turkey), Asian countries (Iran, Pakistan, China), CIS (Ukraine, Russia, Azerbaijan, Kazakhstan), and other countries.

Stable legislative support to the sector has been provided by adoption of laws "On mineral wealth", "On agreements for production sharing", Decree of the President "On measures for attraction of direct foreign investments in exploration and extraction of oil and gas" and a number of other documents supporting this sector.

In 2015-2019, the NHC "Uzbekneftegas" plans to implement 54 investment projects.[47] Amongst the most significant are investment projects being implemented jointly with the foreign companies: Lukoil (Russia), CNODC (People's Republic of China), Petrovietnam (Vietnam), KNOC (Korea), SASOL (Republic of South Africa), Consortium of companies on Aral project and others. According to the Government decisions[48] foreign companies involved in oil and gas exploration have preferences. In particular, they exempt from: all types of taxes for period of geological geological exploration; customs duties on import of equipment, material and technical resources and services, required for explorations and other associated works, etc.

Important priority activities of oil and gas extraction enterprises are expedited commissioning of the explored oil and gas fields, extraction of unconventional and hard to recover reserves, which require intensive studies of deposits features, selection of optimal technology for revelation of producing horizons and intensification of hydrocarbons influx.

In Uzbekistan the annual hydrocarbon materials extraction volume is around 86 million of reference fuel. Since 1991, level of its extraction was increased by more than 60%. Share of oil and gas extraction in the country is 96% from the total primary energy resources consumed by economy of Uzbekistan. Dynamics in hydrocarbon materials extraction volume are illustrated in Figure 1.8.[45]



Source: official site of NHC "Uzbekneftegas", www.ung.uz

Figure 1.8 | *Dynamics in hydrocarbon materials extraction volume for Period 1991-2008*

The advanced processing of hydrocarbon materials is a priority for sector development. Jointly with Consortium of Korean companies it is being implemented the Project on construction of the largest in Central Asia gas-chemical processing plant on a basis of Surgil oil/gas field on the Ustyurt Plateau. The designed capacity of this plant will allow to process 4 billion m^3 of natural gas per year with production of 362 thousand ton of polyethylene and 83 thousand ton of polypropylene.

Natural gas is transported by the main and commercial gas pipelines with the total length more 13.6 thousand km. In accordance with the Decree of the President of the Republic of Uzbekistan[49], the unified technological system of transportation and sale of natural gas has been developed in the country. Transportation of natural gas is managed by administrations of the main gas pipelines and underground gas storage stations. Gas is transportred in the north, south and east directions, ensuring the supply of natural gas to consumers in the Republic of Uzbekistan, for the export and transit. Continuous operation of gas pipelines system is ensured by 25 gas compressor stations, and stability of gas supply – three underground gas storages (Gasli, Khodjiabad and North-Sokh).

[45] http://www. uzneftegaz.uz
[46] http://www.uzneftegaz.uz/ru/business/indicators
[47] http://news.uzreport.uz/news_4_r_141862.html
[48] Decrees of the President of RUz No.UP-2598, dated 28 April 2000 "On Measures for Attraction of Direct Foreign Investments in Exploration and Extraction of Oil and Gas"; No PP-1449, dated 24 December 2010 "On Prediction of Main Macroeconomic Indices and Parameters of the State Budget for 2011"; No. UP-3594, dated 11 April 2005 "On Additional Measures for Incentives in Attraction of Direct Private Foreign Investments; Decree of CM of RUz No. PKM-249, dated 06 December 2007 "On Order for Application of Customs Privileges to Goods Imported by Foreign Investors in Uzbekistan for Own Productional Needs"
[49] Decree of the President ofRUz No PP-438, dated 08 August "On Measures for Improving Activities of JSC "Uztransgas"// Law Book RUz, 2006, No31-32 (312)

Gas distribution system of the JSC "Uztransgas" comprises more than 127.7 thousand km of gas distribution grids and 96.3 thousand of gas distribution stations of high and medium pressure.[50]

As a result of investments increase in this sector, from 1991 length of the main gas pipelines was increased by 1.4 times and length of gas distribution grids by 3 times. Level of gasification was increased by 2 times, from 44.1% to 85.3%. As of today, level of gasification of urban and rural areas is 89% and 80% respectively[51], improving population living standards and facilitation economic growth of the country.

According to assessments of the national expert, in 2013 gas losses from main pipelines and distribution networks due to deteriorated equipment were around 2-2.5%. For solution of these problems, the JSC "Uzbekneftegas" envisages as the main priorities for 2011-2020 construction and reconstraction gas compressor stations, rational use of fuel and energy resources on compressor stations on account of implementing Clean Developmen Mechanism Project of Kyoto protocol.

With oil and gas extraction the highest losses occur due to combustion of accompanying gases. So according to the World Bank data in 2011, 2 billion m^3 of natural gas were flared torches.[52]

Clearing of gas from hydrogen disulfide (with getting commercial sulphur and other products) is carried out on the Mubarek gas processing plant (MGPP) with capacity of around 24 billion m^3/year), on head structures of the Shurtan gas field and Shurtan gas-chemical processing plant (around 20 billion m^3/year). The Shurtan gas-chemical processing plant produces ethane (used for production of polymer material) and propane-butane (for production of liquefied gas and condensate).[53]

There are three oil processing plants (OPP) in Uzbekistan, which produce practically all assortment of products existing in oil processing, for use in various sectors of national economy. The Fergana OPP (fuel and lubricants production), Altyaryk OPP (fuel production) and Bukhara OPP produce high quality motor petrol, diesel fuel and aviation kerosene. The majority of produced petrochemicals assortment, including rare lubricants comply with world standards. The total capacity of operating OPP is 11.1 mln. t/year for processing of oil and gas condensate.

The Governmental policy in oil and gas sector is aimed at increase in efficiency of oil and gas resources use, diversification of sector production, and increase in added value of products. Conditions of the sector's raw-material base require both enhancement of exploration activities and more rational use of already explored reserves of hydrocarbons. Therefore, the government creates conditions of the most-favored-nation treatment for attraction of the direct foreign investments in oil and gas sector. These conditions are fixed by legislative acts and are the basis for contractual relations and carrying out concessional activities on territory of the republic.[54]

According to the Conception of Uzbekistan's oil and gas sector development for 2013-2020, natural gas reserves and liquid hydrocarbon reserves will be increased by 2020 to 488.5 billion m^3 and to 41.7 million ton respectively.[55]

Coal industry. Extraction and supply of coal in Uzbekistan are carried out by the JSC "Uzbekugol", JSC "Shargunkumir" and JSC "Apartak". The main consumer of coal is electric energy sector with share of more than 85% from the total coal consumption. Demand for solid fuel is also formed by industrial enterprises, social and municipal sectors, as well as population.

Over the recent years it is observed increase in coal extraction from 2.6 mln. t in 2000, to 4.1 mln. t in 2013. In 2014, coal extraction was 4.4 mln. ton.[56] In 2013, the Government of the Republic of Uzbekistan has approved the Program for modernization, technical and technological re-equipping enterprises of coal sector and its balanced development for the period 2013-2018.[57]

Electric Energy Sector. The JSC "Uzbekenergo" is the main generator and supplier of electric energy in Uzbekistan. Small share of electric energy is generated by a number of medium and small size hydropower stations, which belong to the SO "Uzsuvenergo" (MAWR), as well as by small number of customer's plants on industrial enterprises.

The Joint Stock Company comprises 39 electric power stations with total installed capacity of around 12.5 million kW, including 10 thermal electric power stations / plants with capacity of 11.0 million kW and 29 hydropower stations with the installed capacity of 1.4 million kW.

[50] http://old.uztransgaz.uz/ru/content/osnovnye-pokazateli
[51] www.uztransgaz.uz/
[52] World Bank Report, Study of Energy and Electric Energy Sectors of Uzbekistan, Tashkent, 2012.
[53] http://www.uzneftegaz.uz/ru/business/indicators
[54] http://www.uzinfoinvest.uz/rus/investiionnie_vozmojnosti/otrasli/neftegazoviy_sektor
[55] http://uzdaily.uz/articles-id-20321.htm
[56] http://www.publika.uz/uzbekistan/economy
[57] Decree of the Cabinet of Ministers of the Republic of Uzbekistan No PKM-161, dated 06 June 2013 "On Approval of Program for Modernization, Technical and Technological Re-equiping of Coal Mining Industry Enterprises and its Balanced Development for 2013-2018" // Law Book RUz, 2013, No 23, p. 307

In all there are 36 hydro-electric power stations (HEPS) in Uzbekistan with the total installed capacity of 1.83 GW and the long-term average power generation of around 6.8 billion KWh.[58] 29 hydro-electric power stations (HEPS) belong to the JSC "Uzbekenergo" and 7 hydro-electric power stations (HEPS) are managed by the Specialized Association "Uzsuvenergo".

Parameters of 10 largest thermal electric power stations/plants (TEPS/TEPP) are presented in Table 1.6.

More than half from the total volume of organic fuel, combusted in TEPS, TEPP and boiler plants, is used for electric power generation.

There is a stable growth in electric power generation over the recent 10 years in Uzbekistan. In 2014, the thermal electric power stations generated 49.3 billion KWh, and hydro-electric power stations – 6.1 billion KWh of electric energy.

Table 1.6 | *Characteristics of Large TEPS and TEPP of Uzbekistan*

Name	Technology	Fuel	Capacity MW
Syrdarya TEPS (1972.)	●	▲▲	3000
Tashkent TEPS (1963)	●●	▲▲	1860
Nove-Angren TEPS (1985)	●	▲▲	2100
Navoi TEPS (1961 and 2013)	●●	▲▲	1250 + 478
Talimaardjan TEPS (2004)	●●	▲	800
Takhiatash TEPS (1961)	●	▲	730
Angren TEPS (1957)	●●	▲▲▲	484
Mubarek TEPP (1985)	●●	▲	60
Tashkent TEPP (1939 and 2014.)	●●	▲	30 + 27
Fergana TEPP (1956)	●●	▲▲	305

Source: JSC "Uzbekenergo", 2014

● - electric power generation, ● – heat generation,
▲ - natural gas, ▲ - underground gas,
▲ - mazut (backup fuel), ▲ - coal

Modernization of electric energy sector is one of the priority directions in the Government policy of the Republic of Uzbekistan. Over the recent 10 years new energy generating blocks were commissioned in three electric power stations: Talimardjan TEPS (800MW), Navoi TEPS (478MW) and Tashkent TEPP (27MW). 2 Two energy generating blocks were partially modernized in the Syrdarya TEPS.

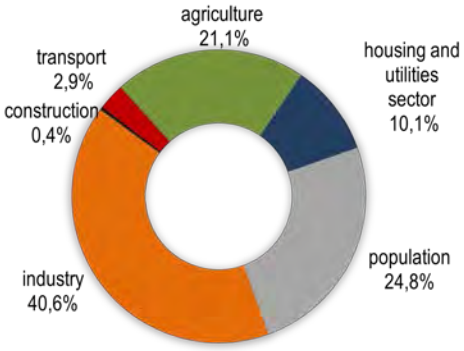
Within the framework of Program for development of small scale hydropower 4 small scale hydro-electric power stations (HEPS) were commissioning: Andijan-2, Akhangaran (in 2010), Gissarak (in 2011) and Ertashsay (in 2013) [59]. The Decree No. 331 of the Cabinet of Ministries of the Republic of Uzbekistan "On program for development of hydropower for 2016-2020" [60] was adopted in November 2015.

Practically all settlements of Uzbekistan have centralized electric power supply, apart from remote and difficult to access kishlaks and cattle breeding farms. Transportation and distribution of electric energy is carried out through 0.4 to 500 KW electric power supply lines with the total length of over 258.6 thousand km.

However, according to estimation of the World Bank experts annual electric energy transportation losses is 20%.[61] Currently the government pays special attention to improvements in efficiency, stability and reliability of electric power supply systems operation, and attraction of investments for this purpose.

Over the recent years three new 500KW electric power supply lines with sub-stations were constructed and commissioning.

Based on JSC "Uzbekenergo" data, the main consumer of electric energy in the republic are industry, population and agriculture (See Figure 1.9). Industrial enterprises consume around 41% electric energy. Share of electric energy consumed by population (24.8%) from the total electric energy consumption is increasing from year to year, which is associated with both population growth and improvement of living standards. Agriculture, transport, construction and municipal sectors consume 21.1%, 2.9%, 0.4% and 10.4% respectively.



Source: JSC "Uzbekenergo", 2014

Figure 1.9 | *Share of Various Types of Electric Energy Consumers in Uzbekistan in 2014*

[58] UNDP/Ministry of Economy Report "Towards Sustainable Energy: Strategy for Low Carbon Development of Uzbekistan", Tashkent, 2015.
[59] The Program was adopted by Decree of CM No PKM-476, dated 28 December 1995, for efficient use of hydropower capacity of rivers, water courses and constructed waterworks, improvement of electric energy supply in rural areas. Implementation of Program was entrusted to the Ministry of Agriculture and Water Resources. Executive Agency is SA "Uzsuvenergo"
[60] Decree of the Cabinet of Ministers of the Republic of Uzbekistan No PKM-331, dated 16 November 2015" On Program for Development of Hydropower Industry for 2016-2020" // Law Book RUz, 2015, No 46 (585)
[61] Ministry of Economy/World Bank," Guidance on Strategic Development of Energy Efficiency in Industry of Uzbekistan" – Tashkent, 2013.

Renewable Energy Sector. Uzbekistan possesses huge potential of renewable energy sources (RES) that is estimated in the volume of approximately 51 billion t.o.e. (See Table 1.7). As of now only 0.6 million t.o.e. (or 0.3%) is used from its technical potential (179 million t.o.e.).[62]

Around 97% from the total RES potential is *solar energy*. The most perspective territories to develop solar power are the Republic of Karakalpakstan and Navoi province.

According to assessments of the Center for Economic Studies, by 2030, total estimated potential of installed capacity of solar electric power stations in Uzbekistan may be not less than 8,000 MW.[62]

Table 1.7 | *Potential of Renewable Energy Sources (RES) in Uzbekistan (million t.o.e.)*

Type of RES	Total	Technical Potential	Used
Hydropower, Total	9.2	2.3	0.8
incl. large rivers	8.0	1.8	0.6
small rivers	1.2	0.5	0.2
Solar energy	50 973.0	176.8	insignificant
Wind energy	2.2	0.4	insignificant
Biomass		0.5	insignificant

Source: UNDP, Final Report "Outlook for Development of Renewable Energy Generation in Uzbekistan", Tashkent, 2007

In 2014, in Samarkand province it was commenced construction of the first solar electric power station with capacity of 100 MW and annual power generation of up to 200 million KWh. In accordance with the Decree No.UP-4707, dated 4 March 2015, of the President of the Republic of Uzbekistan "On Program of Measures for Ensuring Structural Reformation, Modernization and Diversification of Production for 2015-2019" it is planned to construct another 2 solar electric power stations with capacity of 200 MW in Namangan and Surkhandarya provinces

Implementation of a number of pilot projects for use of photovoltaic power plants (PPP) for independent electric power supply to remote settlements indicated their prospectivity for conditions of Uzbekistan. [63] Such power plants may also be used for electricity supply to remote telecommunication facilities, road control signals.

Figure 1.10 | *Installation of 750KW Wind-driven Power Plant in Tashkent Province*

The total potential of *wind energy* in republic is estimated in the volume of 2.22 million t.o.e./year, the technical one is 0.43 million t.o.e./year.[64] Owing to geographical location of the republic spatial distribution of wind energy potential is uneven. The highest values of both total and technical potential (92 and 0.19 million t.o.e. respectively) are observed in Karakalpakstan, the lowest ones are recorded in the Fergana valley (0.04 and 0.02 million t.o.e. respectively).

In 2015, within the framework of technical assistance component of the World Bank Project "Construction of 500KW high voltage line from Talimarjan thermal electric power station to Sogdiana transformer sub-station with 500KW outdoor switchgear", the Wind Atlas – interactive information and analytical system of wind energy potential (WEP) of Uzbekistan was developed and wind energy resources assessed. According to the analysis conducted, the wind resources equal to more than 520,000MW of installed capacity and over one billion of megawatt-hour of electric power generation per year.[65]

To identify possibilities for installation of the advanced wind-driven powerplants (WDPPs) at particular location it is necessary to conduct more detailed studies of wind speeds at various elevations.

The total *hydropower potential* of Uzbekistan, comprising 656 rivers with their tributaries with the total watershed area of 83,369 km^2, is estimated in 88.5 billion KWh, and the technical one equals to 21,09 billion KWh[66]. Currently only 6.27 billion KWh from the technical potential is being used.

[62] Center for Economic Studies, Analytical Report: Alternative Energy Sources: possibilities for use in Uzbekistan" - Tashkent ,2011
[63] UNDP Project "Clean Energy for Rural Communities of Karakalpakstan", Tashkent - 2006, www.undp.uz
[64] Identified on the basis of long-term meteorological data (more than 10 years) from 88 meteostations of Uzbekistan
[65] http://uzbekenergo.uz/ru/press_center
[66] JSC "Uzbekenergo", "Conception and direction for development of renewable energy sources for generation of electric and thermal power in Uzbekistan for long-term perspective" – Tashkent, 2011

Around 13% from the total hydropower potential of republic fall to the share of small rivers. The Tashkent, Surkhandarya, Namangan and Fergana provinces have the highest hydropower potential. However level of its utilization is extremely low. Waterworks, such as reservoirs and main canals, have certain hydropower potential. According to expert assessments of JSC "Uzbekenergo" and SA "Uzsuvenergo", by 2050 the total estimated potential of installed capacity of hydro-electric power stations (HEPS) in the above four provinces will be not less than 2091 MW, which will allow to generate additionally not less than 6.5 billion KWh of electric energy per year.[67]

Biomass, industrial and domestic waste, animal waste can be used as an additional energy source in Uzbekistan. Among the main sources of biomass in the republic is cotton stalks (See Table 1.8). The total energy potential of this type of biomass is estimated in 1.1-2.2 mln. t.o.e./year, and technical potential (with use of thermo-chemical biomass conversion technology) equals to 0.13 - 0.26 mln. t.o.e./year.

Table 1.8 | *Potential of Main Types of Biomasses in Uzbekistan*

Source of Biomass	Area, Quantity	Potential Annual Reserves
Reed	800 - 1000 thousand ha	12 - 15 mln.t.
Cotton stalks	1,342.5 thousand ha	2 - 3 mln.t.
Cattle breeding wastes	>10 mln. large cattle heads	100 mln. m^3
Solid domestic wastes	Sites for collection of solid domestic wastes in large cities/towns	30 mln. m^3

Source: Conception and direction for development of renewable energy sources for generation of electric and thermal power in Uzbekistan for long-term perspective. JSC "Uzbekenergo", 2011

Annual volume of solid domestic wastes in Uzbekistan is more than 30 mln. m^3. As a rule these wastes are disposed without preliminary processing. There are more than 10 million heads of large cattle in the republic that gives over 100 million m^3 of organic wastes.

As a result of processing biomass and other organic wastes biogas is generated. According to the preliminary estimation potential of biomass in the republic is around 8.9 billion m^3, which correspond to 6.5 billion m^3 of natural gas.[68]

According to data from the Ministry of Economy, number of biogas power plants (BPP) was increased from 16 in 2011 to 42 biogas power plants in 2015.[69]

Heat Supply. Secured provision of ecomomy and population with thermal energy is the important factor of economic and social policy of the state. All large cities/towns have the centralized heat supply systems with large and local boiler plants.

Over 72% of thermal energy is generated on water-heating and steam boiler plants (Figure 1.11). In addition thermal energy is generated on thermal electric power stations/plants of JSC "Uzbekenergo".[70]

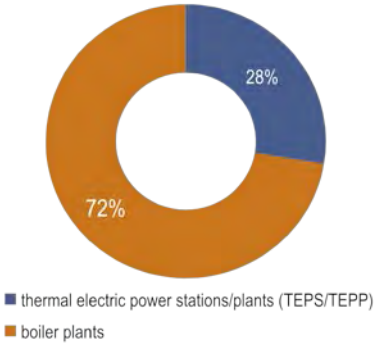


Figure 1.11 | *Pattern of Thermal Energy Generation*

Provision of heat to consumers depends on particular year conditions varying from 71% to 75%. Population consumes more than half of thermal energy, public and administrative buildings – around 14% (See Table 1.9).

Share of industrial enterprises is approximately 35% of the generated thermal energy.

Around 40-42% from the total volume of organic fuel is used for generation of thermal energy. The main fuel for thermal electric power-plants and boiler plants is natural gas (See Figure 1.12).

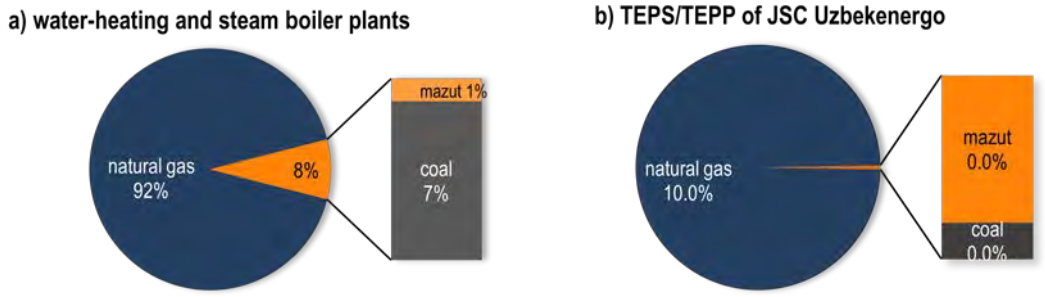
The total length of heat supply network is estimated in 4,965 km, out of which around 70% is underground heat supply network. More than 50% of heat pipelines operates from 10 to 20 years.

[67] UNDP/Ministry of economy Report "Towards Sustainable Energy: Strategy for Low Carbon Development of Uzbekistan", Tashkent, 2015, URL: www.uz.undp.org
[68] UNDP. Road Map for Development of Market for Biogas Technologies in Uzbekistan. – Tashkent, 2012.
[69] UzDaily.uz 28.11.2015
[70] UNDP Report "Energy Efficiency in Buildings: Hidden Resource for Sustainable Development of Uzbekistan, Tashkent – 2014.

Table 1.9 | *Generation and Consumption of Thermal Energy for Period 2008-2013*

Indices	2008	2009	2010	2013
Generation of Thermal Energy, million Gcal [71]				
- thermal electric power stations/plants (TEPS/TEPP)	9.169	8.174	7.682	8.173
- boiler plants	23.574	22.843	22.713	21.400
Consumption of Thermal Energy, million Gcal [72]				
- population (residential buildings)	11.985	11.856	11.804	10.801
- industrial enterprises	8.225	7.752	7.264	7.345
- public and administrative buildings	3.290	3.192	2.951	2.954
Thermal Capacity of Thermal Energy Sources, thousand Gcal/h [73]				
- thermal electric power stations/plants (TEPS/TEPP)	4.479	4.479	4.479	4.479
- boiler plants	19.702	19.223	19.259	19.290

Source: UNDP/Ministry of Economy Report "Towards Sustainable Energy: Strategy for Low Carbon Development of Uzbekistan", Tashkent, 2015.



Source: http://www.iea.org/statistics/statisticssearch/report/?country=UZBEKISTAN&product=balances&year=2013

Figure 1.12 | *Pattern of Fuel Consumption by TEPS.TEPP and Boiler Plants for Heat Genearation in 2013*

Buildings. Almost half of all primary energy of the republic is used every year for electric and thermal supply to various buildings.[74] Meanwhile, specific energy consumption in buildings exceeds significantly similar indices in the developed countries.

In 2012, the total floor area of building in the country was 560 million m^2, of which *residential buildings* was 450 million m^2, including 58.3 million m^2 of apartment blocks and 392 million m^2 of individual private houses.[75] About 67% from the total residential buildings were commissioning before 1990, when construction norms and rules did not include special requirements for energy efficiency of buildings (See Table 1.10).

Table 1.10 | *Residential Buildings of Uzbekistan*

Type	Years	mln. m^2
Total living floor area	2012	450.0
Total living floor area	before 1990	299.5
New construction – apartment blocks	1990-2010	48.5
New construction–houses in rural area	1990-2010	119.2

Source: Data from the State Statistics Committee of the Republic of Uzbekistan

By 2012, availability of living floor area for population was increased up to 15.2 m^{2}per person.[76] In the total volume of residential buildings share of private houses was increased from 97% to 99%, and only 24% residential building was constructed in urban area.

By assessments of Center for Economic Studies, by 2030, the total floor area of residential, public and social buildings may be 764 million m^2 (Figure 1.13).

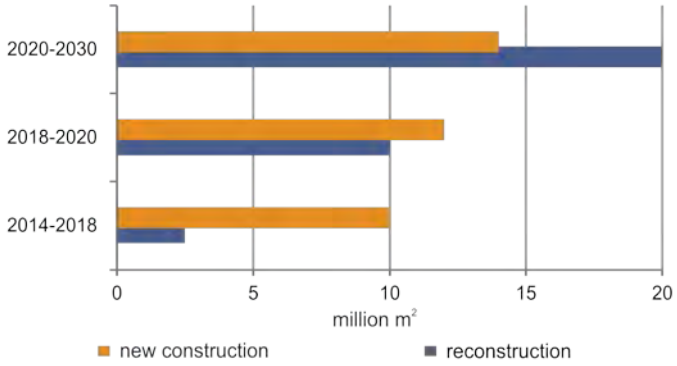
According to other predictions, by 2050, the total living floor area will be increased up to 949-987 million m^2, and living floor area availability – up to approximately 26 m^2 per person.[74] Share of constructed and commissioning apartment blocks will be 2%.

[71] Term "Generation of Thermal Energy" implies release of thermal energy to distribution network
[72] Term "Consumption of Thermal Energy" implies useful provision (sale) of thermal energy
[73] Heat capacity of regulated withdrawal from turbines and peak water-heating boiler plants was taken into account tor thermal electric power stations/plants (TEPS/TEPP)
[74] UNDP Report "Energy Efficiency in Buildings: Hidden Resource for Sustainable Development of Uzbekistan, Tashkent – 2014.
[75] Statistics Yearbook "Residential Sector of Uzbekistan in 2012". State Statistics Committee of the Republic of Uzbekistan, Tashkent, 2012.
[76] Strategy for Increasing Population Living Standards in the Republic of Uzbekistan for 2013-2015, Tashkent - 2013.

Over the recent 15 years rates of residential buildings construction in rural areas were significantly higher than urban ones (See Figure 1.14). In 2009, it was adopted the Program for Construction of Private Residential Buildings in Rural Areas for 2009-2015. During these 5 years more than 33,5 thousand houses were constructed in rural areas of various provinces. Along with houses construction it was commissioning 1,677km of water pipelines, 1,039km of electric grids, 1,346 gas pipelines and 981km of motor roads, as well as over thousand objects of social and market infrastructure.[77]

Starting from 2003, energy consumption pattern in residential housing sector has stabilized, and some variations are mainly associated with weather conditions. Natural gas, used for heating, hot water supply and food cooking has dominated (84%) in energy consumption pattern. It is worth to mention that around 83.5% of the country's population has accesses to gas distribution network.

About 70 % of energy, consumed in residential buildings, is used for heating. In 2012, around 11.2 mln. t.o.e. was used for heating residential buildings. Majority of boiler plants work on natural gas. Coal is used as additional fuel. Approximately 20% of energy is used for hot water supply in houses with centralized heating systems.



Source: Analytical Review "Improvement in Energy Efficiency of Buildings in Uzbekistan: direction of reforms and expected effects", UNDP/CES, Tashkent, 2014

Figure 1.13 | *Outlook for New Construction of Buildings and Reconstruction of Old Ones*

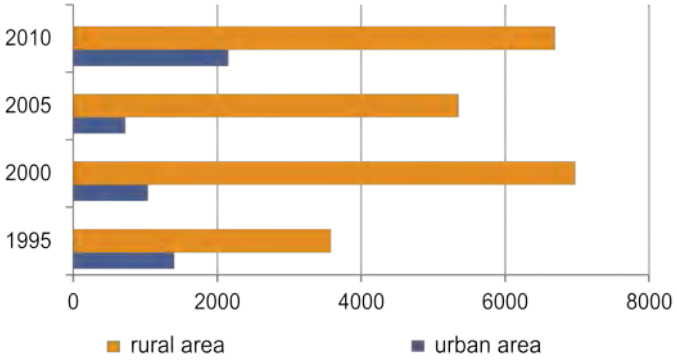


Figure 1.14 | *Total Living Floor Area (m^2), Constructed in Uzbekistan in 1995-2010*

Over the recent years Uzbekistan undertakes some measures aimed at improvement of energy efficiency in building sector:

- efficient systems for energy consumption management are being installed in all social buildings;
- equipping of gas and water consumers with metering devices was improved significantly;
- pursuant to the Decree of the President of the Republic of Uzbekistan[78], boilers with auxiliary equipment have been replaced in 54 boiler plants along with installation of gas, water and electric energy consumption metering devices. As a result costs of thermal energy generation were reduced and 15% electricity saving achived.

Regulatory framework in area of energy efficiency improvement and development of alternative energy sources is gradually enhancing. According to expert prediction this should lead to decrease in specific energy consumption by no less than 25% both in reconstructed and newly constructed buildings. In 1997 it was adopted the Law of the Republic of Uzbekistan "On rational energy use. The Decree of the President of the Republic of Uzbekistan No UP-4512 "On measures for further development of alternative energy sources" was issued in 2013. The draft Law "On alternative energy sources" is currently under consideration. In addition, the "Rules of technical operation and maintenance of heat distribution networks and heat points", "Provision on installation and use of hot water and thermal energy consumption metering devices", etc. are in force.

The Government of Uzbekistan has approved measures for further integrated development and modernization of water supply of sewage systems. One of the priority development directions is to increse up to 100% level of availability for population of centralized water supply in all cities/towns, and up to 85-90% - in rural settlements by 2020. In all by the country by 2020, availability for population of centralized water supply should be 90-95%.

[77] Decree of the President of the Republic of Uzbekistan No PP-2282, dated 07 January 2015 "On Program for Construction of Standard Design Individual Houses in Rural Area for 2015 and Main Construction Sector Parameters for 2016"

[78] Decree of the President of the Republic of Uzbekistan No PP-1297, dated 04 March 2010 "On Measures for Improvement of Heat Supply System in Khorezm Provinse with Attraction of Grant for the Government of the Republic of Korea"

1.5.3 Industry

Uzbekistan is amongst the countries with highly developed industrial production. There are large machine-building complex, ferrous and non-ferrous metallurgic plants, advanced enterprises for production of gold, silver and palladium in Uzbekistan. Chemical, pharmaceutical, motor vehicle manufacturing, light and food processing industry, production of construction materials are well-developed.

Problem with considerable physical and moral depreciation of fixed assets (i.e. in all by industry sector depreciation is more than 40%[79]) has stipulated necessity for development and implementation of innovative policy. This policy will allow using efficiently the country's intellectual and scientific and technical capacity in production. From 2009, governmental programs for modernization of the priority industry sectors, including ginning, fat-and-oil and pharmaceutical industries are being actively implemented in Uzbekistan.

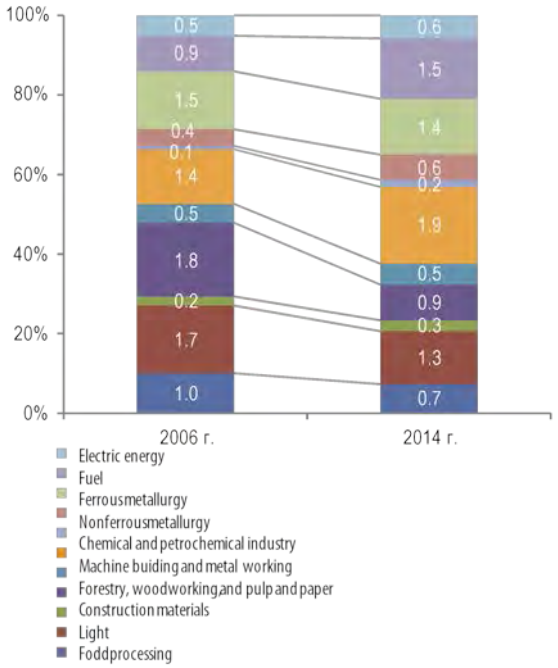
In aid of development of the key economy sectors in Uzbekistan it has been implemented programs for modernization and technical upgrading of enterprises in such industry sectors as:

- textile industry (2006–2008);
- chemical industry (2007–2011);
- machine-building industry (2005–2009).

Similar programs are currently being implemented in all industry sectors. This is indicated by coefficients of industry's fix assets renewal. Values of these coefficients for textile industry, chemical industry and machine-building industry are 11, 12 and 9 respectively (with about 11 on average for the whole industry).

For the period 2006 - 2014, share of industrial production in GDP was increased from 21,8 to 24,1%, rate of industrial production growth in relation to the previous year was 7-8%. There have been changes in the structure of industry in Uzbekistan.

Over the recent ten years share of production in chemical and petrochemical industries was increased. The machine-building and metalwork industries have achieved the significant growth in production. There is a progress with development of construction materials industry, light and food processing industries (see Figure 1.15).



Source: http://www.stat.uz

Figure 1.15 | *Change in Industry Structure of Uzbekistan for Period 2006-2014*

The main directions of Uzbekistan's economic strategy are: maintenance of high growth rates in export-oriented economy sectors; stimulation of development of enterprises with the advanced processing of domestic raw materials and manufacturing products with high added value.

Implementation of more than 500 investment projects aimed at modernization of existing and commissioning of new production facilities with the total cost of about USD50.0 billion under the Program for development of industry in the Republic of Uzbekistan for 2011-2015[80], ensures retention of stable growth rates of industrial production, and first of all in the hi-tech industry sectors. In 2014, in particular, rapid development was observed in such backbone sectors as machine building and metalworking (114.7% compared to similar period in 2013), light industry (115.4%), construction material production (107.8%) and food processing industry (108.3%).[81]

Industry is the largest energy consumer. It consumes almost 41%[82] from the total electric energy consumption (2014), and 24%[83] from the total natural gas consumption.

[79] O.A. Islamova, R. Paygamov, Development of the Uzbekistan's industry on the basis of intensification of innovative and entrepreneurial activities // Bulletin of Uzbek State Economic Univercity. Science. Education. Economy. Economy Series. – No 4 (6). – 2013.
[80] Decree of the President of the Republic of Uzbekistan No PP-1442, dated 15 December 2010 "On Priority Directions for Industry Development of the Republic of Uzbekistan in 2011-2015" //Law Book RUz, 2010, No 50 (472)
[81] http://stat.uz/ru/141-otkrytye-dannye/996-promyshlennaya-produktsiya
[82] Data from JSC "Uzbekenergo" for 2014.
[83] http://www.iea.org/statistics/statisticssearch/report/?year=2013&country=UZBEKISTAN&product=Balances

1.5.4 Transport

Transport sector of Uzbekistan comprises automobile, railroad, air and pipeline transportation. In 2014, volume of freight turnover by all types of transport was 85.7 billion thousand t-km, which by 2 billion thousand t-km more as compared the previous year.

Figure 1.16 | *High-speed Electrical Train, Modification Talgo 250*

In the total volume of freight turnover share of automobile transport is 37%, pipeline transportation – 36%, railroad transport – 26.9% and air transport – 0.1%.[84]

Traditionally the automobile transport has the highest share in the total fright turnover. In 2014, the automobile transport shiped 1,327.4 million ton of freight or 91% from the total freight turnover. Share of railroad transportation is 4%. That of air and pipeline transportation is 0.002% and 4.9% respectively.[84]

On 21 December 2010, the President of the Republic of Uzbekistan signed the Decree "On Acceleration of Development of Transport and Communications Infrastructure in 2011-2015" [85]. In 2013-2014, construction and reconstruction of approximately 800 km of motor roads was completed that ensuring development of overall industrial potential.

In accordance with the Decree of the President of the Republic of Uzbekistan, the new electrified railroad from Angren to Pap[86] is being constructed. Electrification of 186 km long railroad "Pap-Kokand-Andijan" will continue railroad "Angren-Pap". Implementation of this Project will allow to increase by almost 2.5 times length of the electrified railroads in Uzbekistan. This new railroad will be part of international transit railway "China-Central Asia-Europe". According to experts prediction, around 600 thousand passengers and 4.6 million ton of freight[87] will be transferred by the new railroad only during the first year of its operation.

In 2015, the Program for development and modernization of engineering/communication and road transportation infrastructure for 2015-2019[88] was adopted, which also approved targeted list of roads to be constructed and reconstructed as part of Uzbekistan's national motor roads network, as well as technical upgrading of facilities of motor road O&M organizations for 2015-2019. According to the above document, in 2015-2019, on account of the Republican road fund it will be constructed and reconstructed 1,227.8 km of motor roads with bridges, viaducts and road interchanges as part of Uzbekistan's national motor roads network, and 299.5 km of public motor roads (with attraction of the World Bank funds).

Transportation system of Uzbekistan comprises not only railroad, automobile and air transport, but also main gas and oil pipelines (See Section 1.5.2). Taking into account volumes and variety of transport types, introduction of measures for improvement of energy efficiency in this sector will allow saving considerable volumes of energy, and therefore, to reduce greenhouse gases emissions from fuel combustion.

1.5.5 Waste Management

According to the State Cadastre, there are 247 sites with the total area of 9,628.98ha for disposal and utilization of wastes. Waste management is carried out in compliance with the Law of the Republic of Uzbekistan "On Waste Management". There are three groups of wastes: industrial, solid domestic and sewage waters.

The main method of solid municipal wastes (SMW) disposal is their burial into ground. The works on SMW storage and disposal are performed in compliance with normative documents, issued by the Ministry of Health in 2004.[89] Currently, there are more

[84] http://stat.uz/ru/uploads/ekonom/transp/gruz_perevozki14.xls

[85] Decree of the President of the Republic of Uzbekistan No PP-1446, dated 21 December 2010 "On Acelerated Development of Inrustructure, Transport and Communications Construction in 2011-2015" // Law Book RUz, 2010, No 52, p. 512; 2011, No 50, p. 512; 2013, No 45, p. 584

[86] Decree of the President of the Republic of Uzbekistan No PP-1985, dated 18 June 2013 "On Measures for Arrangement Construction of Electrified Railroad "Angren-Pap"

[87] www.Podrobno.uz , 9 November 2015, No 1544663

[88] Decree of the President of the Republic of Uzbekistan No PP-2313, dated 06 March 2015 "On Program for Development and Modernization of Engineering Communication and Motor Road Infrastructure for 2015-2019"

[89] Normative Paper of the Ministry of Health No. 0157-04, dated 12 July 2004, "Sanitation Requirements to Storage and Disposal of Solid Municipal Wastes on Special Sites in Conditions of Uzbekistan"

than 370 mln. m^3 of SMW are accumulated on the operating waste disposal sites of the republic, and this volume is constantly growing: the volume of accumulated waste is increasing annually by 12-13 mln. m^3 of SMW, including 6.3 mln. m^3 – on account of population.[90]

Around 100 mln. m^3 of industrial wastes are generated in the republic annually, of which 14% is attributed to toxic category, and around 68% is mining industry wastes.[91]

The total area of waste sites is 12 thousand ha, with more than 2 billion ton of disposed industrial, construction and municipal wastes and garbage. For efficient solution of problems associated with utilization of wastes it is necessary to introduce advanced non-waste and low waste technologies. As of beginning of 2014, 131 enterprises for utilization and processing of wastes and 66 enterprises dealing with utilization and processing of non-deposited containers and packaging are registered in Uzbekistan.

1.5.6 Telecommunications

Stable and sound development of the national economy of Uzbekistan is impossible without introduction and use of information and communication technologies (ICTs) in various areas of social and economic life of society. To achieve the goals on development of information and communication technologies (ICTs), the necessary normative and legal basis has been formed in the republic, in particular:[92]

- the Laws "On Informatization", "On Electronic Digital Signature", "On Electronic Documents Circulation", "On Electronic Payments", etc. have been adopted;
- the Law "On Electronic Government" was adopted in November 2015:
- for development of national information and communication system, over the recent three years it was adopted more than 20 decrees and orders of the President of the Republic of Uzbekistan, and around 30 Governmental decisions associated with wide introduction of information systems, interactive services and organization of trainings in ICT.

In this sector the republic has well-developed institutional structure.[93] According to the Decree of the President of the Republic of Uzbekistan No. UP-4702, dated 4 February 2015, it was established the Ministry for development of information and communication technologies of the Republic of Uzbekistan with the following main tasks and activities:

- implementation of unified governmental policy in the area of information technologies and communications;
- introduction of "electronic government";
- elaboration and implementation of integrated programs for development of national information and communication system;
- protection and use of information;
- development and modernization of telecommunication infrastructure;
- expansion of broad-banded access to Internet;
- complete transition to digital systems in telephone communication, TV and radio broadcasting;
- carry out function on state regulation, licensing and control over activities in telecommunications area, as well as use of radio-frequency spectrum, etc.

Statistical information on status of implementation and development of ICTs in the Republic of Uzbekistan is presented in Table 1.11.

In 2014, share of ICTs in GDP of the republic was 1.9%, volume of commodity production and services provided in ICTs sphere exceeded 4.1 billion Soum, and export was equal to more than US$213 million.[94]

The well-developed telecommunication infrastructure is the key factor for large scale introduction of ICTs. From 2012, a number of state programs were adopted in this area, in particular:

- "Program for technical and technological transition to digital television in the Republic of Uzbekistan" was approved by the Decree of the President of the Republic of Uzbekistan on 17 April 2012. As a result of the implemented projects, currently 22 digital TV transmitters are operating. 54.3% of population has access to digital TV.
- "Program for development of telecommunication technologies, networks and infrastructure in the Republic of Uzbekistan for 2013-2020" was approved by the Decree of the President of the Republic of Uzbekistan on 27 July 2013. Implementation of the Program will provide possibilities to increase speed of data transfer and Internet access for provinces – by 4 times, for districts – by 10 times.

[90] Center for Economic Studies, Analytical Report "Conceptual Approaches to Formation of Green Economy in Uzbekistan" – Tashkent 2011, http://cer.uz/ru/publications/
[91] www.solidwaste.ru/news/view/9583.html
[92] http://infocom.uz/2015/09/29/o-sostoyanii-i-perspektivax-razvitiya-ikt-v-uzbekistane/
[93] http://ccitt.uz/ru
[94] http://infocom.uz/2015/09/29/o-sostoyanii-i-perspektivax-razvitiya-ikt-v-uzbekistane/

"Targeted Program for development of information technologies and communications for 2015-2019" was approved by the Decree of the President of the Republic of Uzbekistan on 06 March 2015. The Program envisages establishment of centers for data storage and processing, expansion of broad-banded access to Internet, as well as development of mobile network 4G LTE.

In aid of further development and broad introduction of the advanced informational systems, resources and databases, the Program for development of "Electronic Government" system for period 2013-2020, was adopted by the Decree of President of the Republic of Uzbekistan on 27 June 2013.

On 1 July 2013, the Unified portal of interactive governmental services (www.my.gov.uz) was established, which is the integrated access point to interactive governmental services for population and entrepreneurship entities.

More than 600 governmental bodies are connected to the Unified portal that provide more than 250 interactive governmental services.

Table 1.11 | Statistical Information on Status of Implementation and Development of ICTs

Indices	Units	As of 1 January 2014
ATS digitizing	%	100
Number of operators, providers	Nos	924
Speed of access to international information networks (Internet)	Gb/s	10,3
Number of IP domain in zone ".UZ"	'000	17,4
Number of operating entities working on development of software products	Nos	264
Number of registered software products	Nos.	208
Number of keys and certificated keys to EDS (Electronic Digital Signature)	Nos.	376000
Number of governmental informational resources	Nos.	195
Number of governmental information systems	Nos.	110
Number of types of governmental interactive services	Nos.	194
Number of sites registered in www.uz	Nos.	8,2
Book fund of information and library centers	mln.	4,8
Number of educational informational resources in library of Web portal ZiyoNET	'000	50,1
Number of national software products registered in Catalogue software.uz	'000	1,5
Number of households that have computers	%	37,4
Number of households that have access to the Internet	%	58,1
Number of the Internet users	mln.	12
Including number of mobile Internet users	mln.	11,2

Source: http://infocom.uz/2015/09/29/o-sostoyanii-i-perspektivax-razvitiya-ikt-v-uzbekistane/

1.5.7 Tourism

By its tourist resources Uzbekistan occupies one of leading places in the Central Asia and is amongst the world countries possessing unique touristic potential. There are more than four thousand unique architectural, historical and natural landmarks of various epochs in Uzbekistan. Among them there are many well preserved samples of medieval architectonics that have also the religious value.

The important factor identifying attractiveness of the whole region for tourists is the exotic nature of Uzbekistan with its astonishing contrasts, and landscape, flora and fauna diversity. It is mountains of the southern Uzbekistan, landscapes of Kyzylkum desert, mountain regions of the Tien Shan and Pamir-Alay, and large water bodies with rich bird fauna. Large eco-touristic potential has Chatkal, Zaamin, Nurata, Gissar, Baday-Tugay nature reserves, Ugam-Chatkal national park, "Djeiran" eco-center and others.

The UNESCO World list of heritage includes 754 landmarks, and four of them are located in Uzbekistan: Ichan-Kala (in Khiva), historical centers of Bukhara, Shakhrisabz and Samarkand towns. Boysun region of Uzbekistan also possesses the unique eco-touristic potential. It is located at the historical intersection of cultures and religions, including Zoroastrianism, Buddhism and Islam.

Figure 1.17 | *Yangiabad Tourist Camp*

Weather conditions all year round are favorable for recreation and development of eco-tourism. Such large rivers of Uzbekistan as Ugam, Chirchik, Zarafshan may be used for various types of tourism.

It is well-known that one of the rapidly developing types of tourism is ecological tourism. As proven by the world practice, eco-tourism is the efficient tool for environment protection and important element of sustainable development. Experience of foreign countries suggests that eco-tourism with insignificant costs and during short period of time may become one of the most profitable income items for the republic.

Currently, the socio-economic strategy and action plan for development of eco-tourism in various regions is being developed, which should correspond to the overall tasks of sustainable development on the basis of compliance with ecological, social and cultural aspects, traditions and interests of local populations with its broad involvement in formation ecological touristic product. Certain measures are also being undertaken in order to improve level of services for tourists in this sector. All these efforts bring their positive results. Volume of touristic services is growing up, and during last year it is getting higher by 16%.

Development of eco-tourism is also taken into account by introduction of flexible price policy for purchase of tickets for air, railway and automobile transportation, costs of accommodation in hotels and tourist centers, stimulating attraction of foreign tourists. Issues associated with publishing of advertising booklets for eco-touristic routes in the Republic of Uzbekistan are being studied. Touristic companies and firms develop eco-tours and disseminate this information abroad.

The State Committee of Development of Tourism ensures implementation of the unified governmental policy in area of tourism and coordination of tourism development in the country.

1.6 Ecosystems and Territories with High Anthropogenic Load

1.6.1 Biological Diversity

Preservation and sustainable use of biodiversity is extremely important for Uzbekistan. Its territory is entirely located in the arid zone with aridity indices from 0.03 to 0.20. It is vulnerable to climate change, and sunjected to drought and land desertification impacts.

According to updated information from the current sources basis of Uzbekistan's faunal diversity constitutes 14,900 backboneless species and 714 backboned animal species (84 fish species, 3 amphibian species, 60 reptile species, 460 bird species and 107 mammal species).

Uzbekistan's flora currently comprises approximately 4,500 vascular plant species[95], of which more than 10% (including 4 families and 450 species) of endemic ones, i.e. which can be encountered on some particular territory. The country's flora is rich in plant species, which have food, medicine, forage and technical value. A special place in the country's flora is occupied by wild fruit/berry plants (relatives of cultivar plant species).[96]

Several important migration routes of waterfowl are located in the republic. The Central Asian flight route is used by 274 migrating waterfowl populations, comprising 175 species, including 26 globally endangered bird species. The main migration routes of waterfowl in Uzbekistan go through the main water courses of Syrdarya and Amudarya rivers.[97]

Dozen of the country's water bodies are habitat for more than 70 fish species, including those ones of commercial value. Ecosystems are subjected to impacts of many anthropogenic factors, including their fragmentation. Countrywide decline of habitats and wild ecosystems degradation beyond conservation areas are observed. Climate change is additional stress factor that aggravate land degradation and biodiversity losses.

[95] UNDP/GEF/Goskompriroda, Fifth National Communication of the Republic of Uzbekistan on Biodiversity Conservation. Tashkent, 2014. – 66 p.
[96] Geographic Atlas of Uzbekistan, Goskomzemgeosezkadastr, Tashkent - 2012.
[97] National Report on Environment Conditions and Natural Resources Use in the Republic of Uzbekistan (2008-2011) / Edited by N.M. Umarov; State Committee for Nature Protection, Tashkent,, Chinor ENK 2013, - 260 p.

1.6.2 Natural Ecosystems

The globally important tugai (riparian woodland) forests, relic walnut and fruit forests in Western Tien Shan and Pamir-Alay mountains, wetlands, etc., are the endangered habitats.

Figure 1.18 | *Koulans in Jeiran Ecocenter*

Figure 1.19 | *Group of pelicans, Dengizkul Lake*

Foothill plains and adyrs located in Western Tien Shan and Pamir-Alay mountains are subjected to the highest anthropogenic impact. Considerable natural ecosystem areas have been changed as a result of agricultural activities. Degradation of ecosystems and lack of strictly protected areas (reserves) on plains, foothills and low mountains have led to biodiversity reduction in foothill plains and adyrs. Currently transformation of natural ecosystems into agrocenosis is observed on these territories.

Low maintains and cliffs of Ustyurt Plateau, located in the middle of desert, are habitats for many plain flora and fauna species. These species experience impacts from both cattle breeding and mining industry (extraction of building stones, gypsum raw material, etc.).

324 species of rare and endangered plants and mushrooms, and 184 animal species are included in the Red Book of Uzbekistan.

Nature reserves, preserves, nurseries and national parks, which ccupy around 5% of the county's territory, are of a special importnave for conservation of flora and fauna, and revival of critically endangered plant and animal species.

Wetland ecosystems are the most widespread over the recent 50 years type of ecosystems (such as drainage water disposal lakes, reservoirs, etc.). Wetlands are habitats for many settled and migrating bird species. Majority of wetlands are not subjected to direct threat of extinction, but in conditions of arid climate and water deficiency they experience unstable water balance and subjected to degradation during drought periods.

1.6.3 Forest Ecosystems

As of 01 January 2013, the total land area of the State Forest Fund of the Republic of Uzbekistan is 9.6 million ha, or 21.7% from the total land area of the republic, of which around 3.0 million ha are covered with forests. Forest-land percentage in the country, i.e. ratio between area covered with forests and the total land area, equals to 6.7%.

According to orographic, soil and climate conditions, forests (or land area covered with forests) of the country are subdivided into mountainous, valley/inundable and desert forests. In mountains 11% of the total land area of forests in Uzbekistan is occupied by conifer tree species, and 2.8% by nuciferous tree species.

Along river banks in periodically wetted lands tugai forests are growing, presented by oleaster, Asiatic poplar, tamarisk. Share of these forests is around 5% from the total forest area.

The most common (78%) trees and shrubs are the ones growing in deserts, such as saxaul, cherkez, kandym and other species of desert forest vegetation.

Productivity of Uzbekistan's forests is very low, which is associated with overall aridity of the country's territory. Timber supply per 1 ha of matured trees is 6 m^3, on average, that of conifer trees is 29 m^3, hardwood forests is only 6 m^3, including around 3 m^3 of saxaul. Nevertheless, all forests in Uzbekistan are of a great protective and environmental importance, as well as the important factor for maintenance of biological diversity. In addition, they are sustainable ecosystems (in the absence of

anthropogenic impact), maximum adapted to the site-specific soil and climate conditions, including to natural climate variations.

Forests, growing in mountains, prevent erosion and improve hydrology of mountain territories by transforming surface runoff into subsoil one, increasing river discharge, as well as performing other environmental functions and being source of non-timber forest production.

Figure 1.20 | *Mountaineos meadows of Chatkal Mountain Ridge*

Forest plantations in deserts are also the most important environmental factor, fixing shifting sands and protecting various structures from sand filling, providing fuel for local population and increasing desert pasture productivity. Tugai forests growing along river banks prevent their erosion, protect water and provide commercial timber. On plain irrigated lands forests serve as protection belts from harmful impact of water and wind erosion, mudflows and dry hot winds. Forest plantations on irrigated lands are of high productivity and as such may be source of commercial timber for local population.

Forests are sources of non-timber products, such as nuts (walnuts, pistachio, almonds), fruits (apple, pear, cherry, plum, apricot, hawthorn, barberry, etc.), mushrooms and berries, medical raw materials, tanning and tinctorial substances, etc.

By half timber is composed from carbon, which plants absorb from air during growing process. Therefore, role of forests is invaluable for mitigation of climate change impacts, as high capacity natural object for sequestration and deponation of carbon dioxide.[98]

Tugay (riparian woodland) and flood plain forests were retained as small plots along the Amudarya, Syrdarya, Zerafshan, Chirchik, and Akhangaran rivers. Area of these ecosystems is being reduced as a result of agricultural land development and use by local population for their needs. Flood plain forest, which in the past was impassable tugai brushwood, degraded as a result of their development for agriculture, as well as due to change in hydrological regime of the Syrdarya and Amudarya rivers. Lack of annual flooding of tugai forests prevents plants renewal by seeds, causes drying young trees, lead to fragmentation of tugai forests and terrain desertification.

Figure 1.21 | *Tugai Forest*

Relict walnut and other fruit wild forests grow in low and medium elevation mountains, i.e. on the most favorable terrains for their growing, and therefore experience the increased anthropogenic impact. These forests are severely fragmented and remained currently on considerably reduced areas as compared with their natural habitat (Western Tien Shan and Pamir-Alay mountains). Archa (dendroid juniper) forests grow on terrains with elevation ranging from 1,400 to 3,200 mamsl, and located on slopes of the Western Tien Shan and Pamir-Alay mountain ridges.

Unregulated cattle overgrazing has tangible impact on forest fund, as well as eradication of dendroid and shrubbery vegetation. Among the factors that have negative impact on forest fund conditions are: insufficient monitoring of forest resources; low survival rate of forest plant seedlings, associated with non-compliance with agro-technology for their growing in nurseries. Owing to high anthropogenic impact, the biodiversity and ecosystems of the republic are already under threat of destruction. Climate change aggravates desertification processes, reduces water resources availability that in turn increases vulnerability of tugai forests and aquatic ecosystems

[98] Presented statistics data are based on official information from Main Forestry Administration of MAWR

1.6.4 Institutional and Legal Basis for Environment Conservation and UNFCCC Implementation

Legal Basis. The Government of the Republic of Uzbekistan pays great attention to issues associated with environment conservation. More than 30 legislative acts and around 100 normative legal documents in the area of environment conservation have been adopted. Among the main ones are Laws of the Republic of Uzbekistan "On Environment Conservation", "On Protected Nature Territories", "On Water and Water Use", "On Fossil Mineral Resources", "On Flora Conservation and Use", " On Fauna Conservation and Use", "On Atmospheric Air Conservation", "On Forests", "On Waterworks Safety", "On Waste Management", "On Ecological Expertise", "Land Code" and others.[99]

The most important directions of the Government environmental policy are:

- formation and development of relevant legislation;
- elaboration of the program for environment conservation and social and economic development;
- regulation of resource and energy saving issues, introduction of environmentally friendly methods and technologies;
- increase in responsibility of enterprises and organizations, irrespectively of their ownership forms, for ensuring environmental safety of their activities;
- information support, improvement of environmental education level.

The Constitution of Uzbekistan comprises the special clauses on environment conservation; rational use and conservation of land, mineral resources, fauna, flora and other natural resources. Another one important legislative act regulating policy and actions in the area of climate change is the National strategy for sustainable development of the Republic of Uzbekistan (1999).

The Decree of the President of the Republic of Uzbekistan "On Measures for Implementation of Priority Investment Projects under Clean Development Mechanism of Kyoto Protocol" [100] was adopted in December 2006. This Decree envisages creation of the Interdepartmental Council on Clean Development Mechanism (CDM) and the National Body on CDM in the name of the Ministry of Economy. The "Provision on Procedure for Preparation and Implementation of Investment Projects under Clean Development Mechanism (CDM) of Kyoto Protocol"[101], identifying procedure for preparation and approval of CDM Projects at the national level was adopted by the Decree of the Cabinet of Ministries of the Republic of Uzbekistan in January 2007.

The climate change problem is to certain extent considered in the following papers: Strategy for water saving and its rational use in irrigated agriculture; the National strategy for decrease in greenhouse gases emission, and "Towards sustainable energy: strategy for low carbon development of Uzbekistan".

All the above mentioned documents, including system for State environmental monitoring, constitute basis for implementation of UNFCCC in Uzbekistan.

Issues associated with fulfillment of provisions of the article 4 and 12 of the UNFCCC regarding greenhouse gases emission are directly or indirectly regulated by the current legislation. List of regulatory legal acts, directly regulating this issue, includes:

- Law of the Republic of Uzbekistan No 253-1, dated 27 December 1996 "On atmospheric air conservation";
- Decrees of the Cabinet of Ministers of the Republic of Uzbekistan:
  - No.469, dated 20 October 1999 "On environmental action program for 1999-2005";
  - No.389, dated 9 October 2000 "On implementation of environmental action program for 1999-2005";
  - No.183, dated 14 April 2004 "On improvement of hydrometeorological service of the Republic of Uzbekistan";
  - No.212, dated 19 September 2008 "On environmental action program for 2008-2012;
  - No.142, dated 27 May 2013 "On environmental action program for 2013-2017".

According to the Decree of the Cabinet of Ministers of the Republic of Uzbekistan No.389, dated 9 October 2000, and pursuant to commitments to the UNFCCC, inventory of greenhouse gases emission and sink is carried out in the country on a regular basis.

Besides, there are a number of the normative legal documents indirectly related to greenhouse gases emission. The main ones are the following laws of the the Republic of Uzbekistan:

- No.754-XII, dated 9 December 1992 "On nature protection";
- No.171-II, dated 15 December 2000 "On state cadastres";
- No.441-II, dated 12 December 2002 "On state statistics".

[99] List of the main legislative and normative acts in the area of nature protection, environment conservation and climate change control is presented in Annex 1.

[100] Decree of the President of the Republic of Uzbekistan No PP-525, dated 06 December 2006 "On Measures for Implementation of Priority Investment Projects within the Kyoto Protocol Framework for Clean Development" // Bulletin of Oliy Majlis Chmbers, 2006, No 12 (711)

[101] Decree of the Cabinet of Ministers of the Republic of Uzbekistan No PKM-9, dated 10 January 2007 "On Approval of Procedure for Preparation and Implementation of Investment Projects under Clean Development Mechanism (CDM) within the Kyoto Protocol Framework" // Law Book RUz, 2007, No 1-2 (15)

The special attention is paid in the country to strengthening legal and institutional capacity of public society and non-governmental organizations awareness regarding implementation of national environmental policy and climate change control.

The national legal experts have conducted analysis of regulatory and legal framework from the viewpoint of implementing a number of issues, such as mitigation of and adaptation to climate change impact, climatic risks management. They came to conclusion that the regulatory and legal framework in force allows to resolve all necessary issues associated with climate change and may be amended if needed.

The normative legal documents, reflecting issues of mitigation and adaptation to climate change impact, adopted during the period from 2008 to 2015 after preparation of the Second National Communication, are provided in Annex 1.

Measures and actions for prevention of and adaptation to climate change adverse impacts, aimed at ensuring long-term sustainability of investments and decreasing vulnerability to climatic risks, are integrated into a number of the national and sectoral programs and strategies, e.g. the Strategy for improvement of living standards, National actions plan to combat desertification and drought in the context of UN Convention to Combat Desertification (UNCCD), National strategy and actions plan of the Republic of Uzbekistan for biodiversity conservation for the period 2016-2025, sectoral programs in area of energy efficiency and saving, as well as other programs.

International Cooperation. The main principles of the international cooperation in the area of environment conservation are identified by the foreign policy of Uzbekistan, which is based on principles of commitment to the norms of international law.

Environmental Action Plan of the Republic of Uzbekistan for 2013-2017, identifies directions for international cooperation aimed at compliance with obligations adopted in accordance with the ratified multilateral environmental agreements.

The Republic of Uzbekistan is a party to more than 20 international conventions and agreements (apart from bilateral agreements) in the area of environment conservation, climate change and natural resources use.[102]

Figure 1.22 | *Workshop on UNDP/Ministry of Economy Project "Support to Uzbekistan in Transition to Low Carbon Development of National Economy"*

The National Executive Agencies for the main international agreements in the area of environment conservation, ratified by Uzbekistan are: the State Committee for Nature Protection, Centre of Hydrometeorological Service at the Cabinet of Ministers of the Republic of Uzbekistan, Ministry of Agriculture and Water Resources and others.

The United Nations Framework Convention on Climate Change (UNFCCC) was ratified by Uzbekistan on 20 June 1993 and it came into force on 21 March 1994. In accordance with decision of the Government of the Republic of Uzbekistan, Uzhydromet is entrusted with fulfillment of the relevant international commitments (within the framework of activities of World Meteorological Organization) to the United Nations Framework Convention on Climate Change, United Nations Convention to Combat Desertification and Droughts, UNESCO International hydrological program, assistance to the national interests through participation in various programs and international activities.

Uzhydroment cooperates closely with the Global Environment Facility (GEF), United Nations Development Program (UNDP), United Nations Environment Program (UNEP), World Health Organization (WHO), and participates in preparation and implementation of a number of environmental projects in close interaction with relevant ministries and agencies of the Republic of Uzbekistan.

The UN Development Assistance Framework (UNDAF) for 2010-2015, has been implemented in Uzbekistan. The Program is an efficient tool for interaction between the Government of the Republic of Uzbekistan and UN Agencies for medium-term perspective in implementation of priority directions of social and economic development, including environmental and climate change issues.

Uzbekistan has signed the international declarations concerning environment conservation and prevention of climate change, in particular "Declaration on the Environment and Development (Rio Declaration on the Environment and Development", 1992); "The 2030 Agenda for Sustainable Development up to 2030" (2015).

[102] List of the main international agreements, signed by the Republoc of Uzbekistan, is presented in Annex 2.

Besides, Uzbekistan is an establisher of the International Fund for Saving the Aral Sea (IFAS, 1993), the Central Asian Interstate Commission on Sustainable Development (ICSD, 1993), the Interstate Coordinating Water Commission (ICWC, 1997), the Regional Environmental Centre for Central Asia (CAREC, 2000).

Being a party to the FCCC, and as a Non-Annex I Party to the Kyoto Protocol[103], Uzbekistan participates in implementation of CDM projects, which provide possibility for the republic to attract investments, new technologies and knowledge. To ensure successful participation of the Republic of Uzbekistan in implementation of CDM projects, the National Body on CDM (the Ministry of Economy) and the Interagency Council on CDM have been established.[104]

Financing. Great attention is paid in the country to mobilization and efficient use of investment resources, as well as resources for technical assistance from funds, donors, development partners for solution of priority tasks, including implementation of programs and projects aimed at decrease/prevention of GHGs emission and adaptation to adverse impacts of climate change. According to data from the Ministry of finance in 2008-2013, Uzbekistan received in forms of grant and technical assistance the amount of USD 860.4 million, or equivalent to 0.3% from GDP and 1.5% from the State budget over this period. Meanwhile, the annual volume of attracted non-repayable assistance funds in absolute value was increased by 3.3 times and it amounts to USD200.1 million.[105]

Amongst the donors are: governments of the developed countries (that use for this purpose development programs or funds), international agencies and financial institutions, private business. The Global Environmental Facility (GEF) provides financing for a large portfolio of the climatic projects. In particular, over the period 1996-2013, with the GEF financial support (through grants) 16 projects were implemented in Uzbekistan with the total costs around USD50.0 million. These projects covered the following directions: climate change, biodiversity conservation and prevention of land degradation. Large number of projects both investment and technical assistance ones are financed by the World Bank (WB), Asian Development Bank (ADB), Islamic Development Bank (IDB), and European Bank for Reconstruction and Development (EBRD).

Substantial financial assistance to Uzbekistan is also provided by the Adaptation Fund of UNFCCC, German Society for International Cooperation (GIZ), United Nations Food and Agricultural Organization (FAO), United Nations Development Program (UNDP), United Nations Environmental Program (UNEP), World Health Organization (WHO) and others. Under the CDM projects around USD24.4 million of private foreign investments have been attracted.

The Green Climate Fund with capitalization of USD100.0 billion was established in 2010. This fund is the financial mechanism of UNFCCC, which provides financial assistance in form of grants to developing coutries in implementation of projects with costs from USD10.0 million (micro-projects) to USD250.0 million (medium-scale projects) aimed at adaptation to adverse impacts of climate change and decrease in GHGs emissions. Implementation of the GIZ/UNDP/UNEP/WRI Project "Program of Uzbekistan preparation for access to resources of Green climate fund" has been commenced. The Project is aimed at development of the national institutional structure needed for efficient, successful and sustainable management of resources for climatic financing through capacity building of the national agencies, including: (i) creation of favorable conditions for involvement of private sector in solution of climate change issues; (ii) national technical capacity building for evaluation of efficiency of measures aimed at adaptation to and prevention of climate change; and (iii) development of proposals for financially attractive projects.

List of the main recently completed, on-going and planned technical assistance projects (grants) on issues associated with climate change over the period 206-2016, in support of implementation of the national programs and strategies is provided in Annex 4.

Understanding of importance and necessity for climatic financing are gradually entering into practical activities of the governmental institutions and private business of Uzbekistan. Mechanisms and structures for dealing with the international donors and level of coordinating, accounting and managing foreign assistance resources are being improved in the country for increase in efficiency in the international assistance use. At the same time, it will be necessary to study all available international experience, and to develop additional mechanisms for attraction of the international and domestic climatic financing in order to make this process sustainable and self-sufficient.

Institutional Structure. According to the Government decision the Agency responsible for implementation of the United Nations Framework Convention on Climate Change (UNFCCC) is the Centre of Hydrometeorological Service at Cabinet of Ministries of the Republic of Uzbekistan (Uzhydromet). There is the National Secretariat of UNFCCC in the Uzhydromet as permanently operating body that coordinates activities for fulfillment of the country's commitments. The Director General of Uzhydromet is the National Focal Point for implementation of the UNFCCC in Uzbekistan. The Climate change Information Center

[103] Signed by Uzbekistan on 20 November 1998, ratified – on 12 October 1999, and came into force on 16 February 2005.
[104] Decree of the First President of the Republic of Uzbekistan No PP-525, dated 06 December 2006 "On Measures for Implementation of Priority Investment Projects within the Kyoto Protocol Framework for Clean Development Mechanism"
[105] UNDP/CES Report On Millenium Development Goals. Uzbekistan - Tashkent 2015.

operates also under Uzhydromet, where materials of Conferences of the Parties (CoP), IPCC Assessment Reports, methodological and technical manuals, scientific publications regarding climate change are collected on a regular basis.

Uzhydromet is responsible for preparation of the National Communications of the Republic of Uzbekistan under the United Nation Framework Convention on Climate Change (UNFCCC) and National Reports on Inventory of Anthropogenic GHGs Emissions and Sinks. Experts from the key ministries, institutions, agencies, industrial enterprises, scientific institutes, NGOs, etc are involved in implementation of these activities (see Anex 5). The Initial National Communication on the UNFCCC was prepared in 1999, the Second one in 2008.

Inventory of GHGs emission is carried out within the framework of National Communications preparation. The National inventory team has been formed on the basis of Uzhydromet Department for monitoring air, surface water and soil pollution with participation of experts from the institutions concerned. Information for inventory database is collected, compiled and stored this department. In preparation of the Greenhouse Gases Inventory and relevant Report, all the concerned and involved ministries and agencies interact with each other in accordance with the scheme, illustrated in Figure 1.23.

The Ministry of economy is responsible for coordination of CDM activities in Uzbekistan. The Interagency council has been established uder this Ministry. It is worth to mention success achieved by Uzbekistan in implementation of Clean Development Mechanism (CDM) Projects. As of 1 January 2016, 15 CDM Projects were registered in UNFCCC Secretariat, and put into circulation more than 15.2 million ton CER.[106] In the world-wide rating among 94 countries, participating in the Clean Development Mechanism, Uzbekistan is on 16th place (by volume of emission reduction)[107] and on 31st by number of registered CDM projects[108]. Uzbekistan has become the third country in the world, which developed and approved in the UNFCCC Secretariat the standardized base line (greenhouse gases emission factor along with electric energy generation) for the national energy system.[109]

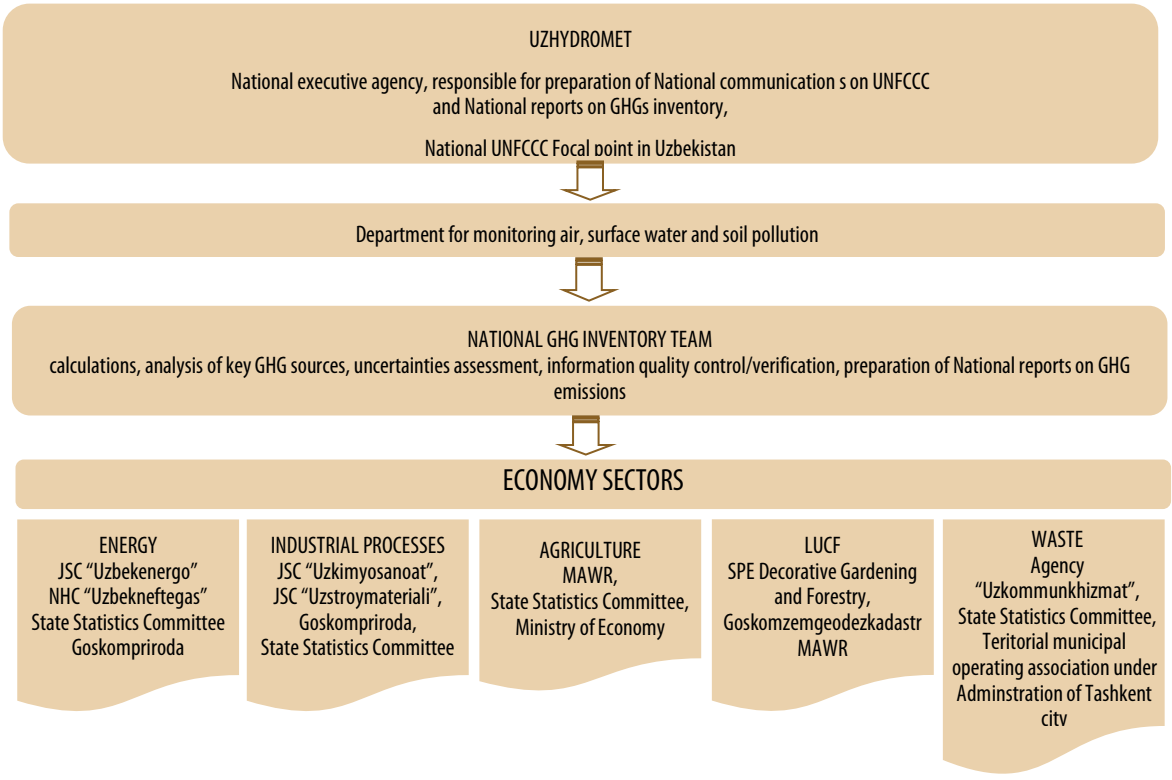


Figure 1.23 | *Organizational Structure of National Inventory System*

[106] http://cdm.unfccc.int/Issuance/cers_iss.html
[107] http://cdm.unfccc.int/Statistics/Public/files/201512/Proj_reg_byHost.xls
[108] http://cdm.unfccc.int/Statistics/Public/files/201512/ExpRed_reg_byHost.xls
[109] https://cdm.unfccc.int/methodologies/standard_base/Standardized_Baseline_PSB005_ver01.0.pdf

GREENHOUSE GAS INVENTORY

2 GREENHOUSE GAS INVENTORY

According to the Articles 4.1 and 12.1a of UNFCCC, reporting on the greenhouse gases emission is an obligatory component of the Parties activities. Therefore the greenhouse gases inventory is considered as one of the main parts of the National Communication.

Objective of inventory is to quantify emissions and sinks of greenhouse gases, emitted into or removed from the air as a result of anthropogenic activities in various sectors of Uzbekistan's economy, as well as preparation of the National report "Inventory of Anthropogenic Emissions Sources and Sinks of Greenhouse Gases in the Republic of Uzbekistan" (GHG Inventory).

In accordance with the UNFCCC requirements, Uzbekistan as Non-Annex I Party carries out GHG inventory within the framework of preparation of the National communications. The First national inventory of greenhouse gases emission has covered period 1990-1997, and was prepared during development of the Initial National Communication. The Second inventory was for the period 1990-2005.

The results of the Third national inventory of greenhouse gas emissions sources and sinks, revised assessments of anthropogenic emissions and analysis of emissions trends for the period 1990-2012, as well as previous omitted emission sources are presented in this Chapter. The national emission coefficients were corrected for some source categories, which to a greater degree comply with the national conditions and aimed at uncertainties reduction. Year 1990 was adopted as a baseline year.

Inventory of the Republic of Uzbekistan contains data on emissions and sinks of greenhouse gases with direct and indirect greenhouse effect, unregulated by the Montreal protocol, namely:

- Gases with the direct greenhouse effect:
  - Carbon dioxide — CO_2
  - Methane — CH_4
  - Nitrous oxide — N_2O
  - Hydrofluorocarbons (HFCs) — CH_2F_2; C_2HF_5; $C_2H_2F_4$; $C_2H_3F_3$
- Gases with the indirect greenhouse effect:
  - Carbon monoxide — CO
  - Nitrogen oxides — NOx
  - Non-methane volatile organic compounds — NMVOC
  - Sulphur dioxide — SO_2

Sulfur hexafluoride (SF_6) and perfluorocarbons (PFCs) are not included in Inventory due to lack of the state accounting on their consumption.

Inventory of Greenhouse Gases in Uzbekistan has been carried out in compliance with the methodology and classification of IPCC by five economy sectors:

- Energy;
- Industrial processes;
- Agriculture;
- Land use change and forestry (LUCF);
- Waste.

Data on the greenhouse gases emissions from the international aviation bunker and biomass combustion are presented in the cadastre, but not included in the total national emissions in compliance with the IPCC requirements and methodology.

For conversion of greenhouse gases emissions into units of CO_2-equivalent the following Global Warming Potentials have been used: 1 for CO_2, 21 for CH_4, 310 for N_2O, in accordance with the "Reporting on Climate Change User Manual for the Guidelines on National Communications from Non-Annex I Parties (2004)".

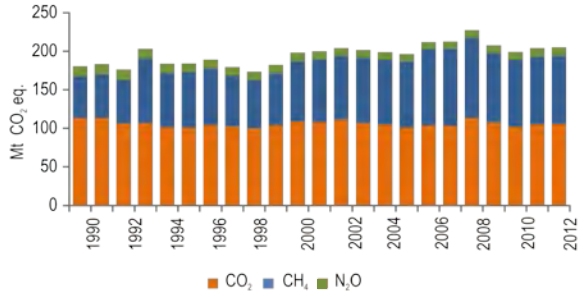
The main sources of data for greenhouse gases emission calculation were the State Committee of the Republic of Uzbekistan on Statistics, large national companies, ministries and agencies, which provide information on volumes of production, as well as other necessary data.

2.1 General Information on Greenhouse Gases Emissions and Sinks

In 2012, the total emission of greenhouse gases without sinks in LUCF sector was 205.2 Mt CO_2 eq. As compared with 1990 level of 180.4 Mt CO_2 eq., adopted as the baseline, by 2012 the total volume of emissions was increased by 13.7%.

Sink of greenhouse gases in LUCF sector in 2012 is estimated in 2.86 Mt CO_2 or 1.4% from the Total Emissions. The Greenhouse Gases emission with account of sink in LUCF sector equals to 202.3 Mt CO_2 eq.

Low growth rates of the greenhouse gases emission (0.6% per year on average) are associated with implementation in the country set of measures and actions aimed at energy resources saving and energy efficiency improvement in all sectors, and first of all in Energy sector, as well as with increase in share of natural gas in fuel use pattern (See Chapter 3).



Note: Emissions of HFC are not shown in Figure 2.1 due to their negligible value

Figure 2.1| *Greenhouse Gas Emissions in1990-2012*

Dynamics of the greenhouse gases emission for the period 1990-2012 is presented in Figure 2.1. There were no sharp variations in the total greenhouse gases emission during reporting period as compared with the baseline level in 1990.

Minimum of the total greenhouse gases emission of 173.6 Mt of CO_2 eq. was observed in 1998 (-3.8% to the level of 1990).

The baseline year level of greenhouse gases emission was noticeably exceeded (by 26%) in 2008, which is associated with growth of fugitive emissions of methane owing to increase in volume of natural gas transportation (including transit), as well as growing of its consumption in the categories of "Residential" and "Commercial" sectors.

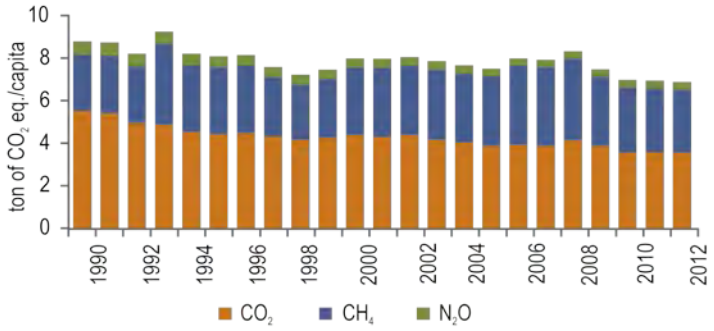


Figure 2.2 | *Greenhouse Gas Emissions per Capita*

Carbon dioxide with 51.4% contribution to the total emission in 2012, dominates in the overall emission in the Republic of Uzbekistan. Further down goes methane with 43.0%, and nitrogen oxide with 5.5%. Emission of hydrofluorocarbons is negligible, with contribution of only 0.04%.

In 2012, the highest emission level of greenhouse gases was in the Energy sector (81.9%), contribution of Agriculture sector was 10.5%, Industrial processes – 3.8%, and Waste - 3.8%. Distribution of emissions by sectors for period 1990-2012, was not changed signify-cantly. As before, emissions from the Energy sector prevail, however their share in 2012 was reduced by 1.9%. Contribution of the Industrial Processes sector was a little bit reduced by 0.7%. Since 1990, contribution of the Agriculture and Waste sectors was increased by 1.1 and 1.5% respectively.

In 2012, the total greenhouse gases emission per capita was 6.9 ton CO2 eq. per capita. As compared with 1990, this index was reduced by 21.6 % (See Figure 2.2). Volume of Emissions of various greenhouse gases per capita was as follows:

- CO_2 – 3.5 t/capita;
- CH_4- 3.0 ton of CO_2 eq./capita;
- N_2O – 0.4 ton of CO_2 eq./capita.

The obtained data on CO_2 emission per capita correspond to assessments of the International Energy Agency (IEA), by which in 2012, Uzbekistan was on the 38th place in the world rating. Contribution of the Republic of Uzbekistan to the Global Emissions of CO_2 from fuel combustion was reduced from 0.57% to 0.35% (by IEA Data)[1].

[1] www.iea.org /IEA Statistics

2.2 Trends of Gases Emission with Direct Greenhouse Effect

In all for period 1990-2012, contribution of CO_2 emission in the total emission of greenhouse gases was decreased by 12%; NO_2 by 1%, and emission of CH_4 was increased by 13% (See Figure 2.3). Dynamics of greenhouse gases emission is presented in Table 2.1.

Carbon dioxide. Over the period 1990-2012, emissions of CO_2 were decreased:

- from 113.3 Mt to 105.5 Mt (without consideration of LUCF);
- from 111.7 Mt to 102.7 Mt (with consideration of sink in LUCF sector).

Decrease in emission of carbon dioxide is mainly associated with increased share of natural gas in the overall pattern of fuel consumption, modernization of energy-consuming industry enterprises, transition to use more efficient technologies and renewal of transport park.

Methane. Over the period 1990-2012 emissions of methane were increased from 54.2 Mt CO_2 eq. to 88.4 Mt CO_2 eq.(See Figure 2.3).

Increase in methane emissions in Energy sector is associated with increase in natural gas extraction, growth of technological gas leakages as a result of increased volumes of gas transportation (including gas transit). Increase in methane emissions was also caused by growth of large cattle and sheep population in Agriculture sector and increase in volume of solid domestic wastes in Waste sector, associated with growth of urban population.

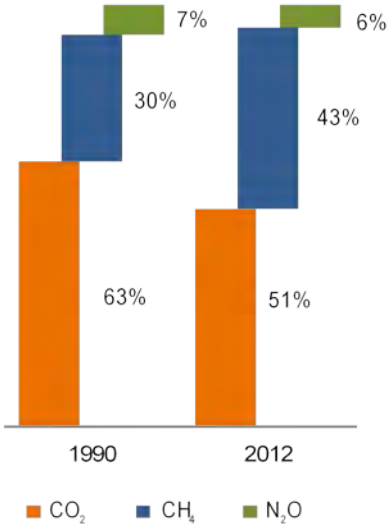


Figure 2.3 | *Change in Share of Particular GHG in Total Emissions*

Nitrous oxide. The total emission of N_2O was reduced by 13.8% (See Table 2.1 and Figure 2.3). Decrease in N_2O emissions is mainly associated with diminution in application of nitrogen fertilizers in agriculture, as well as with implementation of CDM Projects on enterprises producing nitric acid.

Hydrofluorocarbons (HFC). Emissions of hydrofluorocarbons are evaluated for period 2000–2012. Over this period the HFC emissions were increased by 15.7 times, resulting from growth of refrigerating fluid usage in the country, although their contribution to the total emission is insignificant.

Table 2.1 | *Greenhouse Gas Emissions in the Republic of Uzbekistan, Mt CO_2 eq.*

GHG	1990	1995	2000	2005	2010	2012	$\Delta_{(2012-1990)}$
CO_2	113,2	101,0	108,6	100,9	101,8	105,5	-6,7%
N_2O	13,0	11,5	10,7	9,4	10,4	11,2	-13,8%
CH_4	54,2	71,7	78,7	85,9	87,0	88,4	63,1%
HFCs	-	-	0,006	0,012	0,022	0,094	
Total	**180,4**	**184,2**	**198,0**	**196,2**	**199,2**	**205,2**	**13,7%**

Note:* - Data on change in HFC emissions for period 1990-2012, are not presented due to lack of data for 1990.

2.3 Emissions Trend by Gases with Indirect Greenhouse Effect and Sulphur Dioxide

Emission of gases with indirect greenhouse effect is mainly associated with combustion of fuel in Energy sector for generation of electric energy and heat, as well as fuel consumption by motor-vehicle transport. Industrial processes sector contributes small volume to the total emission of these gases.

In 2012, emission of gases with indirect greenhouse effect from sources included in inventory was as follows:

- CO_2 – 1,035 Gg;
- NO_x – 276 Gg;
- NMVOC – 271 Gg;
- SO_2 – 201 Gg.

During the period 1990-2012, it was observed the substantial decrease in emission volume for the whole group of the considered gases (See Figure 2.4). Against the baseline level in 1990, volume of CO_2 emissions was decreased by 47%, NOx and NMVOC – by 25%, SO_2 – by 71%.

Decrease in emission volume of gases with indirect greenhouse effect is associated with increase in share of natural gas consumption by population and industrial enterprises, as well as implementation of governmental policy aimed at renewal of industrial enterprises, and introduction of technologies for intercepting evolved gases, change-over of automobile transport to run on liquefied and compressed natural gas.

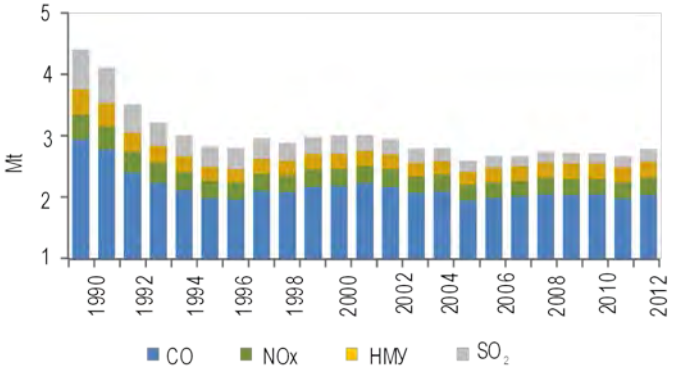


Figure 2.4 | *Gases Emissions with Indirect Greenhouse Effect*

2.4 Greenhouse Gases Emission Trends by Sectors

The Energy sector with contribution of 82%, or 168.1 Mt CO_2 eq. (See Figure 2.5) dominates in the total anthropogenic Greenhouse Gases Emissions. In 2012, greenhouse gases emission in this sector increased by 11.2% against 1990.

The Agriculture Sector takes the second place according to GHG emissions. In 2012, greenhouse gases emission in this sector was 21.6 Mt CO_2 eq. Against 1990, emissions were increased by 26.3%. As a result of cattle breeding development, share of this sector in the total emission over this period was also increased from 9.4 to 10.5% (See Table 2.2).

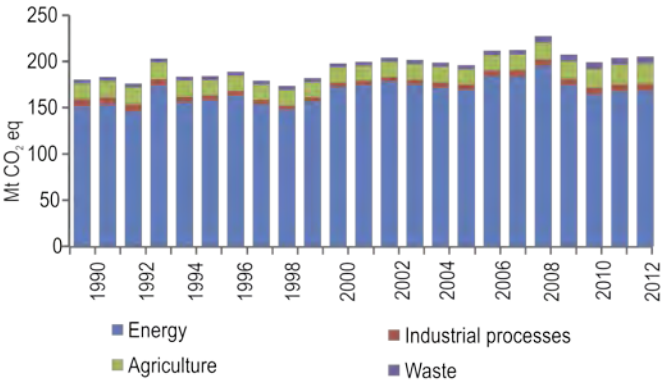


Figure 2.5 | *Greenhouse Gas Emissions by Sectors*

Trend toward decrease in greenhouse gases emission is observed in Industrial processes sector. Reorganization of industry after gaining independence by the Republic of Uzbekistan has led to closing some unprofitable enterprises and gradual reduction in greenhouse gases emission. In 2012, the emission was 7.8 Mt of CO_2 eq., or decreased by 1.5% against 1990. During this period share of the sector in the total GHG emission decreased from 4.5 to 3.8%.

Table 2.2| *Greenhouse Gas Emissions and Sinks by Sectors, Mt CO_2 eq.*

Sector	1990	1995	2000	2005	2010	2012	$\Delta_{(2012-1990)}$
Energy	151,2	157,9	172,4	169,2	164,1	168,1	+11,2%
Industrial Processes	8,1	5,3	4,9	6,2	7,9	7,8	-3,7%
Agriculture	17,0	16,7	16,2	16,1	19,9	21,6	+27,1%
LUCF	-1,6	-1,4	-1,0	0,4	-3,1	-2,9	+81,3%
Waste	4,1	4,3	4,5	4,7	7,3	7,7	+87,8%
Total emissions with LUCF	**178,8**	**182,8**	**197,0**	**196,6**	**196,1**	**202,3**	**+13,1%**
Total emissions without LUCF	**180,4**	**184,2**	**198,0**	**196,2**	**199,2**	**205,2**	**+13,7%**

Over period 1990-2012, sinks of CO_2 in Land Use Change and Forestry sector was increased by 1.8 times, which is associated with increase in area of forests after 2006, as a result of implementation of the governmental program for Forestry development. In addition, calculations of CO_2 sinks by forests biomass were affected by the changes in the order of State inventory of forests area, adopted in 2008.

Over the period 1990-2012, greenhouse gases emission in Waste sector was increased from 4.1 Mt of CO_2 eq. to 7.7 Mt of CO_2 eq. The main reason of observed increase in emissions in this sector is increase in methane emission in category "Solid waste disposal", which in turn is associated with urban population growth. Over the period 1990 – 2012, contribution of Waste sector in the total greenhouse gases emission was increased from 2.3% to 3.8%.

2.4.1 Energy Sector

Energy sector has the highest contribution to the total anthropogenic emission of greenhouse gases in Uzbekistan.

GHG emissions in this sector are associated with combustion of fossil fuel (oil, natural gas and coal) and technological leakages of methane along with extraction, processing and transportation of natural gas.

From 1990 to 2012, share of emissions from "Fuel combustion" was decreased from 71% to 59%, and share of "Methane leakages" in Oil & Gas sector and coal extraction was increased correspondingly (See Figure 2.6). Emission increase, associated with methane leakages, is mainly stipulated by increase in volume of natural gas processing and transportation (including transit gas).

Results of calculation of various Greenhouse Gases Emissions by two main categories (Fuel combustion and Methane leakage) in Energy sector are presented in Table 2.3.

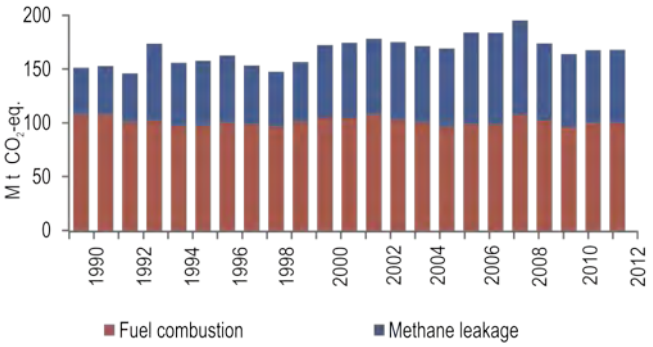


Figure 2.6 | *GHG Emissions in Energy Sector from Main Categories*

Table 2.3 | *Greenhouse Gas Emissions in Energy Sector, Gg CO_2 eq.*

Category	GHG	1990	1995	2000	2005	2010	2012
Fuel combustion	CO_2	107009	97224	105016	96088	95704	99581
	CH_4	385	139	147	145	175	224
	N_2O	177	105	110	93	87	94
Methane leakage	CH_4	43628	60429	67174	72906	68100	68237
Total		**151199**	**157897**	**172447**	**169232**	**164066**	**168135**

Fuel Combustion. Process of organic fuel combustion is accompanied by emission of three greenhouse gases: CO_2, CH_4 and N_2O. In the total emissions from "Fuel combustion", share of carbon dioxide is 99.7%. Contribution of methane and nitrous oxide is insignificant and equals to not more than 0.3%.

In 2012, volume of CO_2 emission from "Fuel combustion" was 99.58 Mt, indicating decrease by 6.9% against 1990. This was enabled by change in fuel consumption pattern (decrease in share of coal and increase in share of natural gas in the fuel balance), implementation of measures on energy saving and improvement of energy efficiency, and modernization of Industry in the country.

In accordance with the IPCC methodology, the categories of Emission sources (presented in Table 2.4) from fuel combustion have been considered in calculation of greenhouse gases emission. The calculations indicate that in "Fuel Combustion" category the largest sources are: "Energy Industries", "Institutional/Commercial" and "Residential" categories, which included in the list of the key categories of Greenhouse Gases Inventory.

Over the period 1990-2012, pattern of GHG emissions from "Fuel combustion" by some categories was changed significantly (See Table 2.4):

- total share of "Institutional/Commercial" and "Residential" categories was increased from 18% to 44%;
- share of emissions from "Energy Industries" was decreased from 51.2% to 33.1%.

Table 2.4 | *Greenhouse GasEmissions from Fuel Combustion by Source Categories, Gg CO_2 eq.*

Source Categories	1990	1995	2000	2005	2010	2012	$\Delta_{(2012\text{-}1990)}$
Energy Industries	55205	44987	44359	37022	31595	33990	-38,4%
Manufacturing Industries and Construction	10199	6244	4995	5397	7540	8039	-21,1%
Transport	16574	8172	11179	9639	12805	12437	-25,1%
Institutional/Commercial	6871	9397	9053	10719	10483	19972	+191,2%
Residential	12504	24564	32777	31183	32018	23961	+94,9%
Agriculture	5715	3887	2704	2032	1392	1310	-77,0%
Other*	503	217	206	334	133	190	-62,4%
Total	**107571**	**97468**	**105273**	**96326**	**95966**	**99899**	**-38,4%**

Note: *- According to IPCC methodology, consumption of lubricants is considered under category "Other"

The main reason of these changes is increase in fuel consumption due to population growth, increase in living floor area and development of infrastructure over the recent 20 years.

Noticeable decrease in GHG emissions is observed in categories "Transport", "Manufacturing Industries and Construction", "Agriculture" and "Other" as a result of liquid and solid fuel substitution for natural gas, introduction of new technologies, modernization of production, renewal of transport park and change-over of significant part of automobile transport to run on liquefied and compressed natural gas (Figure 2.7).

Methane Leakage. In the "Methane leakage" category, methane emissions formed along with extraction, processing, transportation and storage of fossil fuel has been calculated. Sources of methane emissions are subdivided into four categories:

- Coal Mining;
- Oil;
- Natural Gas;
- Venting and Flaring.

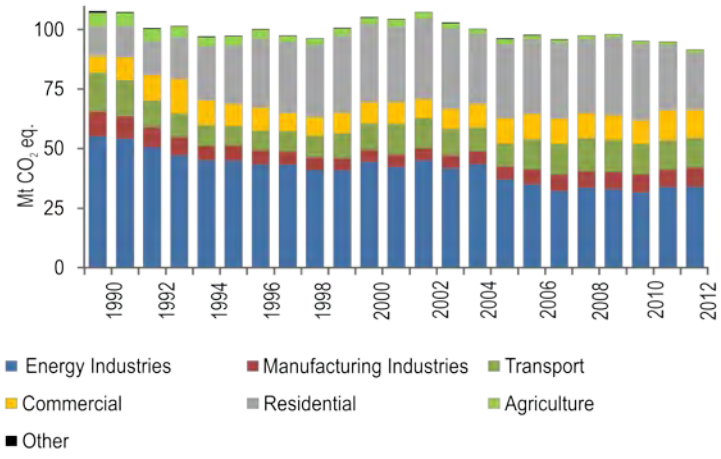


Figure 2.7 | *Greenhouse Gas Emissions in "Fuel combustion" Category*

Share of methane emission in category "Gas" is 99%. This category is the largest, *key* category for both the Energy sector and National Cadastre of GHG as a whole: in 1990, its contribution to the total emissions was 23.9%, and in 2012, – already 33.2%.

2.4.2 Industrial Processes Sector

In 2012, share of GHG emissions in the *Industrial Processes* sector was 3.8% from the total emissions. This sector comprises GHG emissions, generated as a result of:

- processing and use of mineral raw materials (production of cement, lime, use of soda ash);
- production activities of chemical enterprises (production of nitric acid, ammonia, methanol and polyethylene);
- metal production (steel production);
- consumption of hydrofluorocarbons (HFCs).

The most significant source is "*Chemical industry*". In 2012, its contribution to sectoral emissions was 46%. The next source by its significance is "*Mineral Products*" with 38%. Emission of metallurgy is 16%.

Dynamics of GHG emissions from various types of production is presented in Figure 2.8. From 2003, with growth and development of economy in the country, trend towards increase in GHG emissions in all categories of the Industrial Processes sector was observed. By 2012, it not achieved level of 1990.

Over the period 1990-2012, sectoral pattern of GHG emissions was changed to some extent. In particular, emission from *"Chemical industry"* was decreased by 5%, and from *"Metal production"* it was increased by 4%.

Carbon dioxide with share of 76% dominates in the total volume of emissions (See Table 2.5). The main sources of CO_2 emissions are production of cement clinker, ammonia and steel.

Share of nitrogen oxide, generated along with production of nitric acid, is 22.8%.

Emissions of HFCs and methane are insignificant and in total equal to not less than 1.2%.

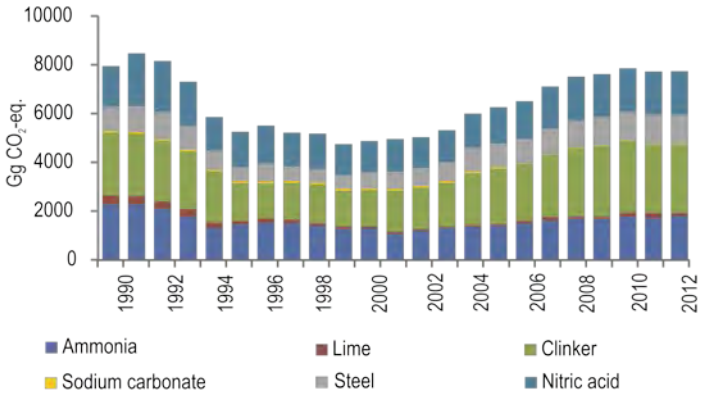


Figure 2.8 | *Greenhouse Gas Emissions in Industrial Processes Sector*

List of the key sources of GHG cadastre comprises categories *"Cement Production"*, *"Nitric Acid Production"* and *"Ammonia Production"* with their contributions to the total Emissions in 2012, of 1.4%, 0.9% and 0.9% respectively

Table 2.5 | *Greenhouse Gas Emissions in Industry Processes sector, Gg CO_2 eq.*

Source Categories	GHG	1990	1995	2000	2005	2010	2012
Mineral Products	CO_2	3007	1765	1633	2406	3127	2965
Chemical Industry	CO_2	2272	1445	1292	1396	1762	1783
	N_2O	1782	1457	1287	1479	1789	1783
Metal Production	CO_2	998	587	665	972	1170	1200
Other production	CH_4	-	-	-	3	3	3
Consumption of hydrofluorocarbons	(HFCs)	-	-	6	12	22	94
Total		**8059**	**5254**	**4883**	**6268**	**7873**	**7828**

2.4.3 Agriculture Sector

Share of Agriculture sector in the total volume of GHG emissions is 10.5%. Emission sources of methane and nitrogen oxide are the following categories:

- Enteric fermentation;
- Manure management;
- Agricultural soils;
- Rice cultivation;
- Field burning of agricultural residues.

Over the period 1990-2012, GHG emission in this sector was increased by 27%. In 2012, it was 21.65 Mt of CO_2 eq.

Methane emission in the sector was increased to 98.2%, caused by growth of large cattle and sheep population. Emissions of nitrogen oxide were reduced by 17.3% as a result of decrease in nitrogen fertilizer application rates on crops.

As compared with 1990, GHG emission pattern by sector categories has been changed significantly. Contribution of *"Field burning of agricultural*

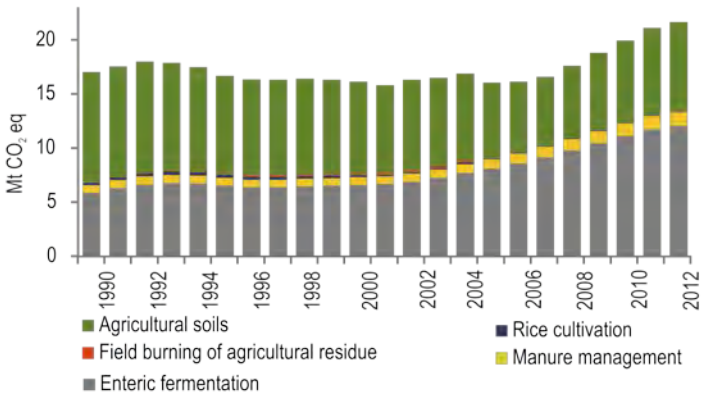


Figure 2.9 | *GHG Emissions in Agriculture Sector*

residues" category has been reduced to zero, which is associated with prohibition on burning cereals crop residues from 2005.[2] Share of "*Rice cultivation"* category was decreased by 1.1%, due to considerable decrease in land area under rice. Development of cattle breeding led to increase in GHG emission from category "*Enteric fermentation"* by 21.4% and "*Manure management"* - by 1.8% (See Figure 2.9).

The categories "*Enteric fermentation"* and "*Agricultural soils"* are the *key* categories of this sector and cadastre of GHG as a whole. In 2012, their contributions in the total national GHG emission were 5.9% and 4.0% respectively.

2.4.4 Land Use Change and Forestry (LUCF) Sector

Emissions and sinks are considered in the sector LUCF in categories "*Changes in Forests and other woody biomass stocks"* and "*CO_2 emissions and sinks from Soils associated with land-use change*".

In 2012, CO_2 net sinks in LUCF sector was 2.86 Mt CO_2, or 2.7% from the total CO_2 emission and 1.4% from the total GHG emission. The net sinks of CO_2 in this sector over period 1990-2012 were increased in absolute value by 82.5% (See Table 2.6).

Table 2.6 | *Emissions and Sinks in LUCF Sector, Gg CO_2*

Source Categories	1990	1995	2000	2005	2010	2012
Changes in forests and other woody biomass stocks	-421	-399	-751	-562	-3590	-3590
CO_2 emissions and sinks from soils associated with land-use change	-1145	-998	-267	+980	+525	+732
Net Values	**-1566**	**-1397**	**-1018**	**+417**	**-3065**	**-2858**

Removal of CO_2 in LUCF sector is mainly identified by biomass accumulation in forests. The main CO_2 sinks in the country are desert forests, which in spite of their low productivity, occupying considerable land area. Increase in carbon dioxide sink by forests, observed from 2008, is explained by change in the inventory order of the State Forest Fund. Part of agricultural lands was attributed to forest fund. In addition, forests area in the country has been increased resulting from fulfillment of the Governmental programs for afforestation of desert territories in the Navoi, Bukhara provinces and Karakalpakstan.

In the category *CO_2 emissions and sinks from soils associated with land-use change* after 2000, only CO_2 emissions are observed, leading to decrease in carbon supply in agricultural soils. Shift from sinks to emissions of CO_2 from soils with change in land use is related to considerable reduction in area under rice and some reduction in pasture areas.

2.4.5 Waste Sector

In *Waste* sector GHG emission in categories "*Solid waste disposal on land"*, "*Domestic and commercial wastewater"* and "*Industrial wastewater"* have been considered. The main GHG in the sector are methane and nitrogen oxide. Share of methane in the total sectoral GHG emission is 91.8%.

In 2012, GHG emission in the sector was 7,660 Gg CO_2-eq. (See Table 2.7). The main GHG sources in the sector are "*Solid waste disposal on land*" (CH_4) and "*Domestic wastewater"* (CH_4 and N_2O), with 99% of the total emission share. Contribution of category "*Industrial wastewater*" (CH_4) in sectoral emissions is insignificant (See Table 2.7).

Table 2.7 | *Greenhouse Gas Emission in Waste Sector by Source Categories, Gg CO_2 eq.*

Source Categories	GHG	1990	1995	2000	2005	2010	2012
Solid waste disposal on land	CH_4	3343	3523	3705	3786	6379	6650
Industrial wastewater	CH_4	60	37	34	41	55	61
Domestic and commercial wastewater	CH_4	240	253	272	281	315	322
	N_2O	479	532	486	551	601	627
Total		**4122**	**4345**	**4497**	**4659**	**7350**	**7660**

2 Decree No. 76, dated 16 May 2005, of the President of the Republic of Uzbekistan "On Arrangement Measures for Cereals Harvesting"

The category "*Solid waste disposal on land"* is the key category of GHG Cadastre. Its contribution to the total GHG emission in 2012 was 3.2%.

Over period 1990-2012, GHG emission in *Waste* sector was increased by 85.8%. Increase in emissions, observed in categories "*Solid waste disposal on land"* and "*Domestic wastewater*" is directly associated with increase in the country's population and calculated based on these values.[3] Considerable increase in urban population took place in 2008, which is associated with changeover of some settlements status for "*Towns"* category.

2.5 Institutional Arrangements and Process of Greenhouse Gases Cadastre Preparation

In accordance with the Decree of Cabinet of Ministers of the Republic of Uzbekistan No. 183, dated 14 April 2004, the Centre of Hydrometeorological Service at the Cabinet of Ministers of the Republic of Uzbekistan (Uzhydromet) is appointed as the Agency responsible for preparation of the GHG Inventory in Uzbekistan. Uzhydromet is the National Executive Agency for implementation of the United Nations Framework Convention on Climate Change (UNFCCC).[4]

The national team for preparation of Greenhouse Gases Inventory has been formed on the basis of one of Uzhydromet departments – Air, Surface Water and Soil Pollution Monitoring Service, which is entrusted with coordination of Inventory preparation. All information for Inventory is collected, compiled and stored in this service.

For fulfillment of specific tasks, experts from various ministries, agencies, organizations and industrial companies are engaged, who provide data on activities being performed and other necessary information, make calculations and prepare documentation (Figure 1.22).

2.5.1 Methodology

Assessments of GHG emissions/sinks have been carried out in compliance with the IPCC methodology, set forth in the following documents[5]:

- "Reporting on Climate Change User Manual for the Guidelines on National Communications from Non-Annex I Parties (2004)";
- "1996 IPCC Revised for National Greenhouse Gas Inventories" (Volumes 1-3);
- "2000 IPCC Guide Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories,";
- "2003 IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry";
- "2006 IPCC Guidelines for National Greenhouse Gas Inventories" (Volumes 1 – 5).

The following sources have also been used for preparation of the National Greenhouse Gases Cadastre:

- national normative, legal and technical documents, result of studies performed within the framework of national projects;
- official statistical data on production in various sectors of economy;
- expert judgments;
- information from international organizations (statistical databases of the International Energy Agency (IEA), UN Food and Agricultural Organization (FAO));
- other literary sources.

Emission factors are mainly used in accordance with the IPCC Guidelines by default. The national emission factors have been calculated for a number of source categories. Their use has allowed reducing degree of Cadastre Uncertainties.

The standard 1996 IPCC Software with some modifications in Worksheets, introduced in compliance with the national circumstances, has been used for calculation of GHG emissions.

[3] Statistical Yearbook of the Republic of Uzbekistan for 2012, Tashkent: State Committee on Statistics of RUz, 2013. – 356 pages.
[4] Decree of the Cabinet of Ministers of the Republic of Uzbekistan No. 183, dated 14 April 2004, "On improving Hydro-meteorological Service of the Republic of Uzbekistan"// Law Book of RUz, 2004, No 15 (179)
[5] Guidelines for National Greenhouse Gas Inventories, IPCC, 2006, (Volumes 1 – 5)

2.5.2 Quality Assessment and Quality Control (QA/QC) of GHG Cadastre

Procedures of QA/QC have been conducted as part of the *Good practice* for improvement of the National Inventory quality in compliance with the IPCC Guidelines 2000 and 2006.

In the first stage of QA/QC the completeness, comparability and consistency of time series data have been assessed, control and refinement of emission factors carried out. In the second stage of QA/QC, the correctness of calculations and obtained results has been checked.

Preparation of emissions/removals Cadastre has been commenced after completion of the QA/QC procedure.

Then National Inventory Report has been submitted to independent expertise in the ministries and agencies concerned of the country. All the comments received have been taken into account in the final version of the National Inventory Report.

2.5.3 Key Sources of GHG Emissions

Sources with 95% of the aggregated emissions at least by one of criteria (level or trend) are considered as *key* ones for GHG Cadastre. In the Third National Communication the *key* sources have been analyzed by Tier1 method in compliance with the IPCC Guide 2000. The analysis comprises all the assessed categories of sources, apart from emissions and sinks in LUCF sector.

In 2012, 22 key categories were revealed, including 16 categories in Energy sector, 3 categories in Industrial Processes sector, 2 - in Agriculture sector and 1 - in Waste sector.

The largest key sources of GHG emissions with the aggravated contribution of 66.9% from the total GHG emissions are:

- Methane emissions in *"Oil"* and "*Gas*" categories (33.2%);
- Natural gas combustion in "*Energy Industries"* category (13.3%);
- Natural gas combustion in "*Residential"* category (11.2%);
- Natural gas combustion in "*Institutional/Commercial"* category (9.2%).

2.5.4 Assessment of Uncertainties

Uncertainty characterizes degree of scatter and probable deviations of data against their true values. The General Uncertainty is a combination of uncertainties of GHG Emission factors and uncertainties of Activity Data.

In preparation of the Third National Communication the Uncertainty of greenhouse gases emissions has been assessed by Tier 1 Approach.[6] Minimum values of uncertainties have been received for those categories, which used the national statistics data and national Emission factors.

Uncertainty of Cadastre has been assessed for 99.7% of GHG emissions, including all key sources. In 2012, sum of emissions by the categories with completed uncertainty assessment was 204770.51 Gg CO_2 eq. Uncertainty of emissions by level was ±8.4%, and uncertainty by trend was also ±8.4%.

As a result Analysis the uncertainties have been assessed for:

- 99.8 % of CO_2 emissions;
- 99.8% of CH_4 emissions;
- 99.9 % of N_2O emissions.

In Energy sector uncertainty has been assessed for 99.8% of GHG emissions. Sum of emissions was 167.82 Gg CO_2 eq. Level of Emissions Uncertainty was ±5.1%; trends uncertainty was ±6.4%.

In Industrial Processes sector uncertainty has been assessed for 98.75% of GHG emissions. Sum of emissions was 7.73 Gg CO_2 eq. Level of emissions uncertainty was ±11.4%; trends uncertainty was ±2.6%.

In Agriculture sector uncertainty has been assessed for 99.6% of GHG emissions. Sum of emissions was 21.56 Gg CO_2 eq. Level of emissions uncertainty was ±65.7%; trends uncertainty was ±79.1%.

[6] Guide on Good Practice and Uncertainty Management in National Greenhouse Gas Inventories. - IPCC, 2000

In Waste sector uncertainty has been assessed for 100.0% of GHG emissions. Sum of emissions was 7.66 Gg CO_2 eq. Level of emissions uncertainty was ±59.7%; trends uncertainty was ±32.7%.

High level of uncertainties in the "Agriculture" and "Waste" sector is mainly associated with use of default emission factors and uncertainties of activity data.

2.5.5 Inventory Completeness

The conducted inventory covers all the key GHG emission sources and sinks on the entire territory of Uzbekistan.

GHG cadastre comprises:

- emissions of all the main gases with direct greenhouse effect, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and sum of hydrofluorocarbons (CH_2F_2, C_2HF_5, $C_2H_2F_4$, $C_2H_3F_3$).
- emissions of gases with indirect greenhouse effect: carbon monoxide (CO), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2).

Inventory does not include emissions of sulfur hexafluoride (SF_6) and perfluorocarbons (PFCs) due to lack of the state reporting of their use. From Agriculture sector, the category "Field burning of agricultural residues" has been excluded from calculations due to introduction in 2005 legal prohibition for burning of cereal residues[7].

For improving of assessments and increasing quality of information on GHG emissions in the Republic of Uzbekistan, the emissions by some categories for period 1990-2005, have been recalculated against assessments of the Second National Communication on UNFCCC. Reasons for recalculation are:

- updated activity data and emission factors;
- appearance of new or close of activities of existing emission sources;
- correction of assumptions made.

Values of the total annual emissions obtained as a result of recalculation are lower than the ones presented in the Second National Communication. Minimum difference between assessments of annual greenhouse gases emissions in the Second and Third National Communications has been obtained for 1997 (0.8 %), maximum one (2.0%) - for 1993.

2.6 Development and Capacity Building Priorities in GHG Inventory

Currently the national GHG inventory in Uzbekistan is carried out only within the framework of the National Communications preparation. In aid of ensuring compliance with the country's commitments, including to Article 12 of Convention (periodically make available GHG cadastre to the UNFCCC), as well as for fulfillment of FCCC decisions on preparation of Biennial Reports (Decision 2/CP17, Durban, 2011), it is necessary to establish permanently functioning governmental system for evaluation of greenhouse gases emissions/sinks from various emission sources.

Despite considerable achievements there are some gaps and limitations hindering preparation, collection and quality check of data for evaluation of greenhouse gases emission. Elimination of these gaps and limitations takes a lot of time and resources.

The main gaps and drawbacks of the current inventory are:

- due to lack of the governmental accounting not all greenhouse gases are included in inventory (e.g. sulfur hexafluoride (SF_6) and perfluorocarbons (PFCs));
- for preparation of GHG cadastre the Tier 1 Approaches and methodologies of the IPCC Guidelines (1996) have been mainly used, which is associated with lack of detailed technical and statistical information about activities of some emission sources;
- in majority of cases emission factors by default have been used for calculation of GHG emissions, which can not reflect national conditions to the full extent.

For further improvement of the national inventory system and cadastre quality, the following tasks should be resolved:

[7] Decree No. 76, dated 16 May 2005, of the President of the Republic of Uzbekistan "On Arrangement Measures for Cereals Harvesting"

- expansion of GHG cadastre on account of coverage of new sources of greenhouse gas emissions and greenhouse gas types;
- decrease in level of cadastre uncertainty on account of development and use of the national emission factors in all the key categories;
- transition to use of advanced methodologies, Software and other tools of the IPCC for evaluation of GHG emissions and sinks in all economy sectors;
- expert capacity building through participation in training courses, international workshops and study of other counties experience.

CURRENT POLICY AND MEASURES FOR GREENHOUSE GASES EMISSION REDUCTION

3 CURRENT POLICY AND MEASURES FOR GREENHOUSE GASES EMISSION REDUCTION

3.1 Regulatory and Legal Framework

Principles of sustainable country development are the cornerstone of legal framework, national and sectoral programs of Uzbekistan in the area of energy and resources saving. Although these documents do not contain clear statements indicating that proposed measures are aimed at decrease in GHGs emission, their implementation contributes to solution of the global problem associated with climate change prevention.

In Uzbekistan the main source of GHGs emission is "Energy" sector. Therefore, legislative acts related to energy saving, energy efficiency and renewable energy sources have mainly been considered in analysis of regulatory and legal framework associated with GHGs emission decrease and increase in their sink.

Laws. Amongst the main legislative acts, regulating and ensuring fulfillment of measures on reduction in GHGs emission are laws of the Republic of Uzbekistan "On air protection", "On rational energy use", "On electrical energy industry", "On waste", etc. (see Table 3.1).

Table 3.1 | *Laws of Republic of Uzbekistan Associated with Energy Saving and Energy Efficiency*

Law	Year	Main Contents
"On air protection"	1996	The Law regulates activity of enterprises, associated with pollutants emission. Article 24 specifies that enterprises and institutions are obliged to save fuel and energy resources through introduction of energy saving technologies and alternative energy sources, thereby reducing GHGs emission.
"On rational energy use"	1997	The Law envisages "state control over compliance with indices of energy efficiency and energy quality, established by normative documents", which should be revised every 5 years (Article 6). Article 10 notes that the State committee on statistics is responsible for carrying out statistical observations of energy generation and consumption. Article 13 determines conditions for carrying out obligatory energetic surveys in enterprises with the total annual energy consumption of more 6,000 thousand t.e.f. Preferential tariffs may be granted to enterprises and institutions in case of reduction in energy consumption versus established norms or manufacturing products with energy content less than established normative (Article 19). It is mentioned in Article 20 that independent energy producers "have a right to sell energy" to owners of electric power grids "in amounts and regimes ensuring the most rational operational mode of power grids and sources of centralized electric energy supply". Electric energy supply authorities should ensure procurement of electric energy by prices formed in accordance with the established order. Article 21 envisages administrative responsibility of physical and legal entities for irrational use of energy.
"On waste"	2002	The Law regulates relations between various entities in regard to collection, storage and processing of wastes. In particular, the Law determines obligations of physical and legal entities for ensuring collection, proper storage and prevention of destruction and damage to wastes of resource value, subjected to utilization. The Law obliges waste keepers to undertake measures on development and introduction of technologies for waste utilization. Some articles of the Law were amended in 2003 and 2011.
"On electrical energy industry"	2009	The Law secures the existing legal framework in this sector. It is mentioned in the Law that thermal electric power stations/plants (TEPS/TEPP) and hydropower stations that use renewable energy sources and connected to the united power grid, may belong to the state or private companies (Article 10). Enterprises of territorial electrical grids, which belong to the JSC "Uzbekenergo", "may transfer to private operators some issues related to sale of electric energy within district or city" in accordance with order, established by the Cabinet of Ministers of RUz (Article 18).

Special laws on energy efficiency, thermal energy sector and renewable energy sources have not been adopted in Uzbekistan so far. The developed draft law "On renewable energy sources" is currently under consideration and coordination stage. The Law "On thermal energy" is being refined.

The above mentioned laws are of indirect actions, therefore bylaws and other normative documents are being developed and adopted to enable their implementation. The Laws are being amended as needed and when necessary.

Decrees and Resolutions. Current regulatory legal acts that to various extents related to energy saving and use of RES in extraction/generation, transportation and end use of primary and secondary energy are presented in Table 3.2 below. The normative acts, identifying the national legal framework for implementation of CDM projects, are also included in this Table.

Table 3.2 | *Regulatory Legal Act in Area of CDM, Generation, Transmission and Consumption of Energy*

Date and Number	Name
Decrees and Resolutions of the President	
6 December 2006, No PP-525	On Measures for Implementation of Priority Investment Projects within Clean Development Mechanism of the Kyoto Protocol
15 December 2010, No PP-1442	On Priority Directions for Industry Development of the Republic of Uzbekistan in 2011-2015
04 October 2011, No PP-1623	On Program of High Priority Measures for Expansion of Production Volumes and Manufacturing New Competitive Types of Products
1 March 2013, No UP-4512	On Measures for Further Development of Alternative Energy Sources
1 March 2013, No PP-1929	On Establishment of International Solar Energy Institute
4 March 2015,. No UP-4707	On Program of Measures for Ensuring Structural Transformation, Modernization and Diversification of Production for 2015-2019
6 March 2015, No PP-2313	On Program for Development and Modernization of Engineering Communication and Motor Road Infrastructure for 2015-2019
5 May 2015, No PP-2343	On Program of Measures for Reduction in Energy Consumption, Introduction Energy Saving Technologies in Economy Sectors and Social Sphere for 2015-2019
Decrees of the Cabinet of Ministers	
10 January 2007, No 9	Provision on Procedure for Preparation and Implementation of Investment Projects under Clean Development Mechanism (CDM) within the Kyoto Protocol Framework
22 August 2009, No 245	On Approval of Rules for Use of Electrical and Thermal Energy
19 March 2009, No 78	On Measures for Development of Concept for Reformation of Heat Supply System and Program of Modernization and Development of Heat Supply System in the Republic for 2009-2015
17 February 2010, No 23	On Measures for Implementation of Law of the Republic of Uzbekistan "On Electrical Energy Industry"
27 April 2010, No 66	Changes in "Rules of Electrical and Thermal Energy Use "
13 December 2010, No 294	On Program for Modernization and Renewal of Low Voltage Electrical Grids for 2011—2015
5 June 2013, No 158	On Measures for Gradual Renewal of Pump/Power Equipment in Water Management Organizations of the Ministry of Agriculture and Water Resources of the Republic of Uzbekistan in 2014- 2018
06 June 2013, No 161	On Approval of Program for Modernization, Technical and Technological Re-equipping of Coal Mining Industry Enterprises and Its Balanced Development for 2013-2018
6 November 2013, No 300	On Measures for Financial Enhancement of Water and Heat Supply Agencies of Republic
5 March 2014, No 52	On Approval of Provision on Order for Licensing of Energy Supply
24 June 2014, No 169	On Approval of Gas Use Rules in Economy Sectors
9 April 2015, No 86	On Measures for Introduction in the Republic of System for Obligatory Labeling and Certification of Selling Household Electric Appliances and Newly Constructed Buildings and Structures
13 August 2015, No 238	On Approval of Provision on the Republican Commission on Energy Efficiency Issues and Development of Renewable Energy Sources
29 August 2015, No 255	On Integrated Program for Mitigation of the Aral Sea Disaster Impacts, Rehabilitation and Socio-economic Development of Priaralie Region for 2015 — 2018
20 October 2015, No 299	On Measures for Development of Domestic Production of Energy Saving Lamps
02 November 2015, No 309	On Improvement of System for Metering Electric Energy and Natural Gas Consumption
16 November 2015, No 331	On Program for Development of Hydropower Industry for 2016-2020
26 November 2015, No 343	On Measures for Promotion of Biogas Plants Construction in Cattle Breeding and Poultry Farms of Republic

The Decree of the President of the Republic of Uzbekistan "On Measures for Implementation of Priority Investment Projects within the Kyoto Protocol Framework for Clean Development" identifies the main rules for implementation of CDM projects in Uzbekistan, including institutional framework: the Interdepartmental Council on Clean Development Mechanism (CDM) and the National Agency on CDM in the name of the Ministry of Economy. The procedures for selection, approval, implementation of CDM projects, and selection of CDM investors have been approved by the Decree of the Cabinet of Ministers of the Republic of Uzbekistan "Provision on Procedure for Preparation and Implementation of Investment Projects under Clean Development Mechanism (CDM)".

One of the priority tasks of economic development of Uzbekistan is reduction in energy consumption on account of improvement in energy efficiency and introduction of clean technologies, including RES. This complicated task may be accomplished only with aid of improvement of legal framework. In response to time challenge, a number of important Decrees were adopted in 2015, aimed at toughening requirements to energy producers and consumers (see Table 3.3). It is expected that further decrease in energy consumption of the republic's economy will be an eventual output of implementing measures, included in these Decrees.

Table 3.3 | *Decrees of the Cabinet of Ministers of the Republic of Uzbekistan on Energy Efficiency, adopted in 2015*

Decree	Contents
PKM-86 "On Measures for Introduction in the Republic of System for Obligatory Labeling and Certification of Selling Household Electric Appliances and Newly Constructed Buildings and Structures"	The Decree identifies pattern and conditions for obligatory energy-consumption labeling locally made and imported household electric appliances, as well as newly constructed buildings. In particular, the State Committee on Architecture and Construction has to develop system for energy consumption labeling of newly constructed buildings.
PKM-238 "On Approval of Provision on the Republican Commission on Energy Efficiency Issues and Development of Renewable Energy Sources"	It is adopted Decree "Provision on the Republican Commission on Energy Efficiency Issues and Development of Renewable Energy Sources"[1] and identified tasks, rights and functions of the Republican Commission, as well as organizational structure and direction of the commission activities
PKM-299 "On Measures for Development of Domestic Production of Energy Saving Lamps"	The Decree envisages the whole set of measures for expansion of domestic production of energy saving lamps and their country-wide introduction. According to the Decree, use of inefficient electric filament lamps with capacity higher than 40W, will be prohibited on territory of the country from 1 January 2017.
PKM-331 "On Program for Development of Hydropower Industry for 2016-2020"	The Decree identifies the list of new hydropower stations to be constructed and existing hydropower stations to be upgraded that belong to JSC "Uzbekenergo" and Ministry of Agriculture and Water Resources. The Decree specifies that funds raised from energy selling generated by MAWR hydropower stations shall be directed to upgrading of existing and construction of new hydropower stations.
PKM-343 "On Measures for Promotion of Biogas Plants Construction in Cattle Breeding and Poultry Farms of Republic"	The Decree regulates conditions and rules for functioning of biological gases technologies market. Within the framework of GEF/WB Project implementation "Ensuring Sustainable Development of Agriculture and Mitigation of Climate Change Impact"[2], the credit lines, providing lax credits for construction of biogas plants, will be opened in 7 regions of the country.

It is worth to especially mention the Decree of the President of the Republic of Uzbekistan №PP-2343, dated 5 May 2015, "On Program of Measures for Reduction in Energy Consumption, Introduction of Energy Saving Technologies in Economy Sectors and Social Sphere for 2015-2019"[3]. In fact this document identifies the national policy and measures on energy efficiency, introduction of energy saving technologies, development of renewable energy sources for upcoming 5 years.

In the "Program – Road Map" on increase in energy efficiency, and introduction of energy saving technologies in economy and social sectors attached to the Decree, the particular actions have been considered, which should be undertaken for its fulfillment, including:

- decrease in energy consumption of output products;
- development of sectoral programs on energy saving and energy audit of enterprises;
- accelerated development of renewable energy sector;
- increase in production of advanced types of energy saving equipment and computer-aided systems for metering of fuel and energy resources consumption;
- ensuring energy efficiency in construction of new and reconstruction of existing administrative and residential buildings.

This Decree also contains target parameters of energy consumption reduction in the key sectors of economy.

Almost half from the total energy consumption is used for buildings heating/cooling. One of the effective actions for energy saving is integration of energy efficiency requirements into construction norms and rules. The "Norms of energy consumption for heating, ventilation and air conditioning of buildings and structures" (KMK 2.01.18-00*)[4] were revised in 2011. According to the new requirements, energy consumption of heating of buildings shall be reduced by 30-40% against existing level. It is planned that the above mentioned construction norms shall be revised every 5 years.

3.2 National and Sectoral Strategies and Programs

In accordance with the long-term development strategy, Uzbekistan strives to join to the group of countries with medium income level by 2030. This will require implementing structural transformation of economy. Currently, the development concepts are prepared and being discussed, and a number of programs with legally binding force are in effect. These programs are aimed at reduction in energy consumption, introduction of energy saving technologies in various sectors of economy and in social area.

[1] http://news.uzreport.uz/files/2015/08/14397939131.pdf
[2] http://www.vsemirnyjbank.org/projects/P127486/sustainable-agriculture-climate-change-mitigation-project-gef?lang=ru
[3] https://www.soliq.uz/ru/normative_legal_acts_tax/postanovleniya-prezidenta-respubliki-uzbekistan/o-programme-mer-po-sokrashcheniyu-energoemkosti-vnedreniyu-energosberegayushchikh-tekhnologiy-v-otra/
[4] KMK – Construction norms and rules

The prepared development concepts are reflected in:

- Report of the Center for economic studies (CES) "Uzbekistan towards 2030: Transition to Resource-efficient Growth Model (Vision-2030)", prepared under the UNDP/CES Project "Strategy of Structural Reforms of Uzbekistan for 2030 "Vision-2030";
- Report "Toward sustainable energy: strategy for low carbon development of the Republic of Uzbekistan", prepared under the joint UNDP/Ministry of Economy Project "Support to Uzbekistan in transition to low carbon development of national economy".
- Document "Strategy for improvement of buildings energy efficiency in Uzbekistan: direction of reforms and expected effects" prepared under the UNDP Projects "Improvement of energy efficiency in social buildings in Uzbekistan" and "Assistance to modernization, speed up reforms and transformation" jointly with the State committee on architecture and construction.

"Uzbekistan towards 2030: Transition to Resource-efficient Growth Model (Vision-2030)". Evaluation of efficiency in the current model of energy resources use and recommendations for transition to resource-efficient development model have been carried out on the basis of three scenarios: basic, realistic and optimistic. The basic scenario assumes that economic development will not be accompanied by drastic changes in the pattern and volumes of energy resources consumption, as well as increase in their extraction and generation. In the realistic scenario as a result of strengthening energy saving policy and adoption of a number of preferences it is observed the tangible energy resources savings and increase in their extraction and generation. The optimistic scenario assumes sharp increase in extraction of energy resources, as well as introduction of the most advanced energy saving methods.

According to expert assessments, if current trends and volumes of energy resources consumption in the republic during the nearest 15 years will remain at the same level, then by year 2030, their deficiency may be around 65.4% (Basic scenario). By the realistic scenario, energy resources deficiency in 2015 is estimated in 10.5%, and it may reach 32% by year 2030. In the optimistic scenario, when demand model complies with consumption model, there is no energy resources deficiency.

The carried out analysis, indicates that maintenance of steady high indices of the country's economic growth (8% of GDP on average) is possible only with transition to resources saving development model, including:

- continuation of structural economy transformation towards development of economy sectors with low energy consumption;
- creation of legal, financial and tax incentives for energy saving and use RES;
- improvement of system of transportation and logistical communications enabling efficient use of energy resources;
- implementation of sectoral and regional programs on energy saving and energy efficiency;
- implementation of programs on energy saving and energy efficiency in domestic household sector;
- gradual introduction of renewable energy sources;
- introduction of system for metering and paying for energy resources used for all categories of consumers;
- introduction of advanced system for detection of leakages and energy resources loss during transportation;
- modernization of all networks for transportation of primary and secondary energy sources;
- concentration of financial resources on geologic exploration works with use of the best technologies;
- countrywide introduction of the advanced methods for hydrocarbons extraction;
- ensuring reconstruction of existing and construction of new energy efficient residential and administrative buildings.
- From the carried out analysis it is also clear that the key driver of energy sector development up to 2030, should be expansion of solar energy use. Its contribution to energy balance of the country should grow up minimum to 6%. Creation of incentives for efficient energy use, including wide introduction of RES technology, will be of significant importance.

In the "Road map for implementation of strategy in energy sector for the period up to 2030" attached to the main document, the above mentioned main measures and actions are presented in details with indication of implementation terms and sources of financing.

"Towards sustainable energy: Strategy for Low Carbon Development of the Republic of Uzbekistan". The strategy is focused on assessment of possibilities for transition to low carbon development in the most energy consumptive sectors of the national economy: "Electrical energy", "Heat supply" and "Buildings". Recommendations for reduction in carbon consumption in these sectors have been prepared, including optimization of energy flows in "electrical energy industry" sector and use of renewable energy sources. For the above mentioned sectors of economy, the target indices on energy resources savings have been developed and predictive estimate of GHGs emissions up to 2030 and 2050 was made. Financing mechanisms of the proposed measures, including through climatic financing, have also been considered.

The "Road map for transition to low carbon development of the Republic of Uzbekistan", attached to the Strategy, is actually plan for implementation of specific measures and action (67 measures) for transition to the low carbon development, including:

- further improvement and liberalization of regulatory and legal framework, governs relations in "Electrical energy" sector;
- further improvement and increase in efficiency of institutional system for management of the "Electrical energy" sector;
- further improvement of mechanism for accounting in energy resources extraction/generation, transportation and consumption;
- energy saving measures in extraction and transportation of natural gas;
- energy saving measures in generation, transportation and consumption of electrical and thermal energy;
- energy saving measures in buildings.

Strategy for improvement of energy efficiency of buildings in Uzbekistan: direction of reforms and expected benefits.[5] According to expert assessments, capacity for energy resources saving on account of introduction of energy saving measures in residential and administrative buildings may by equal to around 2.19 million t.o.e by 2020, and up to 8.6 million t.o.e. by 2030.

The strategy for transition to energy efficient construction implies implementation of measures and actions by the following key directions:

- improvement of technologies for construction of energy efficient buildings and development of auxiliary productions;
- improvement of technologies for reconstruction of the existing buildings to improve their energy efficiency;
- improvement of norms and standards for buildings construction;
- deepening institutional reforms and creation of incentives for improvement of energy efficiency in buildings;
- development of integrated program on increase in energy efficiency of buildings for 2015– 2025;
- further development of market infrastructure and improvement of energy consumption management in residential and administrative buildings.

Sectoral Programs. The Programs for development of economy sectors, approved by the President or Government of the Republic of Uzbekistan and adopted in recent time, are presented on Table 3.4 below.

Table 3.4 | *Sectoral Programs, Associated with Energy Saving and Energy Efficiency*

Program	Implementation Period (years)	Main Contents
Concept for reformation of heat supply system in the Republic of Uzbekistan for 2010–2020	2010-2020	During the first stage, the programs for development and modernization of heat supply systems have been developed for 28 large cities of Uzbekistan. Concept of heat supply system development in Uzbekistan comprises measures on modernization and capital repair of boilers, reconstruction and rehabilitation of heat distribution networks, replacement and repair of worn-out main and distribution heat supply networks. Implementation of this Program will allow saving more than 1 billion m3 of natural gas and 400 million kWh of electric energy.
Program for priority development of electrical energy sector	2011-2015	The Program of JSC "Uzbekenergo" has envisaged implementation of 44 investment projects. In particular, on account of the advanced technologies introduction (combined-cycle plant and gas turbine plant) it was planned to increase the installed capacity up to 2.3 GW, as well as commissioning over 1,000 km of main (110-500 kV) and over 25 thousand km of distribution (0.4-35 kV) electric grids[6].
Program for modernization of technical and technological re-equipment of coal mining industry	2013-2018	The Program was adopted for further sustainable and balanced development of coal mining industry on account of investment projects implementation, expansion of resource basis, ensuring safety in miming works, training of specialists for the sector's enterprises. It is planned modernization of a number of operating enterprises in JSC "Shargunkumir" and construction of new ones at "Apartak" open-pit mine[7].
Development concept of Uzbekistan's oil and gas sector for 2013-2020	2013-2020	By 2021, the National Holding Company "Uzbekneftegas" plans to retain the annual volume of gas extraction at the level of 66 billion m^3, and liquid hydrocarbons at the level of 3.5 million ton. This volume of extraction will be maintained on account of increase in raw material reserves, as well as decrease in consumption of natural gas on domestic market. Ensuring these indices will allow increasing gas export from Uzbekistan by 20% versus 2013. According to the National Holding Company "Uzbekneftegas" data, increase in reserves hydrocarbons will be 622.8 mln t.c.f. [8]

[5] The document has been prepared by the UNDP Projects "Improvement of energy efficiency in social sector buildings in Uzbekistan" and "Strategy of Structural Reforms of Uzbekistan for 2030 "Vision-2030"" jointly with the State Committee on construction and architecture

[6] http://www.gazeta.uz/2010/12/10/energy/

[7] http://podrobno.uz/cat/economic/programma%20po%20razvitiu%20ugolnoy%20otrasli%20na%202013-2018/?sphrase_id=42749

[8] http://www.gazeta.uz/2014/05/15/oilgas/

Table 3.4 Continued

Program	Implementation Period (years)	Main Contents
Concept for development of cement industry	2013-2017	In 2016, within the framework of the Concept implementation, it is planned to commission 2 new cement plants, using the advanced energy efficient "dry" method of production. In 2017, in Karakalpakstan it will be put into operation the new cement plant with capacity of 400 thousand ton per year. The cement plant with capacity of 220 thousand ton per year is being constructed in the Djarkurgan district of Surkhandarya province. Currently, there are 8 cement plants in Uzbekistan. The total capacity of these plants is 8.8 million ton of cement per year[9].
On measures for further irrigated lands improvement and rational use water resources for period 2013-2017	2013-2017	25% decrease in electric energy consumption by irrigation pumping stations will allow saving more than 2 billion kWh of electric energy per year. Modernization of 4 pump stations and construction of new 1 station in Bukhara and Navoi provinces are planned under the ADB funded Project "Rehabilitation of the Amu-Bukhara irrigation system".[10]

3.3 Capacity for Greenhouse Gases Emission Reduction

Uzbekistan possesses substantial supply of organic fuel that ensures it energy independence and safety. At the same time, as mentioned above, level of energy consumption of the country's economy is quite high yet. In 2010, the GDP specific energy consumption (0.673 t.o.e./$1,000 of GDP) exceeded by 3.7 times the world average GDP index (0.183 t.o.e./$1,000 of GDP)[11], i.e. the country has rather high capacity for energy resources saving and correspondingly for greenhouse gases emission reduction.

By 2030, it is planned to decrease energy consumption of the GDP by 2 times as a result of wide use of the advanced energy saving technologies.[12] In 2013, the total capacity for energy saving in Uzbekistan was estimated in 22.7 million t.o.e.[13] Use of this capacity would allow to cut down around 53.1 Mt CO_2-eq. or 26.6% from the current volume of GHGs emission.

According to the World Bank estimations capacity for energy saving in the industrial sector of Uzbekistan is 14.2 million t.o.e.[11] It is worth to stress that, as opposed to majority of countries, rapid growth of Uzbekistan's economy is practically not accompanied by increase in the total volume of GHGs emissions. This correlates with the fact that by 2012, energy consumption of GDP was reduced almost by 2.5 times against 1995.[14] The observed picture is a good indicator of strengthening state policy in area of energy saving.

According to GHGs inventory, the total volume of emissions in 2012 was 205.2 Mt CO_2-eq. The "Energy" sector with contribution of 81.9% in 2012 still dominates in the total volume of GHGs emission (see Table 3.5). The main sources of GHGs emission in this sector (mainly carbon dioxide) are fuel combustion (59.25%) and methane leakages (40.7%) in oil and gas sector.

Share of commercial and residential sectors in GHGs emission from combustion of fossil fuel is more than 78%. That of thermal power stations and boiler plants is 44.4% and 34% respectively. According to the data of national GHGs inventory in 2012 volumes of GHGs emissions from thermal power stations and boiler plants was reduced by 1.6 times versus 1990, and by 1.3 times versus 2000. The observed reduction in GHGs emissions is a result of:

- gradual modernization of generating capacities of the thermal electric power stations/plants (TEPS/TEPP);
- replacement of the old outdated equipment in boiler plants and change-over majority of them to use natural gas;
- sharp reduction in share of mazut in fuel balance of the thermal electric power stations/plants (TEPS/TEPP).

As a result of population size increase, as well as growth in their welfare by more than 2 times versus 1990, the GHGs emissions associated with energy supply to buildings have also been increased. In 2012, volume of GHGs emissions from Commercial and Residential sectors was 44.0 Mt CO_2-eq. or 26.2% from emissions in the "Energy" sector.

On account of increase in volumes of natural gas extraction and transportation by gas pipelines, methane emissions in the "Energy" sector have been increased by 1.6 times.

[9] http://www.naesmi.uz/ru/site/page.html?id=22291
[10] http://www.trend.az/casia/uzbekistan/2496793.html
[11] Report of the World Bank and Ministry of Economy "Guidance on Strategic Development of Energy Efficiency in Industry of Uzbekistan", Tashkent, 2013.
[12] Report of the first President of RUz, Mr. I.A. Karimov, at the extended session of the Cabinet of Ministers devoted to the results of social and economic development of the country in 2015, and the most important priority directions of economic program for 2016.
[13] Energy Efficiency Orbits for Transition Economics, CENEF, Moscow, 2015.
[14] http://data.worldbank.org/data-catalog/world-development-indicators

Table 3.5 | *Volumes of GHGs Emissions in Main Economy Sectors in 1990-2012 (Mt CO_2-eq.)*

Economy Sectors	1990	2000	2005	2010	2012
Total Volume of GHGs Emissions	180,4	198,0	196,2	199,2	205,2
"Energy" Sector, including: • Volatile emissions (methane leakages) • **Fuel combustion,** including in categories: Generation of thermal and Electric energy Buildings Transport*, including: mobile sources Industry and construction Agriculture and others	151,2 43,6 107,6 55,2 19,4 16,6 11,9 10,2 6,2	172,4 67,2 105,2 44,4 41,8 11,2 6,0 5,0 2,8	169,2 72,9 96,3 37,0 41,9 9,6 5,8 5,4 2,4	164,1 68,1 96,0 31,6 42,5 12,8 7,4 7,5 1,6	168,1 68,2 99,9 34,0 44,0 12,4 8,3 8,0 1,5
"Industrial processes" sector**	8,1	4,9	6,2	7,9	7,8
"Agriculture" sector**	17,0	16,2	16,1	19,9	21,6
"Wastes" sector	4,1	4,5	4,7	7,3	7,7

Source: National Report "Inventory of Anthropogenic Emissions and Sinks of Greenhouse Gases in the Republic of Uzbekistan (1990-2012)", 2016
Notes: *in addition to GHGs emissions from mobile sources, the "Transport" category comprises emissions from operation of main gas pipelines
** the "Industrial processes", "Agriculture" and "Waste" sectors do not consider GHGs emissions associated with fuel combustion (see Chapter 2)

3.3.1 Oil and Gas

The main sources of GHGs emissions in oil and gas sector are extraction, processing and transportation of natural gas (methane), as well as combustion of associated petroleum gas (carbon dioxide), emitted into atmosphere with oil extraction.

Approximately half of GHGs emissions from gas systems occur during transportation of natural gas. Maximum methane emissions were observed in 2000-2008, when it took place both increase in gas extraction and in volumes of transit gas, pumped through main gas pipelines of JSC "Uztransgas".

The second, by its size, source of methane emission is gas processing in gas treatment plants. In 2012, contribution from gas processing to the total volume of GHGs emissions from gas systems was 46.5%. Share of natural gas leakages with its extraction is rather small (3.4%-4.2%).

In the National Holding Company (NHC) "Uzbekneftegas" technical losses of natural gas associated with its transportation is estimated to be not less than 2.11% in the main gas pipelines and 2.4-3.0% in the networks of medium and low pressure[15]. According to expert assessments, in 2013 gas leakages from gas pipelines was 1-1.5 billion m^3 in the main gas pipelines and 425 million m^3 in distribution networks.[16] The presented data indicates the rather high capacity for reduction in GHGs emissions in this sector. From the above said, it follows that in oil and gas sector the largest energy resources saving, and, consequently, decrease in GHGs emissions may be achieved in processing and transportation of natural gas, as well as in utilization of associated petroleum gas, mainly flared (Table 3.6).

In spite of positive trends, achieved by the NHC "Uzbekneftegas" in the area related to associated petroleum gas utilization, problem of its flaring at oil fields still remains actual for the sector. According to the World Bank expert assessments, if in 2010 volume of associated petroleum gas flaring was around 2 billion m^3, [17] then by 2015 its volume was reduced to 1.2 billion m^3.[18] The relevant measures on utilization of associated petroleum gases are included in the annual and long-term investment programs of the NHC "Uzbekneftegas" (Table 3.6).

According to expert assessments, implementation of planned by the NHC "Uzbekneftegas" measures will allow by 2019, to reduce GHGs emissions approximately by 850 thousand ton of CO_2-equivalent.

Within framework of the CDM projects implementation, reconstruction of medium and low pressure gas networks for elimination of existing gas leakages in check valves with use of modern gaskets and other consumables have been carried out in 9 provinces of the republic. According to the international audit data, during period from 2012 to 2014, the JSC "Uztransgas" on account of the CDM projects implementation saved more than 1 billion m^3 of natural gas (or 350.1 million m^3 per year)[19]. At the same time decrease in GHGs emissions was 12.8 Mt CO_2-eq.

[15]URL: http://www.uzdaily.uz/articles-id-15594.html
[16]UNDP/Ministry of economy Report "Towards Sustainable Energy: The Strategy for Low Carbon Development of the Republic of Uzbekistan", Tashkent, 2015.
[17]Uzbekistan: Energy Sector Issue Note, World Bank, 2013
[18]http://www.worldbank.org/ru/news/feature/2013/06/18/fighting-gas-flares-in-uzbekistan
[19] https://www.uzdaily.uz/articles-id-26541.htm

Table 3.6 | *Technical Measures Aimed at Decrease in GHGs Emissions in Oil and Gas Sector*

Categories	Measures
Transportation of natural gas	– - modernization of compressor and gas distribution stations; – - modernization of main gas pipelines, including efficiency increase of gas pumping units up 33-36%; – - modernization of gas distribution networks of low and medium pressure, including replacement of metal pipes with plastic ones; – - creation of monitoring system with instrumental control and measuring leakages in medium and low pressure gas networks.
Processing of natural gas	– - modernization of gas processing equipment in the Mubarek GPP; – - modernization of capacities for clearing natural gas from hydrogen sulfide and acid gases in the Mubarek GPP
Associated petroleum gas flaring	– utilization of associated petroleum gases by compressor method in oil fields of Southern Kemachi, Umid, Kruk, Western Kruk, Northern Urtabulak, as well as Northern Shurtan, Garmiston, Kumchuk, Shakarbulak and Head structures of "Shurtan"[20]

3.3.2 Electrical Energy

In the energy sector of Uzbekistan the largest emitter of GHGs is thermal power stations.

Approximately 90% of electric energy in Uzbekistan is generated by 10 large thermal electric power stations/plant (TEPS/TEPP), using mainly natural gas (93%).

Over the recent 10 years, around 11.7% of TEPS/TEPP power generating capacities have been renewed on account of commissioning new power-generating units and replacement of the old ones. Nevertheless, majority of the power generating capacities already does not comply with the world standards and requires replacement. For example, replacement alone of all old power-generating units by the advanced steam-gas generators (SGG) will allow increasing electric energy generation by 26 billion kWh with the same volume of combusting fuel[21].

Figure 3.1 | *Navoiy TEPS*

Electric energy losses associated with its transmission and distribution can be attributed to indirect sources of GHGs emissions. By the World Bank assessments, existing electric energy losses in the JSC "Uzbekenergo" grids equal to not less than 20%[22].

Analysis indicates that the highest energy resources saving may be achieved by complete modernization of existing condensing electric power stations, i.e. replacement of outdated power-generating units in thermal electric power plants (TEPP) by the advanced steam-gas generators (SGG) and gas-turbine unit (GTU). Renewal of power-generating capacities will allow decreasing current fuel consumption for generation of 1kWh electric energy, reducing therefore the total fuel volume, combusted in TEPS/TEPP, by 34% approximately.

During the period after 2005, of energy sector has been developed in accordance with the "Program for development and reconstruction of generating capacities in energy sector of the Republic of Uzbekistan and target "Program of energy saving for period up to 2010". A number of large projects have been implemented, aimed at decommissioning of deteriorated equipment and capacities not complying with current technological requirements and their replacing with the advanced and energy efficient ones.

In 2012, the steam-gas generator (SGG) with capacity of 478 MW was commissioned on the Navoi thermal electric power station (TEPS). Implementation of this Project, funded completely by the country's own budget, has allowed generating additionally 2.8 billion kWh electrical energy per year, with reduction in specific consumption of fuel equivalent by 1.8 times, i.e. to ensure natural gas saving in a volume of 400 million m^3, for more than USD110 million.

[20]Regional conference of European and Central Asian countries: Experience of Russian Federation and Oil Companies on Efficient Use of Associated Petroleum Gases, Surgut, 31 May - 1 June, 2013. – presentation of the NHC "Uzbekneftegas"

[21] Report of the World Bank and Ministry of Economy "Guidance on Strategic Development of Energy Efficiency in industry of Uzbekistan", Tashkent, 2013.

[22] Uzbekistan: Energy Sector Issue Note, World Bank, 2013

During the period from 2013 to 2015 within the framework of implementation of investment programs,

- the steam-gas generator (SGG) with capacity of 370MW was commissioned at the Tashkent TEPP;
- the "Akhangaran" transformer sub-station on the territory of the "Angren" special industrial zone was reconstructed;
- full-scale modernization of the Syrdarya thermal electric power station (TEPS) with commissioning of additional 65 MW generating capacity was completed;
- the 20 MW gas-expansion generator units have been installed at the Syrdarya and Talimarjan thermal electric power stations (TEPS).[23]

Figure 3.2 | *Novo-Angren TEPS*

Currently, implementation of Projects for introduction of the steam-gas generators (SGGs) is on-going at the Talimarjan thermal electric power station (TEPS) with two 450 MW SGGs, and at the Navoi TEPS with one 450MW SGG. New thermal electric power station (TEPS) with two SGGs with the total capacity of 900 MW is under construction in the Turakurgan district of Namangan province.

The following projects are planned to implement by 2020:

- construction of two 450 MW steam-gas generators (SGGs) at the Talimarjan thermal electric power station (TEPS);
- construction of second 450 MW steam-gas generator (SGG) at the Navoi thermal electric power station (TEPS);
- construction of 230-250 MW steam-gas generator (SGG) at the Takhiatash thermal electric power station (TEPS);
- installation of gas-expansion generator units at the Syrdarya and Talimarjan thermal electric power stations (TEPS);
- full-scale modernization of the Syrdarya thermal electric power station (TEPS).

Planned work is carried out in the country for renewal and development of high-voltage power transmission lines for reduction in electric energy losses. In 2008-2009, it was completed construction of 165.0 km long high-voltage power transmission line from the Novo-Angren thermal electric power station (TEPS) to "Uzbekistanskaya" transformer sub-station, which provides reliable electric power supply to the Fergana valley, the high-voltage power transmission lines from the Syrdarya thermal electric power station to the "Sogdiana" transformer sub-station, and Guzar - Surkhan. Construction of 2,018 km long 500 kV power transmission line from the Talimarjan thermal electric power station to the "Sogdiana" transformer sub-station was completed in 2013. Construction of 130 km long 500 kV power transmission line from the Syrdarya thermal electric power station to the Novo-Angren thermal electric power station was completed in 2015.

By 2020, the JSC "Uzbekenergo" plans to construct the following objects:

- 130 km long 500 kV power transmission line from the Syrdarya thermal electric power station to the Novo-Angren thermal electric power station. Implementation of this project will allow to improve reliability of electricity supply to consumers in the Fergana valley and reduce electric energy losses by 279 million kWh per year;
- "Namangan" 500 KW transformer substation with 200 km long 500 kV power transmission line from the Novo-Angren thermal electric power station to the "Namangan" transformer sub-station. Construction of transformer sub-station and high-voltage power transmission line will allow to reduce electrical energy losses by 611-730 million kWh per year.

From 2008, the JSC "Uzbekenergo" implements the "Program for introduction of computer-aided system for electric energy metering and controlling". As of now a number of pilot projects have been implemented for approbation of this system in enterprises of the JSC "Uzbekenergo" in the Angren town of Tashkent province and in some district of the Tashkent city. Introduction of computer-aided system for electric energy metering in enterprises, business entities and household consumers will allow ensuring metering of electricity consumption along the entire chain of electricity distribution and facilitating decrease in technological losses. According to expert opinion, this system will allow to save around 2.75 billion kWh of electrical energy per year, and to reduce green house gases emission by 1.9 million ton per year.

The total cost of saved energy from introduction of computer-aided system is estimated in the amount of around USD125 million/year.[24]

[23] Reports of the First President of the Republic of Uzbekistan, Mr. I.A. Karimov at the extended session of the Cabinet of Ministers on the results of 2013, 2014 and 2015.
[24] www.uzbekenergo.uz

Renewable Energy Sources (RES). Special attention should be paid to the capacity for renewable energy sources, which Uzbekistan has plenty of (Chapter 1, Table 1.7).

Figure 3.3 | *Solar Photoelectric Station in Namangan Province*

According to the strategic document "Uzbekistan towards 2030: Transition to Resource-efficient Growth Model (Vision-2030)" share of the solar energy in the total energy balance of the country is planned to bring up to 6% by 2030.[25] Currently, based on the Road map to development of solar energy, approved by the Government in 2014, the NAMA document "Development of solar energy sector in Uzbekistan" [26] has been prepared. In NAMA it is proposed a set of measures aimed at promotion of solar energy use in the country up to 2030, which envisages construction of a number of solar power stations with capacity of 100MW each. Currently, test solar power station with capacity of 130MW has been constructed in the Namangan province. The first 100MW solar electric power station is under construction in the Samarkand province. It is planned to commence construction of another two solar power stations by the end of 2019.

Implementation of NAMA will allow reducing greenhouse gases emission by 2030:

- by 14.4 million t CO_2/year by optimistic scenario;
- by 10.8 million t CO_2/year by realistic scenario;
- by 5.3 million t CO_2/year by pessimistic scenario.

Figure 3.4 | *Modernization of the third Hydroelectric Generating Unit in Charvak HPS*

Great attention is paid in the country to development of hydropower sector. Large scale works are carried out for modernization and reconstruction of existing hydropower stations. In mid-term perspective it is envisaged modernization of hydraulic turbine generators in the Charvak hydropower station, modernization and reconstruction of the Farkhad hydropower station, hydropower station-14 of the Lower Bozsu cascade of stations, hydropower station South Fergana Canal-1 of the Shakhrikhan cascade of stations, hydropower station-10 of the Chirchik cascade of stations, hydropower station-2Б of the Samarkand cascade of stations, and construction of the "Kamolot" hydropower station with capacity of 8MW.[27]

Uzbekistan possesses considerable source of raw materials for generation of biogas, technical potential of which is estimated in 1.9 billion m^3. Use of biogas technologies is considered as alternative source of electrical energy in the rural areas, as well as efficient method for processing of cattle breeding wastes. The Decree of Cabinet of Ministers No. 343 was issued on 25 November 2015 (see Table 3.3) in order to encourage development and construction of biogas power plants.

Systems for hot water supply of residential houses and social facilities based on solar water heating units are manufactured and experimentally used in the country for more than 10 years.

Amongst the project promoting introduction of RES in agriculture of Uzbekistan is the WB Project "Rural Enterprises Support Project, Phase II", and incorporated into it the GEF Project "Development of sustainable agriculture and mitigation of climate change impacts". In 2016, within the Project implementation in some private farms of seven provinces in the republic it will be installed 20 deep well pumps driven by photoelectric solar panels, 20 solar water heaters for residential houses, 25 small, 7 medium and 1 large biogas power units and 7 energy efficient pumps for on-farm use.

According to expert assessments introduction of renewable energy sources (solar, wind, hydro-, biomass, biogas) will allow to increase generating capacities of the national energy system by 3.4GW and to ensure by 2030, growth in electric energy generation by more than 11.4 billion kWh and saving of natural gas in volume of around 3.46 billion m^3 per year (see Table 3.7).

[25] Center for Economic Studies. "Uzbekistan towards 2030: Transition to Resource-efficient Growth Model (Vision-2030)" – Tashkent, 2015. – 34 p.
[26] NR-236 «Solar Energy Development in Uzbekistan» http://www4.unfccc.int/sites/nama/_layouts/un/fccc/nama/NamaForRecognition.aspx?ID=159&viewOnly=1
[27] www.uzbekenergo.uz

Table 3.7 | *Evaluation of Capacity for Introduction of RES for Electric Power Generation up to 2030*

RES Type	Proposed regions of implementation	Designed Capacity, MW	Designed Electric Power Generation billion KWh	Gas Savings billion m^3
Solar	Karakalpakstan, Navoiy province	2 000	5,000	1,517
Wind	Karakalpakstan, Navoiy province	40	0,080	0,024
Hydropower	Tashkent, Surkhandarya, Namangan, Fergana provinces	938	2,600	0,788
Biogas from Cattle and Poultry Breeding Wastes	All regions	450	3,600	1,092
Biogas from Sewage Water Treatment Plants	Treatment plants of large cities	15	0,120	0,036
TOTAL		3 443	11,4	3,457

Source: UNDP Report "Towards Sustainable Energy: Strategy for Low Carbon Development of Uzbekistan", Tashkent, 2015.

The demonstration UNDP Project "Policy and Best Practices in Use of RES in Residential Sector" has been implemented in 2013, with the objectives to improve reliability of electric energy supply to rural medical centers in Uzbekistan through use of RES (photoelectric solar panels, solar water heaters, efficient water heating boilers), and introduction of measures for energy saving in construction of building in rural areas (such as construction of wind-porches, installation of plastic windows, etc.).

Over the recent several years a number of researches have been published. In these researches the current conditions of electric energy sector in Uzbekistan have been analyzed, barriers hindering transition to energy efficient low carbon development model of this sector were considered, and specific recommendations prepared.[28]

All researches note availability in the country the substantial capacity for energy resources saving throughout the entire energetic chain: generation, transmission and consumption. It is recommended to support modernization of generating and transmitting capacities by relevant institutional changes, strengthening regulatory and legal framework, new financial arrangements and incentive measures.

The Road maps and Action plans, based on the above mentioned researches, comprise measures, majority of which has been included in the "Program – Road Map" on increase in energy efficiency, and introduction of energy saving technologies in economy and social sectors, attached to the Decree of the President of RUz No. PP-2343[29] (Table 3.8).

Table 3.8 | *Policy and Measures for Energy Consumption Decrease in Electric Energy Sector*

Documents	Policy and Measures
Strategies / Plans	– - adoption of the state program on energy efficiency and action plan for medium- and long-term perspectives, as well as integration of the proposed measures into annual investment programs.
Regulatory and legal framework	– - introduction of obligatory target indices on energy saving/energy efficiency in absolute or specific values, as well as system for monitoring, verification and reporting about their fulfillment; – - adoption of Laws "On renewable energy sector" and "Energy efficiency"; – - energy management and obligatory audit of energy consumptive enterprises, as well as introduction of programs for permanent control over energy consumption in medium and small size enterprises; – - adoption of standards for implementation of agreements on procurement by state electric energy generated by RES; – - establishment of the state system of metering electric energy consumption for all categories of consumers and formation of database on generation and consumption of electric energy.
Financial mechanisms and incentive measures	– - attraction of private capital for financing infrastructural projects, projects on energy efficiency and RES, including participation in implementation of the state / sectoral programs on energy efficiency; – - financial benefits and credits for enterprises, implementing programs on energy efficiency improvement and use of renewable energy sources; – - customs privileges for import of energy efficient equipment and spare parts, as well as equipment for renewable energy sector; – - tax benefits for enterprises reducing specific energy consumption per unit of production; – - introduction of the state "green" procurement for energy efficient equipment and renewable energy technologies; – - reduction in depreciation period for energy efficient equipment and RES installations.

[28] Uzbekistan: Energy Sector Issue Note, World Bank, 2013; Report of the World Bank and Ministry of Economy "Guidance on Strategic Development of Energy Efficiency in Industry of Uzbekistan", Tashkent, 2013; UNDP/ Ministry of Economy Report "Towards Sustainable Energy: Strategy for Low Carbon Development of Uzbekistan", Tashkent, 2015.; UNDP/ Ministry of Economy Report "Road map for transition of Uzbekistan to low carbon development", Tashkent, 2015; UNDP/ Ministry of economy/World Bank Project "Uzbekistan towards 2030: Transition to Resource-efficient Growth Model (Vision-2030)"

[29] https://www.soliq.uz/ru/normative_legal_acts_tax/postanovleniya-prezidenta-respubliki-uzbekistan/o-programme-mer-po-sokrashcheniyu-energoemkosti-vnedreniyu-energosberegayushchikh-tekhnologiy-v-otra/

Table 3.8 Continued

Documents	Policy and Measures
Technical measures	– - diversification of generating capacities for solution of problems with peak energy demands; – - modernization of generating capacities of the JSC "Uzbekenergo" enterprises on account of introduction of advanced technologies and equipment (SGG/GTU); – - introduction of cogenerating units in large industrial enterprises and boiler plants; – - large-scale use of RES for independent energy supply of remote settlements and cattle breeding farms, as well as enterprises for agricultural production processing; – - modernization of transmitting capacities, including low voltage electric power grids; – - introduction of computer-aided systems for electric energy metering in its generation and transmission to consumers.
Information policy	– - establishment of training centers in energy efficiency and RES in ministries and agencies, as well as in provincial administrations (khokimiyats); – - implementation of obligatory trainings in energy efficiency and RES for management staff and engineers of energy consumptive enterprises; – - carrying out public awareness campaigns in energy efficiency and RES issues for population with use of TV and other mass media capacities.

3.3.3 Heat Supply

In Uzbekistan the centralized heat supply to consumers (population, social facilities and various enterprises and institutions) is provided by thermal electric power plants of the JSC "Uzbekenergo" and boiler plants with the total installed capacity of 4,479Gcal/h and 19,290 Gcal/h respectively (Chapter 1, Table 1.9).

Analysis of data on generation of thermal power for 2008-2014 has indicated substantial decrease (practically by one third) in its generation in the republic over the recent years from 32.74 mln. Gcal in 2008 to 21.06 mln. Gcal in 2014. Generation, transportation and consumption of thermal energy are characterized by low energy efficiency. Open heat supply system and outdated heat distribution network in buildings are sources of substantial heat losses at the consumption stage.

The data provided show high capacity for energy resources saving and, correspondingly, capacity for decrease in GHGs emissions in the "Thermal Energy" Sector.

Currently, the sectoral Integrated Program for introduction of energy saving technologies in the housing and public utilities sector is being implemented. The Program includes reconstruction and gradual replacement of worn-out heat supply network, outdated and inefficient steam generating units, which enable to reduce the specific energy consumption for generation of thermal energy by 25-30% and decrease losses of generated heat from supply network to normative volumes. So, only combined generation of thermal and electric energy at large boiler plants will allow to save up to 0.5 billion m^3 of natural gas per year.

Technical measures aimed at increase in energy saving and improvement of energy efficiency in the "Thermal Energy" Sector are presented in Table 3.9 below. It is worth to mention that many items of policy and measures, proposed for the "Electrical Energy" Sector, may be applicable to this sector.

Practically all proposed technical measures are reflected to various extent in the "Concept for reformation of heat supply system in the Republic of Uzbekistan for 2010 – 2020".

According to the Decree of the Cabinet of Ministers of the Republic of Uzbekistan No. 300, the master plans for development of heat supply systems for period up to 2020, are being prepared for 28 cities/towns of the country. [30]

Table 3.9 | *Technical Measures Aimed at Losses Decrease in Thermal Energy Sector*

Items	Measures
Generation of thermal energy	– reconstruction of boiler plants (commissioning of highly efficient boiler plants); – reconversion of boiler plants into mini -TEPP (introduction of cogeneration technologies in boiler plants); – introduction of steam gas generators in thermal electric power stations; – construction of new coal steam power plants with over supercritical steam parameters; – commissioning of efficient modular water treatment systems in boiler plants; – introduction of gas-expansion generator units in thermal electric power plants; – installation of frequency-regulated drives on pump and draft equipment of boiler plants; – use of solar collectors for water warming in boiler plants.
Transportation of thermal energy	– rehabilitation of old and construction of new heat supply pipelines using modern insulating materials; – modernization of indoor heat distribution networks in buildings
Consumption of thermal energy	– transition to closed heat supply systems; – installation thermal power meters in apartment blocks; – installation of heat distribution boxes in buildings

[30] http://lex.uz/getwordfile/2264545

3.3.4 Buildings

In Uzbekistan, "Buildings" sector is one of the largest energy consumers. By different estimates, specific energy consumption in buildings varies from 150 to 690 kWh/m^2.[31] Maximum values have been obtained by energy audit conducted in old buildings.

The above presented data on specific energy consumption in buildings shows quite high capacity for energy resources saving in this sector. According to the data from Center for Economic Studies, technical capacity for energy saving in building of Uzbekistan is estimated in 5.9 mln. t.o.e. for residential buildings and 2 mln. t.o.e. for administrative buildings. [32]

A number of analytical reports, considering policy and measures for reduction in energy consumption of buildings in Uzbekistan, have been prepared during recent years.[33] Practically all these reports state that one of the main barriers, hindering decrease in energy consumption of buildings, is lack of incentives to save energy resources for both households and governmental institutions. The tools, proposed for increasing energy efficiency in buildings, are described in Table 3.10.

It is worth to note that as a result of the state energy saving policy strengthening, energy consumption in buildings has been reduced over the recent years by 5-10%.[33] In 2015, the Cabinet of Ministers of RUz adopted the Decree №PKM-86 on obligatory labeling of household electric appliances with indication of their energy efficiency class. According to another decree of the Cabinet of Ministers, selling electric filament lamps will be prohibited in Uzbekistan from 2017 (Table 3.3). Preliminary estimations indicate that replacement of only one electric filament lamp by LED lamp in each of 5 million households in Uzbekistan will allow saving around 93 million m^3 of natural gas annually.

Table 3.10 | *Policy and Measures for Reduction in Energy Consumption of Buildings*

Documents	Policy and Measures
Strategies / Plans	– adoption of the state program on energy efficiency of buildings, including reconstruction old multistoried apartment blocks and individual houses.
Regulatory and legal framework	– revision (every 5 years) of construction norms towards strengthening requirement to energy efficiency; – establishment of system for control/monitoring over compliance with relevant norms and rules in construction and maintenance of buildings; – establishment of system for energetic certification of buildings; – establishment of system for standardization of new thermal insulating construction materials; – introduction of energy efficiency standards for household equipment; – establishment of the state system of metering electric energy consumption in buildings and formation of unified database.
Financial mechanisms and incentive measures	– development of system for mortgage credit lending, e.g. use of "green" mortgage credits; – establishment of energy efficiency funds under APHO (Associations of Private Housing Owners) for energy-efficient repair of multistoried apartment blocks; – lending to household owners lax credits for reconstruction of old housing; – creation of local enterprises for production of thermal insulating construction materials.
Information policy	– establishment of training centers in energy efficiency in provincial administrations (khokimiyats); – carrying out public awareness campaigns in building energy efficiency issues for population with use of TV and other mass media capacities.
Technical measures	improvement of building thermal insulating, including: – roof repair (with heat insulating and waterproofing); – basement repair (with basement floor heat insulating); – outside wall heat insulating; – installation of energy efficient 2 or 3-layer glass windows; – repair of front-entrance doors in porches with installation of automated door closing devices); – use of energy efficient lamps; – use of solar photoelectric power plants and collectors for buildings heating; – use of energy efficient boiler equipment for heating houses without centralized heat supply.

3.3.5 Transport

As opposed to many countries, transport sector (mobile sources) contribution to the total volume of GHGs emission in Uzbekistan is not too large, and equals to only 4.0%. In "Energy" Sector share of transport in GHGs emission is 4.9% (Table 3.5).

In all, share of automobile transport in the total GHGs emission is around 94%, air transport (in-country transportation) contributes 0.5% and railroad transport – 5.2%. Substantial increase in number of private cars, observed during the recent years, has led to GHGs emissions growth in this sector (Figure 3.5). In 2012, volume of GHGs emissions by automobile transport was 7.8 Mt CO_2-eq., compared with 5.2 Mt CO_2-eq. in 2005.

[31] UNDP/ Ministry of Economy Report "Towards Sustainable Energy: Strategy for Low Carbon Development of Uzbekistan", Tashkent, 2015.
[32] Analytical Report "Conceptual Approaches to Formation of "Green Economy" in Uzbekistan", Center for Economic Studies, Tashkent, 04/2011, http://cer.uz/ru/publications/
[33] GEF/UNDP Report "Improvement of Energy Efficiency in Buildings of Uzbekistan: Direction of Reforms and Expected Effects", Tashkent, 2014.

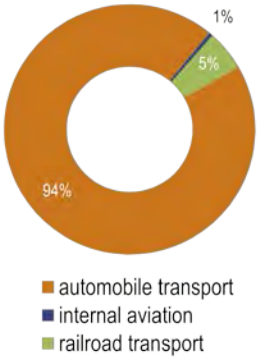


Figure 3.5 | *The structure of GHG emissions from mobile transport*

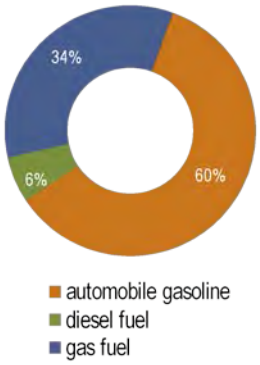


Figure 3.6 | *Structure of consumption of fuel for automobile transport*

The main source of GHGs emission in the "Transport" Sector is automobile transport. Around 2 million of motor vehicles have been registered in the republic, out of which:

- 60% run on automobile gasoline;
- 6% run on diesel fuel;
- 34% - on gas fuel (Figure 3.6).

From the total number of motor vehicles share of passenger cars is 85%, 10% of lorries and 5% of buses.

The world practice indicates that energy consumption per one passenger is 5 times less in case of urban public automobile transport use, and by 10 times less with use of subway transport. [34] Therefore, in lack of incentives encouraging private cars owners to use more public transport, unavoidable growth in number of private cars will lead to further increase in volume of GHGs emissions.

Technical and institutional measures aimed at improvement of energy efficiency and reduction in GHGs emissions in the "Transport" sector are presented in the National Programs and Action Plans for environment conservation and rational use of natural resources for periods 2008-2012 and 2013-2017, as well as in the following Decrees:

- Decree of the President of RUz No PP-531, dated 14 December 2006 "On Measures for Further Development of Production in Samarkand Automobile Plant and Renewal of Automobile Transport Park in the Republic"; and
- Decree of the Cabinet of Ministers No.30, dated 10 February 2007 "On Measures for Developing Network of Automobile Gas Filling Compressor Stations and Gas Refilling Stations, and Gradual Change-over of Automobile Transport to Run on Liquefied and Compressed Natural Gas" (Table 3.11).

Table 3.11 | *Measures on Decrease in Energy Consumption of Automobile Transport*

Items	Measures
Technical Measures	– further renewal of automobile, air and railroad transport parks; – change-over of automobile transport to run on liquefied or compressed natural gas; – organization of serial production in the country of automobile transport run on gas fuel; – construction of automobile gas refilling stations and workshops for re-equipment of automobiles to run on gas fuel; – reconstruction and construction of motor roads; – further electrification of railroads; – public transport traffic optimization in large cities of the republic; – introduction of hybrid electrical automobile transport; – quality improvement of engine fuel and development of new types of engine fuel; – carrying out "clean air" campaigns.
Institutional Measures	– introduction of fuel consumption standards; – introduction of tires marking; – establishment of CO_2 emission standards; – "modal shift" or priority development of urban public transport, including access limitation to cities center, establishment of paid parking, development of bicycle infrastructure; – establishment of system for metering energy resources consumption in "Transport" Sector.

In accordance with the Decree of the Cabinet of Ministers No.30, dated 10 February 2007, during recent years more than 20 thousand vehicles per year are changed over to run on gas fuel. During the period from 2008 to 2012, in aid of decrease in pollutant emissions more than 161 thousand motor vehicles were changed-over to run on liquefied natural gas. As a result, decrease in pollutants emission into atmosphere from motor vehicles equals to more than 78 thousand ton.[35]

[34] http://solex-un.ru/energo/review/avtomobilnyy-transport/cifry-i-fakty
[35] http://mcfr.uz/ru/online/news/1810/

"Clean Air" months are conducted every year by staff of the State Committee for Nature Protection and Traffic Police, when all transport vehicles are inspected on compliance with the current norms of pollutants emission.[36]

Efficiency of energy resources use by automobile transport is associated with arrangements of vehicle traffic and conditions of roads. Programs for construction and reconstruction of public automobile roads of domestic and international importance, being implemented in the republic, make certain contribution to reduction in GHGs emissions. Over the period from 2008 to 2012, more than 1, 000 km of motor roads were rehabilitated. Only over the recent years in the Tashkent city it was constructed 7 road interchanges, 11 overhead crossings, 7 tunnels, 19 bridges and 12 pedestrian bridges, completed construction of small circular motor road. Implementation of computer-aided system for traffic management is on-going. In accordance with the Program for development and modernization of engineering communications and motor road transportation infrastructure for period of 2015-2019, construction and reconstruction of motor roads will be continued.[37]

Measures aimed at reduction in GHGs emissions from railroad transport are being implemented. Projects on electrification of railroad sections and renewal of railway vehicles are being implemented. Section of railroad from the Tukumachi station to Angren station with a length of 114 km is completely electrified. Due to use of electric locomotives instead of Diesel-electric locomotives saving of Diesel fuel equals to 3 thousand ton/year. Decrease in pollutants emission into atmosphere on account of saved fuels equals to more than 300 tons.[38] The National Air Company "Uzbekiston Khavo Yullari" (Uzbek Airlines) makes its contribution to decrease in GHGs emissions on account of renewal of aircrafts park.[38]

3.3.6 Industry and Construction

Industry sector, comprising more than 39 thousand enterprises, is one of the largest consumers of energy in Uzbekistan. The total energy consumption in the sector is estimated in 7.8 mln. t.o.e. or 21.7% from the total energy consumption in the country (as of 2009), including 38.3% of electric energy, 23.6% of natural gas and 6.2% of oil products. [39]

Capacity for energy resources saving in energy consumptive industry sectors, e.g. in mining, chemical, machine-building, and construction materials industries is approximately 20%. High capacity for energy and fuel saving is available in all industry sectors of Uzbekistan, which may be materialized on account of production modernization, introduction of advanced technologies and other measures envisaged in the Program for Ensuring Structural Reformations, Modernization and Diversification of Production for Period 2015-2019[40] and the Program of Measures on Reduction in Energy Consumption, Introduction of Energy Saving Technologies in Economy Sectors and Social Area for Period 2015-2019.[41]

Figure 3.7 | *Kungrad Sodium Carbonate Plant*

Chemical Industry. The chemical industry enterprises consume around 1.78 mln. t.o.e. annually. Share of electric energy in production costs is 27.4%. Specific energy consumption per unit of production, manufactured by the chemical enterprises of Uzbekistan, exceeds similar value in modern enterprises[42] of the developed countries.

The Decree of the Cabinet of Ministers "On Additional Measures for Reduction in Production Costs in Industry" (2012) has established the obligatory levels of energy saving for industrial enterprises, including 0.9%/year for chemical industry.[43]

This has allowed reducing current natural gas and electric energy consumption per unit of production by 17% and 14% respectively.

[36] National Report on Environment Conditions and Use of Natural Resources in the Republic of Uzbekistan (2008-2011) / Edited by N.M. Umarov; State Committee for nature protection – Tashkent, Chinor ENK, 2013. - 260 p.
[37] Decree of the President of the Republic of Uzbekistan No.PP-2313, dated 06 March 2015 "On Program for Development of Engineering Communications and Transportation Roads Infrastructure for 2015-2019"
[38] Report of the First President of RUz, Mr. I.A. Karimov, at the extended session of the Cabinet of Ministers devoted to the results of social and economic development of the country in 2014, and the most important priority directions of economic program for 2015.
[39] Report of the World Bank and Ministry of economy "Guidance on Strategic Development of Energy Efficiency in Industry of Uzbekistan", Tashkent, 2013.
[40] Decree of the President of the Republic of Uzbekistan No.UP-4707, dated 04 March 2015 "On Program of Measures for Ensuring Structural Transformation, Modernization and Diversification of Production for 2015-2019"
[41] Decree of the President of the Republic of Uzbekistan No.PP-2343, dated 05 May 2015 "On Program of Measures for Reduction in Energy Consumption, Introduction Energy Saving Technologies in Economy Sectors and Social Sphere for 2015-2019"
[42] World Bank/Ministry of Economy of Ruz. Guidance on Strategy of Energy Efficience Facility in Industrial Enterprises of Uzbekistan. – Tashkent, 2013
[43] Decree of the Cabinet of Ministers of the Republic of Uzbekistan No. PKM-333, dated 28 November 2012 "On Additional Measures for Reduction in Production Costs of Products in Industry" // Law Book RUz, 2012, No 48-49 (538)

The main industrial enterprises with the largest contribution to GHGs emissions are those producing ammonia (emissions of CO_2) and nitric acid (emissions of N_2O). Implementation of the CDM Projects in three enterprises: JSC "Navoiazot", JSC "Ferganaazot" and JSC "Maksam-Chirchik" has allowed to reduce significantly emissions of nitrogen oxide. According to the international audit data, emissions of nitrogen oxide have been decreased by 2.32 Mt CO_2-eq., with 10% increase in production of nitric acid.

Metallurgy Industry. Capacity for reduction in GHGs emissions in ferrous and non-ferrous metallurgy is in improvement of production technologies, modernization of melting furnaces, improvement of quality and assortment of mill products, utilization of emitting gases heat generated by technological processes, electric power generation by use of pressure drops, and use of modern thermal insulating materials in melting furnaces.

Production of construction materials. Manufacturing of cement and burnt bricks are the most energy consumptive processes in the production of construction materials sector. In 2013, these enterprises consumed over 980 million kWh of electric energy and more than 1 billion m3 of natural gas, of which 93% was consumed by cement plants. Due to use of outdated technologies, energy consumption for production of 1 ton of cement or burnt bricks exceeds the similar indices of the leading countries.

Use of advanced technologies in cement industry, e.g. change-over from "wet" to "dry" process of cement production allows saving around 31% of energy resources annually. It is planned that in accordance with the Program of "Main Measures for Saving Fuel and Energy Resources (FER) up to 2030", lines for "dry" method of cement production will be installed in operating cement plants of the JSC "Uzstroymateriali".[44] Accomplishment of modernization will allow reducing consumption of natural gas by more than 200 million m^3/year with the same volume of production. The another one direction for reduction in GHGs emission in production of construction materials is utilization of secondary thermal resources and emitted gases.

It is planned to use high-ash coal for production of burnt bricks, which reduces consumption of natural gas by 15-25%.[44]

3.3.7 Agriculture and Land Use

Agriculture. Agriculture consumes approximately 20% of the total electric energy, generated in the country. More than 8.5 billion kWh was consumed in 2014. The main part of electric energy (up to 8 billion kWh) is used by irrigation pump stations. The major part of equipment of these stations exceeds its life time.

In general, capacity for energy saving in agriculture is associated with:

- renewal of worn-out pump units and electro-technical equipment of pump stations on irrigation systems and vertical drainage wells,
- improvement of agricultural machinery and equipment, increase in efficiency of its use,
- more wider use of lighter machinery and equipment for individual farmers;
- use of advanced technologies in greenhouses.

According to experts conservative evaluations, the total capacity for reduction in energy resources consumption by irrigation pump stations on account of use more efficient pumps is 25%, or 2.1 billion kWh electric energy (as of 2014). Such reduction corresponds to decrease in GHGs emission by 1.13 Mt CO_2 - eq.

Figure 3.8 | Drip Irrigation System in Intensive Gardens

At the present time a number of projects have been completed, namely, the "Drainage Project of Uzbekistan" for improvement of drainage, irrigation and wetlands with participation of World Bank, "Rehabilitation of Kuyumazar Pumping Station" jointly with the Organization of Petroleum Exporting Countries, "Rehabilitation of Karakul Pumping Station" with assistance from Chinese investors. Implementation of the project "Rehabilitation of Main Canal of Tashsaka Irrigation System in Khorezm Province" with participation of the Islamic Development Bank is on-going. Currently it is planned to implement jointly with France the Program "Rehabilitation of Navoi and Uchkara Pumping Stations" and rehabilitation of the Amu-Bukhara irrigation system[45] with participation of the Asian Development Bank.

[44] JSC "Uzstroymateriali", 2013.

[45] Decree of the President of the Republic of Uzbekistan No.PP-1958, dated 19 April 2013 "On Measures for Further Irrigated Lands Improvement and Rational Use of Water Resources for 2013-2017" // Law Book of RUz, 2013, No17, p. 223

Forest Resources: Afforestation and reforestation are amongst the efficient approaches to mitigation of climate change, since forests are the main GHGs sink. Desert forests in Uzbekistan have considerable capacity for reduction in GHGs emission, which despite their low productivity, occupy vast areas. According to GHGs inventory data for period 1990-2012, CO_2 sink, associated with biomass buildup, was increased by 8.5 times. Such GHGs sink increase is a result of reforestation and forest amelioration measures being implemented in the country.[46,47]

According to expert estimations, there is a certain capacity for GHGs sequestration (CO_2 sink) by the main forest forming plant species in case of implementation of measures aimed at facilitation of natural forests regeneration, such as:

- prohibition or limitation on cattle grazing,
- control of illegal tree cutting,
- facilitation of natural forests regeneration for improvement of forest density up to 0.6-0.8, instead of currently existing 0.3-0.4,
- replacement of over aged forest vegetation by young one will lead to increase in productivity of forest vegetation, i.e. increase in sink of carbon dioxide up to 7.7 million ton in equivalent of fixed carbon (Table 3.12).

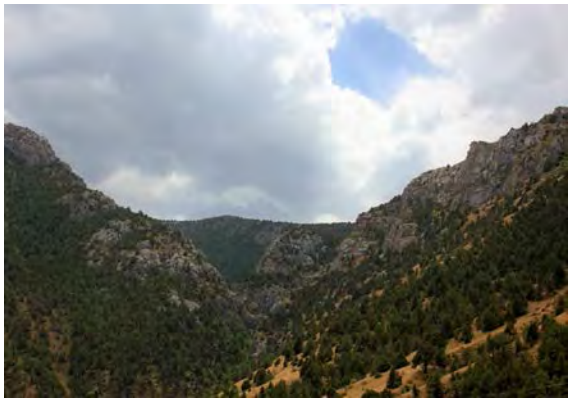


Figure 3.9 | *Zaamin National Park*

Table 3.12 | *Capacity for CO_2 Sequestration by Main Forest Forming Plant Species*

Main Forest Forming Plant Species	Annual Increase in Carbon Volume due to Biomass Buildup, ton C/ha/year			Land Area Covered by Forest, '000 ha	Annual Increase in Carbon Volume due to Biomass Buildup, ton C/ha/year		
	On Average by Forest Plantation	For Young Forest Plantation	Total		Current Conditions	With Measures for Facilitation of Forests Regeneration	Due to Measures for Facilitation of Forests Regeneration Only
I. Mountain Forests							
1. Juniper	0.20	1.9	2.1	153.3	30.7	321.9	291.2
2. Pistachio	0.18	3.33	3.51	8.7	1.6	30.7	29.1
II. Plain- Tugai Forests							
1. Poplar	0.98	3.92	4.9	16.1	15.8	79.1	63.2
2. Asiatic poplar	0.33	1.24	1.57	95.6	31.5	150.1	118.5
III. Desert Forests							
Saxaul	0.88	3.25	4.13	2218.2	1952.0	9161. 3	7209.3
Total				2492.0	2031.6	9743.1	7711.3

Source: Expert assessments of URSPCDH and F [48]

Forest lands without vegetation, intended for afforestation (area of which is around 30% from the total forest land area), have estimated sink capacity of around 2,5 million ton of fixed carbon (Table 3.13). Therefore, the task is to establish quality forest vegetation on this territory as soon as possible. To achieve this it will be required:

- to increase volume of financing for afforestation from various sources;
- to strengthen capacity of forest enterprises staff on account of professionally trained specialists in afforestation, forest amelioration, forest conservation, soil scientists, etc.;
- to improve technical facilities of forestry enterprises;
- to strengthen system for control and protection of forests from pests and diseases, fire and other disasters, etc.;
- to involve local population in forestry activities and cooperation with forestry sector.

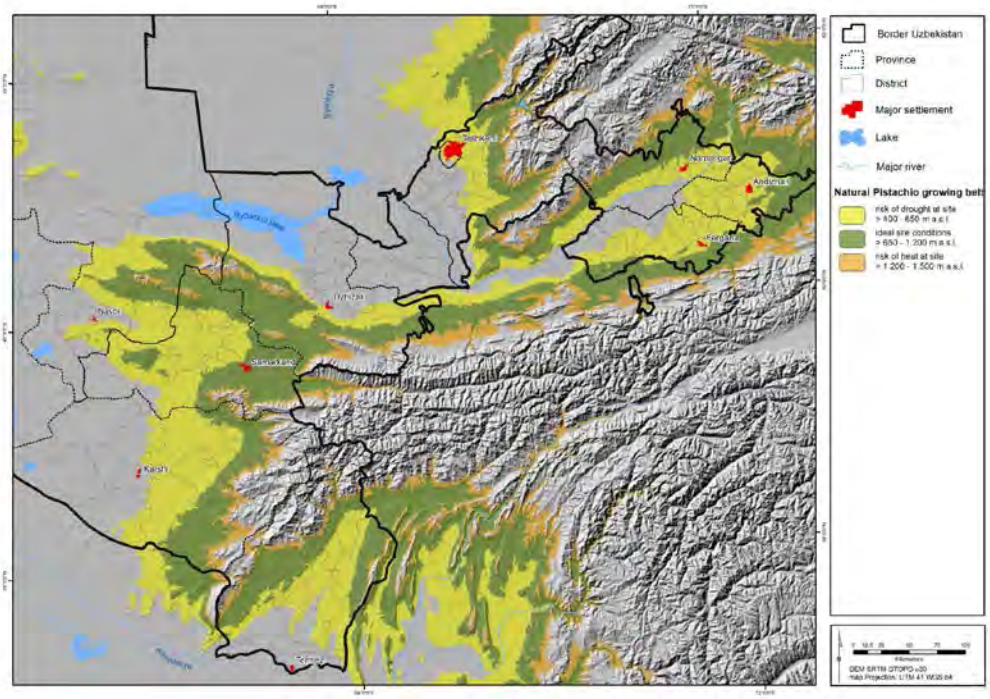
[46] National Report on Environment Conditions and Use of Natural Resources in the Republic of Uzbekistan (2008-2011) / Edited by N.M. Umarov; State Committee for Nature Protection – Tashkent, Chinor ENK, 2013. - 260 p.
[47] National Report "Inventory of Sources and Sinks of Anthropogenic Greenhouse Gases Emissions in the Republic of Uzbekistan (1990-2012 rr.) – Tashkent, 2016.
[48] Scientific-Production Center of Decorative Gardening and Forestry of the Republic of Uzbekistan

Table 3.13 | *Capacity for CO_2 Sequestration by Forest Lands without Vegetation*

Main Forest Forming Plant Species	In % from Forest Lands without Vegetation	Land Area, ha	Annual Increase in Carbon Volume due to Biomass Buildup, '000ton C/year
I. Mountain Forests			
1. Juniper	0,062	53426,0	101,5
2. Pistachio	0,003	3048,4	10,2
II. Plain- Tugai Forests			
1. Poplar	0,006	5624,9	22,0
2. Asiatic poplar	0,039	33316,1	41,3
III. Desert Forests			
Saxaul	0,890	773184,6	2512,9
Total	1,000	868600,0	2687,9

Source: Expert assessments of SRPCDG&F

Piedmont Rainfed Lands. Adyr lands, located at elevations from 600 to 1500mamsl, occupy in Uzbekistan huge areas (Figure 3.10). There are such lands in the Tashkent, Samarkand, Navoi, Djizak, Kashkadarya, Surkhandarya provinces and at the surroundings of Fergana valley.



Source: http://pistachio.uz/images/map_pistachio_eng_.jpg

Figure 3.10 | *Piedmont and Low Mountain Areas Suitable for Growing Pistachio and Almonds*

Climate change in perspective may reduce moisture availability, and correspondingly reduce possibility to get acceptable crop yields on rainfed lands, as well as fodder phytomass on pastures. Lack of moisture in combination with increasing anthropogenic load will lead to enhancement of pressure on natural pastures, their further degradation and abandonment of rainfed lands. At the same time, land belt at elevations of 650-1200 mamsl is the most favorable lands for growing pistachio. It occupies huge land area of more than 30 thousand km2 or 3.0 million ha.

According to expert estimations, in case of establishment of pistachio commercial plantations on piedmont land area of 1 million ha, annual increase in volume of carbon sink due to biomass buildup may be equal to 3.33 million ton C/year (Table 3.14).

In order to use this potential possibility the following will be required:

- to get permit for long-term lease (for 49 years) of lands without forest vegetation from the State Forest Fund;
- to ensure accessibility to mini-credits for farmers;

- to provide 5-6 year tax holidays for farmers after establishment of pistachio plantations;
- to create nursery of varietal pistachio plants;
- to provide consulting services for farmers in pistachio growing.

Therefore, there is a considerable capacity for increasing GHGs sink on lands of the State Forest Fund and on other land categories in Uzbekistan (Table 3.14).

Table 3.14 | *Capacity for GHGs Sequestration by Afforestation and Reforestation*

Measures	Capacity for GHGs Sink, '000 ton C/year
Facilitation of natural forests regeneration on lands covered by forests	7711.4
Forest lands without vegetation	2687.9
Field-protective belt on irrigated lands	392.0
Piedmont rainfed lands for establishment of pistachio plantations	3330.0
Total	14121.3

Source: Expert assessments of SPCDG and F

A number of measures, aimed at improving efficiency of forest resources management are being implemented in the country. In particular:

- in accordance with the integrated program of measures aimed at mitigation of the Aral Sea disaster impact, rehabilitation and socio-economic development of Priaralie for 2015-2018[49] it is planned to establish forest plantations on around 1.0 million ha of the dried Aral Sea bottom, with annual planting of 40-50 thousand ha. Implementation of such works will be the main direction for the long-term development of this region.
- establishment under GEF Small grant projects of varietal pistachio plantations in piedmont areas for rational use of low productive lands is currently getting wide-spread distribution.
- the Main forestry administration under MAWR has prepared and registered on the UNFCCC site request for creation of pistachio plantations in Uzbekistan as implementation of the NAMA mitigation actions.[50]

In the process of radical agriculture reformation in the country, special attention is paid to further development of horticulture.[51] During 2010-2014, new orchards were planted on the land area of almost 50 thousand ha, including more than 14 thousand ha of intensive orchards, as well as vineyards on the land area of 23 thousand ha.

3.3.8 Waste

According to inventory data over the period 1990-2012, volume of greenhouse gases emission in Wastes sector was increased by 86% (See Chapter 2). The main volume of GHGs emissions in wastes sector (86.7%) is attributed contributed to the "Solid Waste Disposal on Land" category (Figure 3.11).

The National strategy and Action plan for waste management[52] have been developed and being implemented in Uzbekistan. Objective of the National Strategy and Action plan is to create conditions facilitating:

- complete collection, transportation, utilization, disinfection and burial of municipal wastes,
- restriction of their harmful impact on environment and human health.

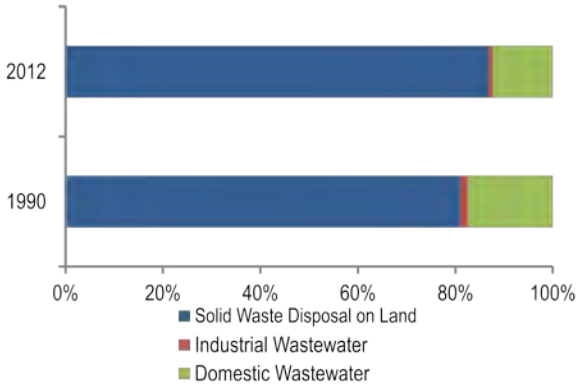


Figure 3.11 | *Change in Structure of GHG Emission in "Waste"*

The main measures aimed at inhibition of GHGs emission from decomposition of solid municipal wastes at dumps are:

- increase in share of processing and reusing of wastes;
- developing and commissioning new equipment for domestic wastes management;
- introduction of separated collection and sorting solid municipal wastes for their maximum use and elimination of irretrievable loss of their components with burial, prevention of dangerous municipal wastes ingress to environment, decrease in land area required for creation of solid municipal wastes disposal sites;

[49] Decree of the Cabinet of Ministers No. 255, dated 29 August 2015 "On Integrated Program of Measures Aimed at Mitigation of the Aral Sea Disaster Impact, Rehabilitation and Socio-economic Development of Priaralie for 2015-2018" // Law Book of RUz, 2015, No.35, p. 469; 2016, No 9, p. 91

[50] NS-249 "Rainfed Mountain Belt Reforestation" http://www4.unfccc.int/sites/nama/_layouts/un/fccc/nama/NamaSeekingSupportForPreparation.aspx?ID=169&viewOnly=1

[51] Decree of the President of the Republic of Uzbekistan No. UP-3709, dated 9 January 2006 "On Measures for Deepening Economic Reforms in Horticulture and Grapes Production" // Law Book of RUz, 2006, No.2 (6)

[52] http://uznature.uz/printpdf/809

- acknowledgment of burial ground disposal of wastes as the most inefficient technology for solid municipal wastes management and transition to advanced highly efficient methods of their utilization and disinfection;
- introduction of advanced efficient technologies for utilization of solid municipal wastes along with energy generation;
- land recultivation at disposal sites of solid municipal wastes;

3.4 Mitigation Capacity Building Needs

Analysis of cause-effect relations in the revealed problems in the context of political, economic and legal frameworks has allowed to identify a number of key directions for nationally appropriate capacity building required for capability enhancement in prevention of climate change.

Gaps, barriers and needs for Mitigation capacity building have been analyzed in details in a number of analytical reviews. [53]These barriers are of various nature: price and financial barriers associated with structure and organization of economy and market; institutional, social, cultural, behavioral barriers, etc.

The main problems with implementation of priority measures associated with climate change prevention and fulfillment of commitments to the UNFCCC are: lack of organization and coordination between large number of ministries and agencies involved in this process; insufficient institutional, professional and informational capacity; shortage of technical and financial resources; lack of integrated climatic program; poor awareness of the parties concerned. Amongst the technological barriers are: lack of design skill; shortage of material and energy efficient technologies; shortage of statistics data; and lack of qualified and experienced specialists.

For enhancement of coordination and mutually beneficial cooperation between various ministries and institutions facilitating successful implementation of measures aimed at decrease in GHGs emission and mobilization of resources there is a need for establishment of the special governmental body (coordination council, commission, etc.), which will be directly responsible for formation of the country's climatic policy and results of its implementation, development of the relevant Strategies/Action Plans and control over their fulfillment.

A number of important normative and legislative acts in area of energy efficiency, energy saving, introduction of renewable energy sources has been adopted in Uzbekistan. However, the majority of adopted documents are of indirect action acts. Therefore, there is a need for adoption of large number of bylaws, development and adoption of target indices for increase in energy efficiency in the key economy sectors.

Integration of fundamental and applied scientific climatic and climate-related knowledge is required for the objective assessment of climate change impacts, application of the advanced software products (LEAP) for estimation of decrease in GHGs emission and development of the integrated response measures, including information dissemination, preventive measures, support to vulnerable population groups and natural objects. Carrying out outreach campaigns for population awareness raising about simple energy saving measures and implementation of program of actions for energy saving may give positive effect.

In the forestry management area it is necessary to complete the integrated inventory of the state forest fund lands that carried out currently with the FAO support and identify priorities in forestry policy for perspective; to amend the "Forest Law" and other normative and legal documents; to develop mechanism for involvement of local population in forestry development; to revise human resources policy for improvement of forestry staff training, retraining and advanced training; and to expand international cooperation.

Further intensification of international cooperation and substantial assistance from the international financial institutions and partner countries will be required for implementation of efficient, targeted and properly financed projects and programs aimed at low carbon development. Attraction of climatic resources (grants), including resources of the Green Climate Fund, Adaptation Fund, Global Environment Facility may substantially decrease the government expenses for these purposes. These circumstances encourage to study more thoroughly issue of access to climatic resources, to develop capacity of experts for preparation and promotion of the attractive projects and programs.

There is a need for development of staff capacity for formulation, development and implementation of Strategies and Action plans on issues of low carbon development, energy efficiency, carrying out greenhouse gases inventory.

There is a problem with shortage of statistical information and databases fragmentation. Large volume of information collected within framework of implementation of numerous projects remains property of the project and its implementing agency and, as

[53] UNDP/Ministry of Economy of RUz. "Energy Efficiency in Buildings:Hidden Resource for Sustainable development of Uzbekistan" – Tashkent, 2015
UNDP/Ministry of Economy of RUz. "Towards Sustainable Energy: Strategy for Low Carbon Development of Uzbekistan" – Tashkent, 2015
UNDP/Centre for Economic Studies. "Uzbekistan Towards 2030: Transition to the Resource-efficient Growth Model (Vision-2030)" – Tashkent, 2014
Second National Communication of RUZ under UNFCCC. – Tashkent, 2008.

a rule is inaccessible to parties concerned. Improvement of the State statistics committee's databases on issues of climate change (mitigation and adaptation) would allow to respond promptly to various requests.

In order to increase efficiency in introduction of environmentally sound and innovative technologies facilitating mitigation of and adaptation to climate change impacts, it is necessary to improve awareness level of the potential investors, and concerned governmental bodies and private companies about the country's market of ESTs and benefits from their introduction. There is a need for further development of normative basis, including definition of clear criteria for selection of national climate resistant technologies and their commercial appraisal for subsequent broad introduction and transfer.

Climate change processes affect directly or indirectly practically all components of environment and social and economic sphere, therefore there is a certain interrelation between fulfillment of commitments to the UN Rio conventions (FCCC, CBD, CCD) and necessity for coordinated actions for enhancement of synergy from implementation of these conventions through preparation and implementation of joint projects, including the ones with international financing.

3.5 Prediction of Greenhouse Gases Emission

Prediction of greenhouse gases emission for the period 2010-2020 has been developed and presented in the Second National Communication of the Republic of Uzbekistan under UN FCCC (SNC).[54] The predictive estimates have been made taking into account possible options of country's economy development for the period from 2010 to 2020. The GDP growth rates and possible variations in its structure have been used as the main predictors. Range of the values of total GHG emissions predicted in the Second national communication by 2010, 2015 and 2020 for all considered calculation scenarios is presented in Table 3.15.

Table 3.15 | *Range of Total GHG Emissions Predicted in SNC for All Calculation Scenarios*

Years	GHGs Emissions (minimum – maximum), Mt CO_2-eq.
2010	263.1-289.4
2015	335.3-431.5
2020	422.0-675.9

GHGs emission predictions, presented in the Second National Communication, have turned out to be overestimated by all scenarios of economy development. E.g. according to GHGs inventory, conducted within framework of the Third National Communication, the total GHG emissions in 2010 was 199.2 Mt CO_2-eq, versus predicted 260-290 Mt CO_2-eq.

The obtained discrepancy between actual and predicted values of GHG emissions is stipulated by both the adopted assumptions and high rates of decrease in energy consumption of the country's economy for period 2005-2015 as a result of implementation of the governmental development programs.

Within the framework of preparation of ***the Third National Communication*** predictions of greenhouse gases emission have been developed for perspective up to 2030 taking into account development of the key economy sectors and forecast of macroeconomic indices, such as the GDP and population growth rates.

Amongst the main methodological approaches used were:

- model calculations of GHGs emissions for long-term perspective on a scale of whole economy;
- calculations of GHGs emissions on the basis of various scenarios of fuel consumption up to 2030.

Information and forecasts of economic development, presented in the strategic documents for the long-term perspective and in number of studies, have been used for identification of assumptions and evaluation of capacity for GHGs emissions reduction[55,56,57,58]. It should be noted that identification of any long-term perspectives involves considerable uncertainty. Therefore, very often accuracy of such predictions substantially lower as compared with short-term or mid-term predictions. In Uzbekistan both the national and sectoral development plans are mainly prepared for the mid-term perspective, for not more than 5 years.

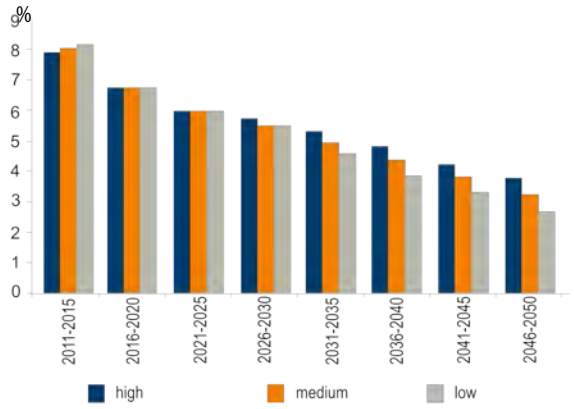
Prediction of macroeconomic indices. Change in existing GHGs emission trends depends directly on the growth rates of country's economy (GDP), including population growth ratio, as well as efficiency of the state policy in energy saving.

Macroeconomic stability and balanced development of the national economy allow in the recent years to retain stable GDP growth rates at the level of 8.0-8.2%. Development of industry and service sectors has led to increase in their share in the GDP by 2014 up to 24.1% and 54.0% respectively (Chapter 1).

[54] "Second National Communication of the Republic of Uzbekistan on UN FCCC", Tashkent, 2008.
[55] Decree of the President of the Republic of Uzbekistan No.PP-2343, dated 05 May 2015 "On Program of Measures for Reduction in Energy Consumption, Introduction of Energy Saving Technologies in Economy Sectors and Social Sphere for 2015-2019"
[56] Analytical Report of the Center for Economic Studies "Uzbekistan towards 2030: Transition to Resource-efficient Growth Model (Vision-2030)", 2015 – 34 p.
[57] UNDP / Ministry of economy, "Towards Sustainable Energy. Strategy for Low Carbon Development of the Republic of Uzbekistan" – Ташкент, 2015.
[58] UNDP / Ministry of Economy Report "Energy efficiency in buildings: hidden resource for sustainable development of Uzbekistan", Tashkent, 2013.

Forecasts of GDP, used as predictors for calculations of GHGs emission for perspective, are reflected in a number of papers. The following tree options of the GDP growth rates have been used for evaluation of GHGs emission in the country for perspective up to 2030:

- in accordance with estimations, presented in the documents "Targeted Indices on Decrease in Energy Consumption/Greenhouse Gases Emission in The Key Sectors of Economy" of Uzbekistan"[59] and Analytical Report of the Center for Economic Studies "Uzbekistan towards 2030: Transition to the Resource-efficient Growth Model (Vision-2030)", GDP growth rate in Uzbekistan up to 2030 is predicted at the level of 8% per year;
- in the UNDP Report "Energy Efficiency in Buildings: Hidden Resource for Sustainable Development of Uzbekistan" GDP growth rate in 2016-2020 is estimated at the level of 6%, and depending on scenario in 2030-2050 its value will vary in the range from 2.7% to 3.8% (Figure 3.12);
- in accordance with the planned task "to increase the country's GDP by not less than two times by 2030" it will be sufficient to ensure the annual average GDP growth rate at the level 4.8% per year.[60]



Source: UNDP Report "Energy efficiency in buildings: Hidden resource for sustainable development of Uzbekistan", 2013.

Figure 3.12 | *Prediction of Uzbekistan's GDP Growth Rate*

Another important macroeconomic index, used for prediction GHGs emission, was population growth ratio. According to the UNDP data, population growth ratio in the Republic of Uzbekistan is estimated at the level of 1.2–1.3%/year.[61] Correspondingly by 2030 population size in the republic will be around 36-37 million people. These predictive estimates are similar to those used by the Strategy for low carbon development.

All three above options of the GDP and population growth rate forecasts (see Table 3.16) have been used for assessment of greenhouse gases emission in the country for perspective up to 2030.

Table 3.16 | *Predictive Estimates of GDP and Population Size up to 2030*

Indices	2010	2014	2020	2025	2030
GDP growth rates % per year	8.5	7.1	8.2	8.2	7.0
			6.0	6.0	6.0
			4.8	4.8	4.8
GDP*, USD billin	38.04	59.80	92.9	137.7	204.2
			87.9	117.6	157.4
			84.0	106.2	134.2
Population growth rates, % per year	2.8	1.7	1.3	1.2	1.2
Population size, mln people	28.6	30.5	32.3	34.3	36.3

* Note: For convenience's sake actual GDP values for 2010-2014[62] expressed in Uz Soum, have been converted into USD at exchange rate of the of the National bank of the Republic of Uzbekistan as of the end of year [63]

Model calculations of GHGs emissions for long-term perspective on a scale of whole economy. Two approaches have been used for evaluation of greenhouse gases emission in Uzbekistan for perspective up to 2030, namely: GACMO[64] model and linear trend.

The Model GACMO (Greenhouse Gas Abatement Cost Model) has been developed by specialists from the Danish Technical University and recommended by the IPCC as one of the models for development of baseline for GHGs emission. The model is

[59] UNDP / Ministry of Economy. Towards sustainable energy. Strategy for low carbon development of the Republic of Uzbekistan. Target indices for reduction in energy consumption/greenhouse gases emission in the key sectors of economy" – Tashkent, 2015.
[60] Report of the first President of RUz, Mr. I.A. Karimov, at the extended session of the Cabinet of Ministers devoted to the results of social and economic development of the country in 2015, and the most important priority directions of economic program for 2016.
[61] UNDP, World Population Prospects, The 2015 revision, New York, 2015.
[62] http://stat.uz/ru/index.php/141-otkrytye-dannye/989-valovoj-vnutrennij-produkt
[63] http://www.cbr.uz/
[64] GACMO (Greenhouse Gas Abatement Cost Model) has been developed by specialists from the Danish Technical University and recommended by UNEP-DTU Partnership for development of baseline for GHGs emission

based on spreadsheet calculations. The model allows estimating dynamics of greenhouse gases emission for perspective taking into account predictions of development rates of various economy sectors and social sphere, including dynamics of population growth.

Two GACMO model scenarios (i.e. "Business as usual" (baseline) and "Realistic" scenarios) with use of all three options on forecast of the GDP and population size growth ratio (see Table 3.17), have been used for calculations. Results of the Third national GHGs inventory have been used as initial data for calculation of greenhouse gases emission, and year 2010 was selected as a baseline year.

Linear trend. Results of GHGs inventory, carried out within the framework of the Third national communication, have indicated increase in their emission by 13.7% during the period from 1990 to 2012. Linear trend of GHGs emission for the period up to 2030 has been plotted, assuming that these tendencies will retained in future. This approach does not take into consideration impact of possible changes in macroeconomic indices on pattern and volumes of GHGs emission.

"Business as usual" (baseline) scenario. The scenario describes growth in GHGs emission relevant to the current situation. The following assumptions have been adopted for this scenario: energy consumption increases proportionally to growth of the GDP (including three options of the GDP growth rates) and population size; no any substantial additional measures for decrease in GHGs emission will be undertaken; GHGs emission increases in energy sector due to commissioning additional capacities, development of oil and gas sector, including increase in volume of extraction and transportation of natural gas; GHGs emission increases in industry sector due to industrial production growth versus current trends; GHGs emission increases in transport sector due to growth of population size, number vehicles and volume of cargo transportation; GHGs emission increases in agriculture sector due to development of cattle breeding.

"Realistic" scenario. It is assumed that during considering period the government implements efficient policy in energy saving and energy efficiency, including extensive use of RES, modernization of industrial enterprises and introduction of advanced technologies that decrease fuel consumption considerably.

Results of all predictive calculations of GHGs emission by the GACMO and linear trend are presented in Table 3.17 below.

Table 3.17 | *Prediction of Total Volume of GHGs Emission for Period up to 2030*

Prediction scenario	Range of GHGs emission, Mt CO_2-eq.				Change in GHGs emission, in % to 2010		
	2010	2020	2025	2030	2020	2025	2030
Business as usual (baseline)	199,2	225 -241	262 -288	305 -358	+13…21%	+32…45%	+53…80%
Realistic		221 -237	244 -270	277 - 330	+11…19%	+23…36%	+39…66%
Linear trend		221	228	235	+11%	+14%	+18%

Source: *expert evaluations*

The completed calculations indicate that maximum growth in GHGs emission is distinctive for the base scenario ("Business as usual"), reflecting the current economy development rates. By 2030, depending on the GDP growth rates, the total volume of GHGs emission may be increased by 53-80% (or from 199.2 to 305-358 Mt CO_2-eq.).

The predicted positive growth in GHGs emission is stipulated by: increase in energy consumption in the country as a result of population growth and improvement its living standards; development of industry, oil & gas and transport sectors; increase in use of refrigerating fluid with high global warming potential; increase in share of coal in the fuel consumption pattern.

In particular, according to development plans of coal mining industry of the Republic of Uzbekistan for the period 2013-2018[65] coal extraction will be increased by two times in 2018. Therefore, increase in volume of carbon dioxide emission from coal combustion may reach 4% from the total GHGs emission. With further increase on coal extraction by 2030, emission of CO_2 from its combustion may be increased around 6% from the total GHGs emission (currently share of coal combustion contribution to the total volume of GHGs emission is 2.4%).

In case of "realistic scenario" growth rates of GHGs emission may be dropped down considerably. With implementation of a set of measures for energy saving in the key sectors of economy, by 2030 GHGs emission will vary in the range of 277-330 Mt CO_2-eq (Ref. Table 3.17). Measures, taken into account in calculation of predicted GHGs emissions by the "realistic" scenario, are reflected in the national and sectoral programs, in particular in the "Program of Measures for Reduction in Energy Consumption, Introduction of

[65] Decree of the Cabinet of Ministers No. PKM-161, dated 06 June 2013 "On Approval of Program for Modernization, Technical and Technological Upgrading of Coal Mining Industry Enterprises and its Balanced Development for Period 2013-2018" // Law Book RUz, 2013, No. 23, p 307

Energy Saving Technologies in Economy Sectors and Social Sphere for 2015-2019"[66], "Program of measures for ensuring structural reformations, modernization and diversification of production for the period 2015-2019"[67] and others. Complete implementation of the above mentioned programs, as well as materialization of forecasts on development of solar energy sector together with capacity of forestry for GHGs sink, will allow reducing GHGs emission by 20 Mt CO_2-eq. (Ref. Table 3.18).

Table 3.18 | *Capacity for Decrease in GHGs Emission from Planned Measures for Period up to 2020*

Measures	Probable Reduction in GHGs mission, Mt CO_2-eq
Energy efficiency, energy saving in energy generation and industry sectors	11.9
Development of solar energy sector, fuel saving*	1.0
CO_2 sink by forests. Afforestation, reforestation	7.6
Total	20.5

Note * indicated value of probable decrease in GHGs emission from introduction of solar energy stations is attributed to level of 2030
Source: Expert assessments

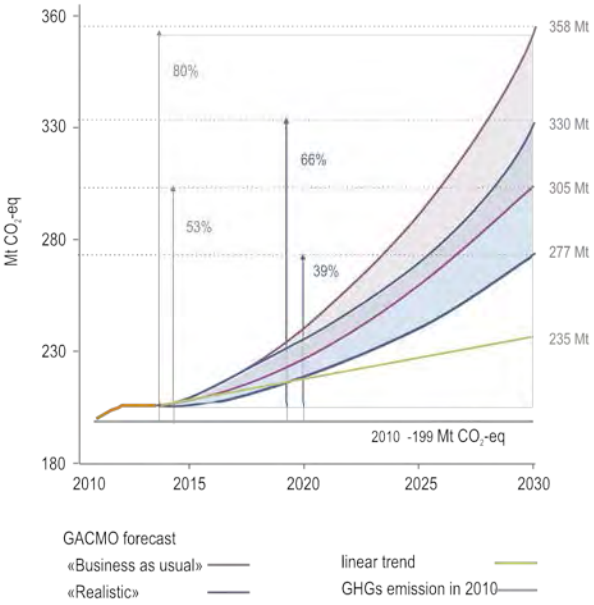


Figure 3.13 | *Prediction of GHG Emissions up to 2030*

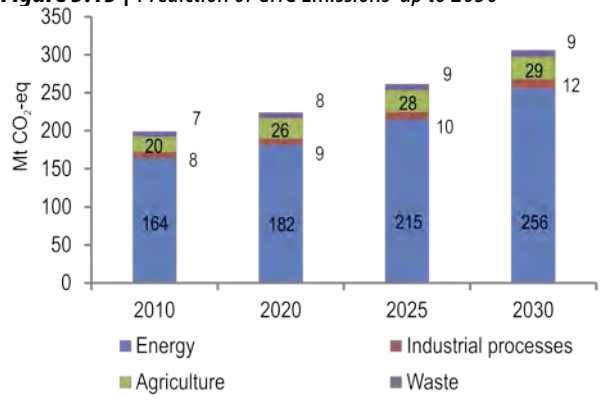


Figure 3.14 | *Forecast of GHGs Emission by Economy Sectors for Period up to 2030 by "Business as usual" Scenario, Mt CO_2-eq*

Hence, all forecast options demonstrate further growth in GHGs emission, which is stipulated by rates of the country's economic development and may make up around 235 Mt CO_2-eq (see Figure 3.13).

In all forecast scenarios by the GACMO model for the short-term perspective (up to 2020) volume of GHGs emission increases by 11-21% against level of 2010. Difference in emission by "baseline" and "realistic" scenarios is approximately 2%. In the long-term perspective (up to 2030) volume of GHGs emission will be increased substantially as compared with 2010 (by 36-80% depending on calculation option). Difference in value of emissions between "baseline" and "realistic" scenarios is around 14%.

Linear extrapolation of the current trend ("Linear trend") demonstrates increase in GHGs emission by 2030 only by 18% from the level of 2010. However, with the existing and planned rates of economy development, realization of this GHGs emission scenario is scarcely probable.

Expert evaluations of GHGs emission trends for the "Business as usual" (baseline) scenario by various economy sectors have been made in the process of study. The evaluations assume that share of particular sector input in the overall emissions pattern will remain unchanged. As in the previous years, share of the "Energy" sector in the total volume of emissions will remain determinative (around 80%). GHGs emissions in this sector may reach 181.5 Mt CO_2-eq. by 2020, and 256 Mt CO_2-eq. by 2030 (Ref. Figure 3.14). Since, the "Energy" sector remains, as before, the main source of GHGs emission, implementation of measures for increasing efficiency of fuel use and energy saving policy will play the important role in emissions limitation. Implementation of measures for reduction in natural gas leakages and utilization of accompanying gases will remain of a high priority in future, which is reflected in the programs for the oil and gas sector development.

Evaluations of GHG emissions by various options on fuel consumption forecasts. Quantative evaluation of GHGs emission/fuel consumption is one of indicators for comparative assessment between various countries, since carbon dioxide emissions from fuel combustion are as a rule the key source of GHGs emissions. According to inventory data share of GHG emissions from fuel combustion in Uzbekistan is around 50%.

For evaluation of GHG emissions in Uzbekistan associated with fuel combustion (CO_2 emissions), the

[66] Decree of the President of the Republic of Uzbekistan No.PP-2343, dated 05 May 2015 "On Program of Measures for Reduction in Energy Consumption, Introduction of Energy Saving Technologies in Economy Sectors and Social Sphere for 2015-2019"
[67] Decree of the President of the Republic of Uzbekistan No.UP-4707, dated 04 March 2015 "On Program of Measures for Ensuring Structural Reformations, Modernization and Diversification of Production for Period 2015-2019"

following three calculation options have been considered:

A evaluation of GHGs emissions for perspective within the framework of the UNDP/Ministry of economy Project "Support to Uzbekistan in transition to low carbon development of the national economy".

B evaluation of GHGs emissions on the basis of predictive estimates of the main fuel types consumption in the country up to 2030.

C evaluation of GHGs emissions on the basis of the IEA data on primary energy consumption in Uzbekistan by fuel types up to 2030.

Option A. Under the above mentioned project, evaluation of GHGs emissions associated with fuel combustion (CO_2 emissions) in the most energy consumptive sub-sectors of the "Energy" sector, i.e. electric and thermal energy generation and buildings has been made. According to inventory data share of these emission sources is around 40% from the total emissions. Forecasts up to 2050 were prepared for three scenarios: "Baseline", "Realistic" and "Optimistic" ones. Assumptions, used in the scenarios for calculations of GHGs emissions, are presented in Table 3.19 below.

Data of macroeconomic forecast, prepared on the basis of simplified macroeconomic model[68], as well as plans for economy sectors development have been used for identification of perspectives up to 2030.

Table 3.19 | *Assumptions, Adopted for Evaluation of GHGs Emissions Forecasts up to 2030 in Electrical Energy, Thermal Energy and Buildings Sectors (Option A)*

Scenario	Assumptions	Economy Sector	2014	2020	2030
Baseline	Rates of reconstruction and commissioning new generating and transmitting/transporting capacities in electrical and thermal energy sectors correspond to the current situation in economy. Insignificant decrease in specific energy consumption in buildings takes place.	Electrical energy		31.06	35.88
		Thermal energy		20.28	24.72
		Buildings	47.85	55.41	58.95
		Total for 3 sectors		106.75	119.55
Realistic	Stiffening the governmental requirements to energy saving and energy efficiency allows to significantly reduce energy consumption in the "Electrical Energy" and "Thermal Energy" sectors. In accordance with adopted construction norms (KMK) specific energy consumptions in buildings is being decreased considerably.	Electrical energy	29.16	30.37	34.21
		Thermal energy	19.49	15.33	18.69
		Buildings		51.33	49.86
		Total for 3 sectors		97.03	102.76
Optimistic	Measures, adopted for realistic scenario, are supplemented by a wide range of measures on use of renewable energy sources, including in buildings.	Electrical energy		30.86	32.91
		Thermal energy		10.52	12.83
		Buildings		50.98	47.46
		Total for 3 sectors		92.36	93.2

Source: UNDP/Ministry of economy Report "Targeted indices on decrease in energy consumption / GHGs emissions in the key economy sectors of Uzbekistan", Tashkent, 2015

The results, obtained by experts, indicate that in all considering economy sectors maximum growth in GHG emissions is distinctive for the base scenario reflecting the current rates of modernization in the electrical energy and thermal energy sectors, as well as degree of introduction into practice the revised construction norms with regard to energy efficiency. According to the base scenario by 2030 the total emissions in three considering economy sectors will be increased up to 119.55 Mt CO_2-eq.

Implementation of policy on energy saving in the realistic scenario allows to reduce fuel consumption for generation of energy unit (kWh, GJ) and correspondingly to restrict growth in GHGs emission to 102.76 Mt CO_2-eq. by 2030.

By the optimistic scenario, extensive introduction of renewable energy sources in addition to implementing government policy on energy saving, as well as sharp decrease in specific energy consumption in buildings (down to 50kWh/m^2) lead actually to freezing growth in the total GHG emissions in the "Electrical energy", "Thermal energy" and

Table 3.20 | *Evaluation of GHGs emissions on a scale of whole economy for long-term perspective up to 2030 (Option A)*

Scenario	Units	2020	2030
Base	Mt CO_2-eq.	282	316
	% to 2010	+42%	+59%
Realistic	Mt CO_2-eq.	257	272
	% to 2010.	+29%	+37%

Note: Emissions in 2010 were 199.2 Mt CO_2-eq.

[68] UNDP/Ministry of Economy "Energy efficiency in buildings: hidden resource for sustainable development of Uzbekistan", Tashkent, 2013.

"Building" sectors at the level of 93.2 Mt CO_2-eq. by 2030.

Predictive estimates of GHGs emissions on a scale of whole economy have been made on the basis of calculations by these scenarios (Ref. Table 3.20), taking into account the following assumptions:

- in 2010-2012 share of evaluated economy sectors was 37-38% from the total GHGs emissions;
- pattern of the total emissions will remain unchanged during forecasting period.

Recalculation has been made for the base and realistic scenarios.

Option B. Evaluation of GHGs emissions on the basis of predictive estimates of the main fuel types consumption in the country up to 2030 has been made using data, provided by the Ministry of Economy of the Republic of Uzbekistan.[69] It was envisaged in the prediction the probability of gradual reduction in consumption of oil and oil products and increase in share of coal consumption in the total fuel consumption.

The IPCC methodology with application of the national emission factors for each type of fuel has been used for calculation of GHGs emissions (Table 3.21).

On the basis of obtained results the predictive estimates of GHGs emissions on a scale of whole economy have been made, assuming that share of emissions from fuel combustion is around 50% from the total GHGs emission in the country.

Calculation results have indicated that the total CO_2 emissions from fuel combustion may reach 135 Mt CO_2 eq. by 2030. Taking into account conversion into the full emissions, level of the whole emission may reach around 281 Mt CO_2 eq. by 2030.

These predictive estimates correlate closely with the results of GHGs emission, calculated by the GACMO model for the "realistic" scenario (taking into account the relevant measures and actions).

Table 3.21 | *Evaluation of GHG Emissions Based on Prediction of Fuel Consumption up to 2030 (Option B)*

Fuel Type	2010	2016	2020	2025	2030
GHGs emissions from fuel consumption (Mt CO_2)					
Natural gas	80.2	84.0	81.9	87.4	112.7
Oil products	12.3	6.0	6.1	6.3	6.4
Coal	3.2	5.0	9.7	15.2	16.4
Total	95.7	95.0	97.7	108.9	135.5
Total GHGs emissions (on a scale of whole economy)					
GHGs emissions, Mt CO_2-eq.	199.2	196.0	202.0	225.0	281.0
% to 2010 г.		-1.6%	+1.4%	+13.0%	+41.1%

Source: Expert evaluations

Option C. The IEA World Energy Outlook for 2010[70] presents forecast of Uzbekistan's energy sector development for period up to 2030, including estimations of consumption of all energy products (Table 3.22). Forecast is based on the IEA scenario "New Policy for Countries of the Caspian Sea region", which assumes annual increase in the primary energy consumption of 1.1% and annual increase in energy efficiency of 3.0% from the level of 2008. Retention of natural gas position as the main energy resource is reflected in this scenario.

Table 3.22 | *Consumption of Primary Energy in Uzbekistan by Fuel Types (IEA data), mln. t.o.e.*

	1990	2010 [71]	2015	2020	2025	2030
Coal	3.4	1.2	1.5	1.8	2	2.3
Oil and oil products	10.1	3.8	5.9	6.4	6.1	6.6
Natural gas	32.5	41.9	51.7	54.2	56.4	57.2
Hydropower	0.6	1	1	1	1	1
Others	0	0	0	0	0.1	0.2
Total	46.6	47.9	60.2	63.4	65.6	67.2

Source: "World Energy Outlook 2010", IEA: 2010, p. 489

The IEA information on predicted fuel consumption has been used for calculation of GHGs emissions from its combustion. Therefore, values of various fuel types consumption have been converted from energy units into natural ones. The IPCC methodology with application of the national emission coefficients for each type of fuel has been used for calculation of GHGs emissions. Calculation results are presented in Table 3.23.

[69] Data on predictive consumption of main types of fuel from the Ministry of Economy, dated 5 May 2016.
[70] World Energy Outlook 2010. IEA, 2010.
[71] IEA database of energy statistics (www.iea.org)

According to the data, received from the IEA prediction of fuel consumption, emissions of CO_2 from fuel combustion in Uzbekistan may reach by 2030 the volume of 159.2 Mt, or in the total GHGs equivalent - 326 Mt CO_2-eq. Increase in emissions against level of 2010 is 42%, which practically coincides with the Option B forecasting results, received on the basis of prediction of the Ministry of economy regarding fuel consumption (41%) – Ref. Table 3.21.

Table 3.23 | *Evaluation of GHGs Emissions in Uzbekistan for Period up to 2030 Based on IEA Fuel Consumption Data (Option C)*

	1990*	2010*	2015	2020	2025	2030
Coal	12.0	4.2	5.3	6.4	7.1	8.2
Oil and oil products	30.7	11.5	17.9	19.4	18.5	20.06
Natural gas	74.4	96.0	118.5	124.1	129.3	131.0
Total from fuel combustion, mln. t CO_2	117.2	111.8	141.7	150.0	155.0	159.2
Total GHGs emissions, mln.t CO_2-eq**	239	229	287	308	318	326
Growth in GHGs emissions versus level of 2010			25.3%	34.5%	38.9%	42.4%

Source: expert evaluations
Notes: * - data from the IEA statistical database are presented in the table for 1990 and 2010, www.iea.org
** - the total GHGs emissions have been calculated assuming that share of GHGs emission from fuel combustion is around 50% from the total GHGs emission.

Conclusion. Hence, based on the analysis of various options for evaluation of GHGs emissions, it is possible to make a conclusion that all presented predictions of GHGs emission are pretty close to each other falling in the range from 230 to 360 Mt CO_2-eq. The least predictive values have been received for the linear trend of emissions. However, with the planned rates of the country's economy development, probability of accuracy of such forecast is not too large. Materialization of the "baseline" scenario of emissions growth, which assumes increase in GHGs emissions up to 80% from the level of 2010, is also not to large, since as of today a number of measures, facilitating decrease in emissions growth rates in the key economy sectors, are implemented in the country.

The highest convergence in the available forecasts of GHGs emissions by 2030 is achieved with implementation of the following scenarios: "realistic" scenario by the GACMO model (277 Mt CO_2-eq); predictive evaluation of emissions based on fuel consumption data from the Ministry of Economy (281 Mt CO_2-eq); and realistic scenario of the Strategy for Low Carbon Development of the country's economy (272 Mt CO_2-eq). All these scenarios are based on assumptions that all measures aimed at increase in energy efficiency and RES share in the energy balance of the country have been implemented. Close coincidence of the obtained GHGs emission evaluations allows making a conclusion regarding the highest probability of such scenario materialization. Hence, according to expert opinion, increase in GHGs emission volume by 40-60% by 2030 against 2010 level will be the most probable.

OBSERVED CHANGES, VULNERABILITY ASSESSMENT AND ADAPTATION MEASURES

4 OBSERVED CHANGES, VULNERABILITY ASSESSMENT AND ADAPTATION MEASURES

The conducted studies indicate that current climate changes have adverse impact on the social and economic development.1 High vulnerability of Uzbekistan to climate change impact is confirmed by the World Bank assessment, based on the integrated indicator that takes into account three indices:

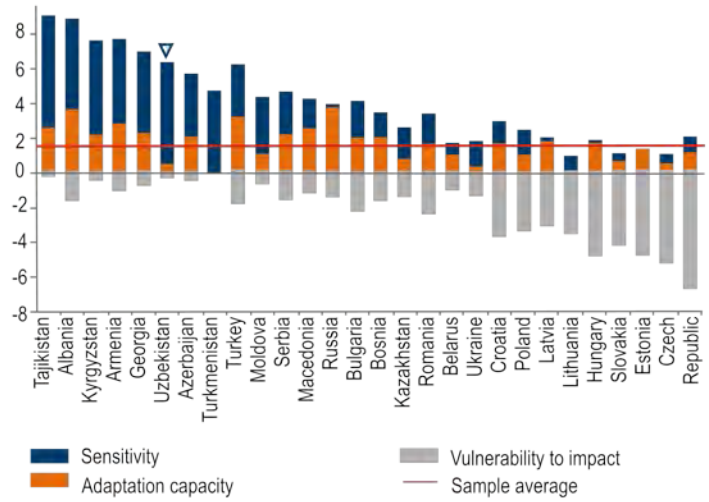


Figure 4.1 | *Ranking of ECA Countries by Index of Vulnerability to Climate Change*

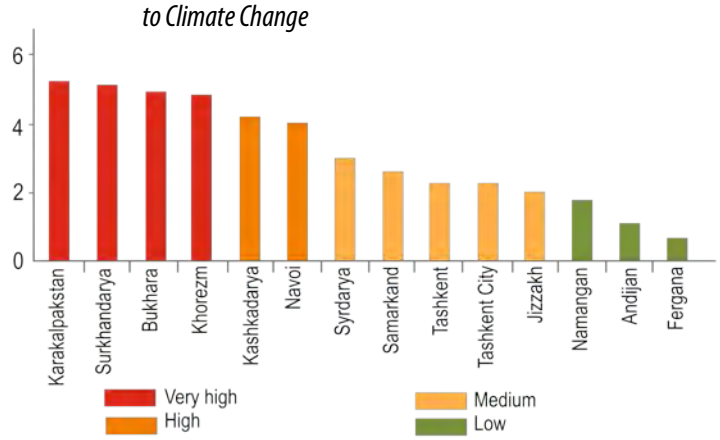


Figure 4.2 | *Ranking of Uzbekistan's Territory by Degree of Vulnerability to Climate Change*

– *vulnerability to impact*, which describes degree of climate change;

– *sensitivity to climate change*, which takes into account factors strengthening impacts of climate changes, and comprises: availability of water resources per capita, economic indices, conditions of infrastructure, degree of environment pollution;

– *adaptation capacity*, which depends mainly on economic capabilities of the country (GDP per capita, level of adaptation measures financing, availability of advanced technologies and institutional support). Due to high sensitivity and still low adaptation capability, Uzbekistan is attributed to the group of countries of Europe and Central Asia (ECA), which are the most vulnerable to climate change adverse impacts (Figure 4.1).[1]

Within framework of preparation of the Third National Communication the administrative provinces of Uzbekistan have been classified by their sensitivity to climate change on the basis of climatic variables analysis (Figure 4.2) using statistical methods (correlative and factorial analysis).[2]

Later on, taking into account for analysis the socio-economic and demographic indices, information on land fund, agriculture and water management sectors, various factors have been summarized and integrated (aggregated) factor of vulnerability formed, which has the following vulnerability ranking: very high; high; medium; and low.

According to the aggregated factor:

– the Republic of Karakalpakstan, Khorezm and Syrdarya provinces are attributed to the most vulnerable territories to climate change;

– Navoi, Djizak, Bukhara, Surkhandarya, Namangan, Kashkadarya and Tashkent provinces are attributed to the medium vulnerable territories to climate change;

– Andijan, Fergana and Samarkand provinces are included in the group of low vulnerable territories to climate change (Figure 4.2).

[1] WB, Adapting to Climate Change in Europe and Central Asia, Washington DC., 2009

[2] B.K. Tsarev, A.S. Merkushkin. Comparative assessment of the vulnerability of regions of Uzbekistan to climate change. // Climate change, causes, consequences and responses. – Bulletin No 10. – Tashkent, 2016. – p. 85-95.

4.1 Observed Climate Change Trends and Adopted Scenarios

As baseline information for assessment of climate change by territory of Uzbekistan, archives of the monthly timescale climate data by 50 meteorological stations of Uzbekistan have been used. Archives have been replenished by data up to 2013, along with their control and restoration of missing data.[3]

4.1.1 Climate Change Assessment by Territory of Uzbekistan

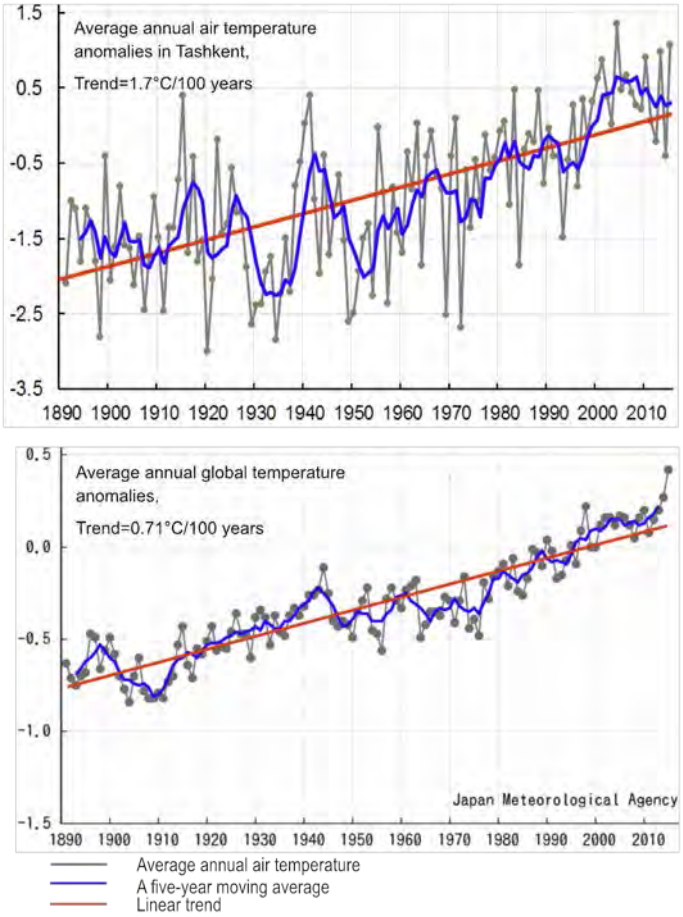


Figure 4.3 | *Change in Average Annual Air Temperature Anomalies (Deviations from Norm of 1981-2015, °C)*

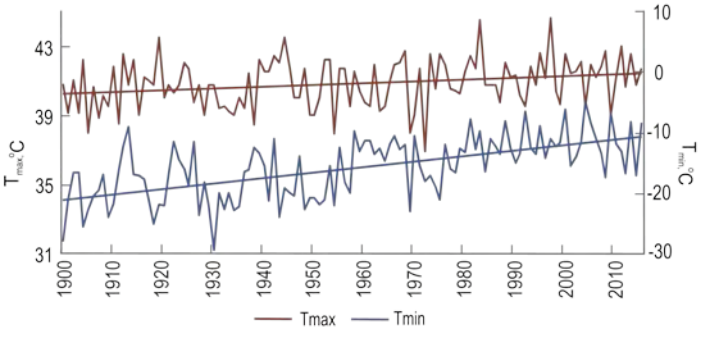


Figure 4.4 | *Change in Absolute Annual Maximum and Minimum Air Temperatures in Tashkent*

Long-term Changes in Air Temperature and Precipitation Amount. Increase in *average annual air temperatures* in Uzbekistan occurs on background of high natural variability, which is stipulated by considerable interannual variations. Rates of climate warming in the republic exceed the average ones observed on a global scale (Figure 4.3).[4]

Trends towards climate warming are being shown up in all meteorological stations of the republic having long-term observation data series. The most considerable increase in average annual air temperatures has been observed in meteorological stations of Tashkent and Fergana. Increase of 20-year average summer air temperatures (for 1900-1919 and 1994-2013) for the above two stations was 1.8 and 1.6C^0, respectively. These changes are statistically significant (ratio of trend increment to the standard deviation is $\Delta Tr/\sigma>1.5$).[5] Trends towards climate warming are weaker in the south of republic (Termez meteorological station). The lowest rates of climate warming, associated with large scale land irrigation in Golodnaya steppe, are observed at the Djizak meteorological station.

The long-term changes in *absolute annual maximum and minimum of air temperatures* in Tashkent meteorological station are presented in Figure 4.4. Variability of absolute annual maximum air temperatures is considerably smaller than variability of absolute annual minimum air temperatures. The mean-square deviations of absolute annual maximum and minimum air temperatures, calculated for observation period from 1900 to 2013, were 1.42°C and 5.08°C respectively. Differences in 20-year average maximum and minimum air temperatures (for 1900-1919 and 1994-2013) were 1.0°C and 8.0°C, with indices of trends significance (Tr/σ) – 0.71 and 1.58 respectively. Changes in the absolute annual minimums are also statically significant ($\Delta Tr/\sigma$=1.58).

Trends in change of air temperatures for various regions of the country's territory may be evaluated starting from 1925. Practically by all considered

[3] T.Yu Spectorman., E.V. Petrova, M.A. Plotsen. Development of Database for Assessment of Climate Change in Uzbekistan // NIGMI Papers, 2006. Edition. 6(251).-p. 3-12

[4] V.E. Chub, T.Yu. Spektorman. Climate Trends on the Territory of Uzbekistan. // Climate Change, Causes, Consequences And Responses – Bulletin No 10. – Tashkent, 2016. – p. 5-16.

[5] Progress report to CCl on statistical methods. WMO-TD N834, 1997.

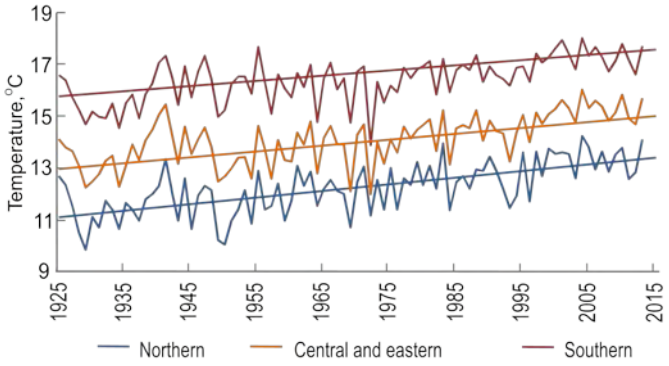


Figure 4.5 | *Variations in Average Annual Air Temperatures, Averaged by Various Parts of Uzbekistan*

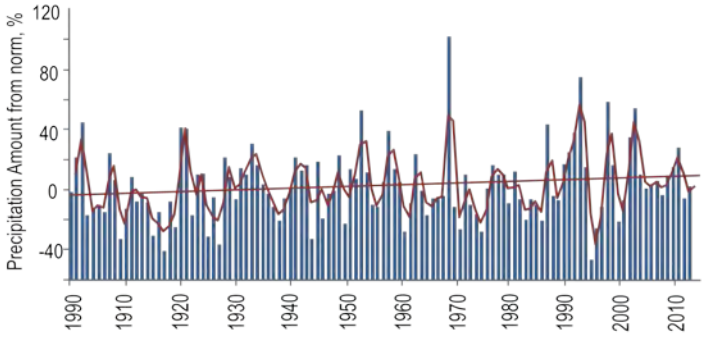


Figure 4.6 | *Variations in Total Annual Precipitation Amount (% from norm), Averaged by Uzbekistan's Meteorological Stations with Long-term Observation Series*

meteorological stations the observed increase in average air temperatures has exceeded its natural variability and is statistically significant. Averaging air temperatures by territory of republic flattens influence of various local impacts (growth of cities, development of irrigation) and increases trends significance.

Values $\Delta Tr/\sigma$, calculated for period from 1925 to 2013, for the northern, central and southern parts of Uzbekistan equal to 1.69, 1.63 and 1.72 respectively (See Figure 4.5). So, it is possible to make conclusion regarding presence of statistically significant increase in average annual air temperatures over the considered period throughout entire territory of Uzbekistan.

Total Annual Precipitation Amount. Analysis of standardized precipitation index (total annual precipitation amount in % from the long-term average) from 1900 to 2013 indicates lack of significant trends towards change in precipitation amount on background of high variability (See Figure 4.6).

By considering total annual precipitation amount data series from 1925, averaged by various parts of Uzbekistan, it is possible to come to conclusion regarding presence of insignificant trends towards increase in total annual precipitation amount in the northern part and their practical absence in other regions of Uzbekistan. Variations in precipitation amount over the cold half year in majority cases have equal sign with variations in total annual precipitation amount.

Changes in Climatic Characteristics from 1950

Average Annual Air Temperatures. In majority of meteorological stations of Uzbekistan increase in average annual air temperatures from 1950, is statistically significant. Trend towards warming has exceeded natural variability by almost 2 times. The highest warming rates are observed in the northern part of republic and in large cities (0.30-0.43°C over 10 years), and the least ones in mountain zone (0.10-0.14°C over 10 years). Moderate warming rates are observed in the regions where irrigation has been developed over the considered time period. The average warming rates by Uzbekistan is 0.27°C over 10 years.

Minimum (night) air temperatures increases more intensively than maximum (day) air temperatures. More strongly it is observed in comparison of annual minimums and maximums, excluding the Aral Sea littoral zone, where due to sea shrinking its mitigation influence has disappeared. The former littoral zone has turned into desert. Intensive increase in maximum air temperatures (0.53°C over 10 years) has occurred here, while minimum ones remained practically unchanged. From 1950, on average by Uzbekistan maximum air temperatures have been increased by 1.6°C, and minimum ones – by 2.0°C.

Seasonal Air Temperatures. In all seasons of year considerable increase in air temperatures is observed, however warming rates in winter period in Uzbekistan have been slowed down. For period from 1950 to 2013, the average rates *(ΔT/10years)* of air temperatures increase over each 10 years were as follows: 0.13°C in winter, 0.39°C in spring, 0.25°C in summer, and 0.31°C in autumn. The revealed linear trends in seasonal air temperatures change (apart from winter temperatures) were statistically significant. Over the recent 50 years, seasonal air temperatures were increased by 0.8°C in winter, 2.5°C in spring, 1.6°C in summer and 2.0°C in autumn, (values of $\Delta Tr/\sigma$ in winter, spring, summer and autumn were 0.40, 1.93, 2.02 and 1.82 respectively).

Total Annual Precipitation Amount. Analysis of variations in the total annual precipitation amount over the period 1950-2013, averaged by various regions of Uzbekistan, indicates in the majority of cases very low trends towards decrease. The most pronounced trends towards decrease in precipitation amount are observed in the southern plains of Uzbekistan (in Bukhara and Kashkadarya provinces). With averaging the total annual precipitation amount by all territory of Uzbekistan, trends are practically completely leveled down.

Total Seasonal Precipitation Amount. Mountain territories (offspurs of the Tien - Shan and Gissar – Alay mountain ridges) are the main contributor to watering of Uzbekistan (Table 4.1). Analysis of data, presented in Table 4.1, indicates presence of insignificant trends towards decrease in precipitation amount in warm and cold half years, apart from winter months (December – February). Similar trends towards change in precipitation amount are predicted for future in accordance with climate change scenarios. Hence, overall decrease in level of watering is observed in Uzbekistan. However in mountain zone it is possible certain increase in precipitation amount in winter season.

Table 4.1 | *Variations in Total Seasonal Precipitation Amounts (mm) Averaged by Meteostations of Western Tien Shan and Gissar Alay within Uzbekistan for Period 1950-2013*

Characteristics	Offspurs of Western Tien Shan			Offspurs of Gissar – Alay		
	Cold half year	Warm half year	December-February	Cold half year	Warm half year	December -February
Trend increment (ΔTr)	-15	-29	40	-5	-8	5
Standard deviation (σ)	131	95	71	69	58	38
$\Delta Tr/\sigma$	-0.11	-0.30	0.56	-0.07	-0.14	0.14

Characteristics of Air Humidity. For assessment of air humidity variations the relevant data have been averaged by the following parts of Uzbekistan: the Aral Sea littoral zone, surrounding desert areas, piedmonts of the western Tien – Shan, Fergana valley and piedmonts of the Gissar – Alay mountain ridge. This allows smoothing the low-scale impacts on watering regime and revealing mesoscale ones, which appear mainly during warm half year.

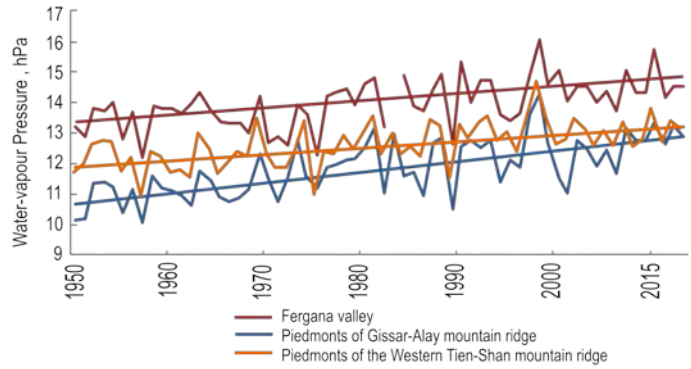


Figure 4.7 | Variations *in Water-vapour Pressure by Uzbekistan in Warm Half-year*

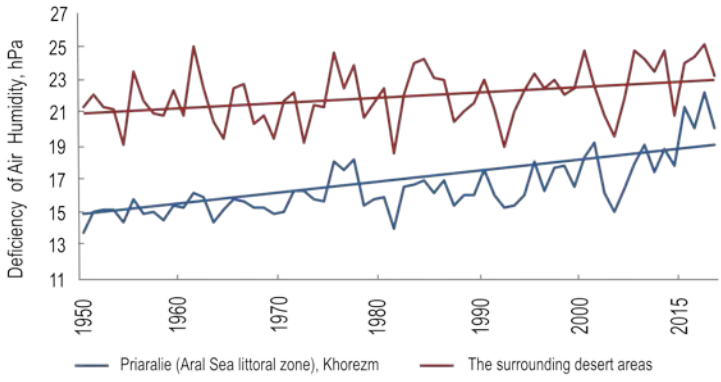


Figure 4.8 | *Variations in Deficiency of Air Humidity in Aral Sea Littoral Zone and Lower Reaches of Amudarya River in Warm Half-year*

Trends towards increase in water-vapour pressure are observed in all territory of Uzbekistan (See Figure 4.7). However, over the recent two decades decrease in water-vapour pressure are observed in the Aral Sea littoral zone, Khorezm province (in lower reaches of Amudarya river) and adjacent deserts, associated with shrinking of the Aral Sea, i.e. conditions in former coastal areas are becoming similar to desert ones. Decrease in relative air humidity is observed here. On the rest of territory slight trends towards its increase are observed.

Over the considered period, deficiency in air humidity has undergone to the highest changes. In the Aral Sea littoral zone and lower reaches of Amudarya river it is increased by 28% (See Figure 4.8). On the rest of territory increase in deficiency of air humidity was 8-13%. Therefore, it is possible to make a conclusion that shrinking of the Aral Sea has led to additional aridization of climate not only in the Aral Sea littoral zone, but also in the lower reaches of Amudarya river. In all by Uzbekistan increase in deficiency of air humidity in warm half-year occurs due to intensive increase in air temperatures on background of growth in absolute moisture content (water- vapour pressure).

Change of air humidity in cold half-year depends to greater extent on circulation process. Warm periods correspond to increased values of water-vapour pressure on background of statistically significant positive trends. Correlation coefficients between data series of water- vapour pressure and air temperatures over cold half-year reach 0.78. Increase in water- vapour pressure is observed throughout the territory of Uzbekistan. Impact of the Aral Sea shrinkage on air humidity regime is also took place in cold half-year - a significant trend of decrease in relative air humidity and increase in air humidity deficit is observed in the Aral Sea littoral zone and lower reaches of Amudarya river.

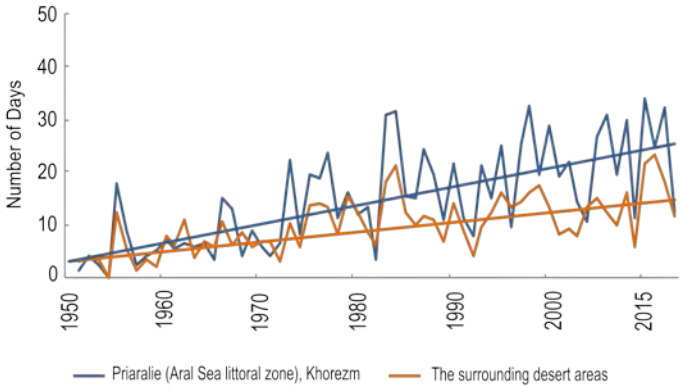


Figure 4.9 | *Variation in Number of Days with Heat Waves over Summer Season by Territory of Uzbekistan*

Climatic indices. High Air Temperatures and "Heat Waves". Increase in number of significant positive temperature anomalies is observed by all territory of Uzbekistan and all year seasons (against norm of 1961-1990). During summer season, significant positive anomalies come out by "heat waves" dangerous to human health. The highest rates of increase in number of days with "heat waves" have been registered in the Aral Sea littoral zone and lower reaches of Amudarya river (See Figure 4.9).

The highest frequency of high air temperatures is observed in desert zone (Buzaubay meteorological station), and in the south of republic (Termez meteorological station) (See Figure 4.10 and Figure 4.11).

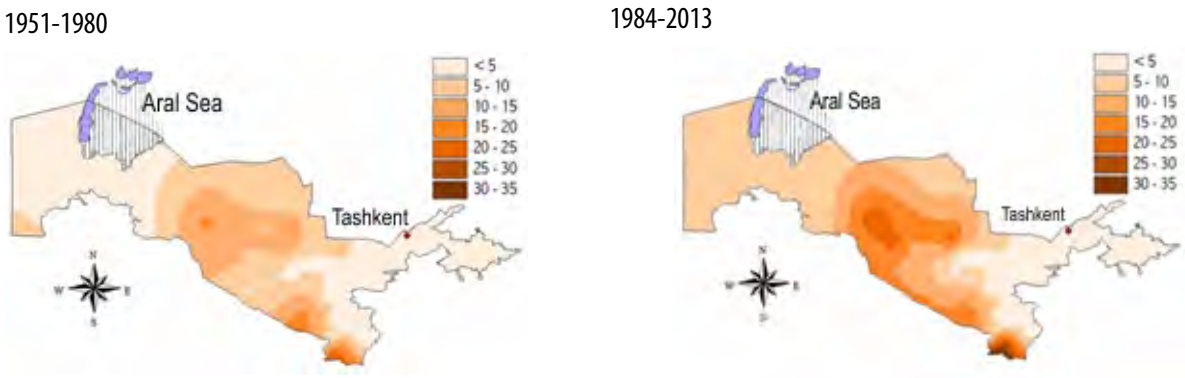


Figure 4.10 | *Average Number of Days with Air Temperature above 40°C by Territory of Uzbekistan*

Index of hot conditions in night time is a number of days with minimum air temperatures (TN) above 20°C (tropical nights). Criterion of 22°C is adopted for Uzbekistan due to lower air humidity. Analysis has indicated significant increase in number of tropical nights by all territory of the country. Stronger trends are registered in plain territory of the republic (Nukus, Bukhara), moderate ones – in piedmont area (Tashkent, Fergana) (See Figure 4.11).

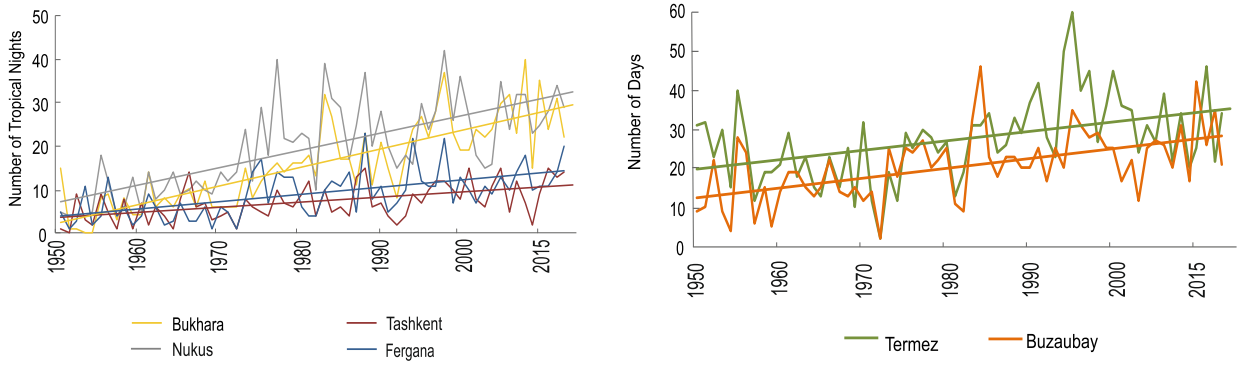


Figure 4.11 | *Changes in Number of Very Hot Days (TX>40°C) and Tropical Nights (TN>22°C)*

Extremes of Low Air Temperatures. Decrease in number of days with low air temperatures (TN<-10°C) on background of very high variability is observed by territory of Uzbekistan (See Figure 4.12).

Extremes of High and Low Air Temperatures, identifying by use of quintiles with specified probabilities of maximum and minimum air temperatures. In all by Uzbekistan it is observed significant increase in number of extremely warm (above TX90p quintile) days and significant decrease in number of extremely cold nights (below TN10p quintile). Rates of change in minimum air temperature exceed significantly rates of maximum air temperature change (See Figure 4.13).

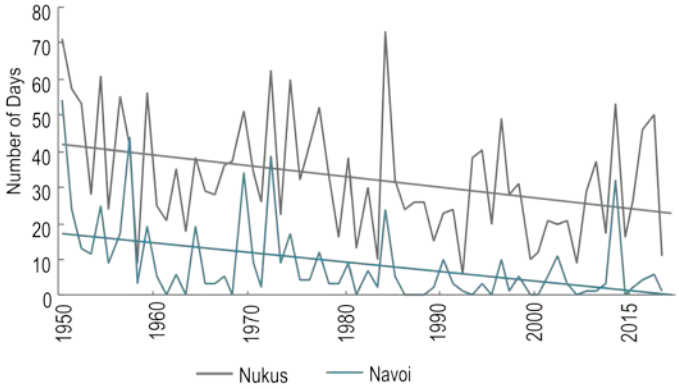


Figure 4.12 | *Variation in Number of Days with Air Temperature below -10°C by Some Meteorological stations of Uzbekistan*

Extremes of Precipitations. In majority of Uzbekistan's meteorological stations (67%) low trends towards increase in recurrence of days with precipitation amount more than 10mm are observed. 60% of meteorological stations record increase in Simple Daily Intensity Index (SDII,) and low trends towards increase in number of days with precipitation amount more than 15mm/day. Growth in precipitation extremeness takes place on background of insignificant trends towards decrease in the total annual precipitation amount and insignificant increase in precipitation amount during winter season in the Aral Sea littoral zone and mountains. All changes are statistically insignificant.

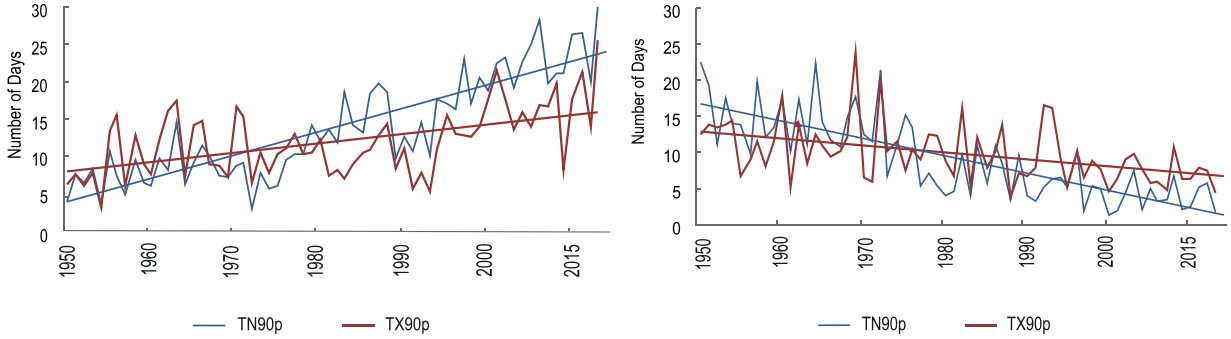


Figure 4.13 | *Variation in Number of Days with Extremes of High (above 90% quintile) and Low (below 10% quintile) Air Temperatures in Samarkand Meteorological Station*

Main Conclusions. The statistically significant changes in various climatic characteristics are observed in Uzbekistan. Rates of air temperature increase in Uzbekistan exceed significantly the average global rates.

Minimum air temperatures increase more intensively than the maximum ones. From 1900 to 2013, the absolute annual maximum air temperatures in Tashkent were increased by 1.0°C, and absolute annual minimum ones - by almost 8.0°C. Variability of absolute annual maximum air temperatures is considerably smaller than variability of absolute annual minimum air temperatures with indices of trends significance – 0.71 and 1.58 respectively.

Increase in average annual air temperatures in large cities is higher on account of additional urbanization effect (Tashkent, Fergana, Samarkand). Over period from 1950 to 2013, the highest warming rates were observed in the Samarkand meteorological station, where increase in average annual air temperatures has exceeded natural variability by almost 2 times. Throughout the entire territory of Uzbekistan it is observed significant increase in frequency of extremely high air temperatures and "heat waves", as well as considerable decrease in frequency of low air temperatures. Rates of decrease in number of days with frost (TN<0°C) by the territory of republic vary from 3 to 9 days over 10-year period.

Due to increase in air temperatures, the general trends towards increase in water- vapour pressure (absolute humidity) with simultaneous growth in air humidity deficiency are observed in all territory of Uzbekistan. At higher air temperatures warming enhances moisture-retention capacity of atmosphere and increases difference between saturating and actual vapour pressure. The trends revealed come out both in cold and warm year periods. Over period from 1950 to 2013, enhancement of climate aridization is observed in the Priaralie (Aral Sea littoral zone) and lower reaches of Amudarya river. Over the above mentioned period increase in air humidity deficiency in warm six months was 28% due to practical disappearance of vast aquatory of the Aral Sea.

Analysis of variations in the total annual precipitation amount over period 1950-2013, averaged by various regions of Uzbekistan, indicates in the majority of cases low trends towards its decrease. Trends towards decrease in precipitation amount in mountain zone are observed in all year seasons, apart from winter months in off spurs of the western Tien – Shan. Similar trends towards change of precipitation amount are predicted for future in accordance with climate change scenarios. Hence, overall decrease in level of watering is observed in Uzbekistan.

4.1.2 Climate Change Scenarios Adopted for Territory of Uzbekistan and Upper Watersheds of Syrdarya and Amudarya Rivers

For assessment of climate change impact in Uzbekistan it was selected three scenarios of greenhouse gases (GHGs) emissions with use of the MAGICC5.3 (Model for the Assessment of Greenhouse-gas Induced Climate Change).[6]

The most *soft* scenario reflects global warming within range of 2°C against pre-industrial period. It is scenario of CO_2 stabilization at the level of *450ppm (WRE450),* which envisages introduction of strict measures for restriction of GHGs emissions.

Moderate scenario assumes CO_2 stabilization at the level of *750ppm (WRE750),* which will lead to increase in global temperature 3°C up to year 2100.

According to the *Extreme* scenario (A1FI), by year 2100, increase in global temperatures will reach 4.9°C, and concentration of carbon dioxide will approach to *990ppm* (Figure 4.14).

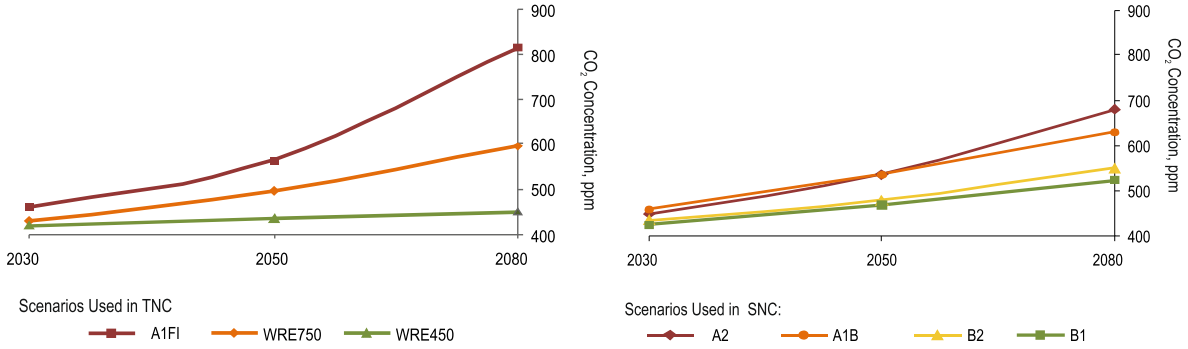


Figure 4.14 | *Values of Carbon Dioxide Concentration in Atmosphere by Assessment Periods in Accordance with GHGs Emission Scenarios, Used in Third and Second National Communications*

The selected scenarios of GHGs emissions correspond by CO_2 concentration to ranges of *Representational carbon dioxide concentration pathways* (RCP2.6, RCP6 and RCP8.5), respectively in the current century.[7]

Box 4.1

Future climate will be identified not only by the Earth own natural dynamics of climatic system, but also by ways of mankind impact on this system. It is possible to imagine the various ways for development of world economy – from continuation of intensive combustion of fossil organic fuel (oil, gas, coal) to introduction of certain limitation to this process, e.g. broad introduction of renewable energy sources (RES). Certain trend in change of greenhouse gases concentration in atmosphere (its own trend for each gas) corresponds to each of these ways.

Several such ways with their own trends in change of greenhouse gases concentration in atmosphere are considered in the Fifth IPCC assessment report. Radiative forcing is used as generalized measure of their joint impact on climatic systems. The radiative forcing is a change in net radiative energy flow towards earth surface at tropopause altitude as compared with preindustrial value. Curves describing change in GHG concentration are referred to as Representative Concentration Pathways (RCP). It is used RCP2.6, RCP4.5, RCP6.0 and RCP8.5.

Numbers indicate possible increase in radiative forcing (average annual global) in the end of XXI century (W/m^2) against 1750, depending on target level of GHG stabilization in atmosphere and measures for their reduction.

RCP2.6 – maximum value of GHGs concentration – 490 ppm CO_2-equivalent up to 2100, then decline.
RCP4.5 – stabilization after 2100, with GHGs concentration around 650 ppm CO_2-экв. in 2100.
RCP6.0- stabilization after 2100, with GHGs concentration around 850 ppm CO_2- equivalent in 2100.
RCP8.5 – GHGs concentration may reach 1370 ppm CO_2-equivalent in 2100, which is practically consistent with "business-as-usual" scenario, i.e. with no policy changes to reduce GHGs emissions.

6 Wigley, T.M.L. 2008: MAGICC/SCENGEN 5.3: Technical Manual, Tom Wigley, National Center for Atmospheric Research, Boulder, CO 80307. June 2008.

7 Malte Meinshausen & S. J. Smith & K. Calvin & J. S. Daniel & M. L. T. Kainuma & J-F. Lamarque & K. Matsumoto & S. A. Montzka & S. C. B. Raper & K. Riahi & A. Thomson & G. J. M. Velders & D.P. P. van Vuuren. The RCP Greenhouse Gas Concentrations And their Extensions from 1765 to 2300 // Climatic Change, 2011, DOI 10.1007/s10584-011-0156-z.

Within framework of the Second National Communication (SNC, 2005-2008) regional climatic scenarios were developed for assessment of climate change impacts on natural resources and various economy sectors. Necessity for updating climatic scenarios has been caused by the following reasons:

- previous climatic scenarios have been developed in accordance with GHGs emission scenarios A2, A1B, B1 and B2, but without consideration of extreme scenario (A1FI);
- scenarios of stabilization of GHGs concentration in atmosphere, allowing to evaluate to what extent adaptation policy and measures may ease adaptation and decrease anthropogenic impact, have not been considered within framework of the SNC;
- quality of climate modeling is constantly improving due to consideration of bigger number of acting factors and feedback links, and improving climatic models themselves.

GHGs emission scenarios, used in the SNC, have indicated small differences in values of carbon dioxide concentration between scenarios A1B, A2 and B1, B2. Curves of increase in the average annual air temperatures, calculated for Uzbekistan, also turned out to be very close to each other, and their crossings were observed in perspective up to 2050. GHGs emission scenarios, selected in the Third National Communication, have sufficient divergency after 2030. Comparison of emission scenarios by concentration of carbon dioxide in atmosphere, used in the SNC and TNC, illustrated in Figure 4.14.

Box 4.2

Experts of IPCC have developed a set of scenarios (A1 (A1B, A1FI, A1T), A2, B1, B2) for future GHGs emissions in atmosphere in XXI century and published it in the Special Report on Emissions Scenarios (SRES). Scenario plotlines are based on various hypothesis of future global development. The global development is identified by demographic, economic and technological factors, which in turn stipulate intensity of fossil fuel combustion and emission of greenhouse gases and aerosols into atmosphere.

Models of carbon cycle allow computing variations in GHGs concentration corresponding to each scenario, which are called projections as opposed to forecasts since it is unclear which scenario will actually be occurred. With the aid of global climatic modes projections of air temperatures, precipitations and other climatic variables are computed for each GHGs emission scenario.

A1. The plotlines and A1 family of scenarios are characterized by: rapid economic growth; a global population that reaches its peak in 2050 and then gradually declines; and the quick spread of new and efficient technologies. The basic concept is a convergent world - income and way of life converge between regions and extensive social and cultural interactions worldwide. There are three subsets to the A1 family based on their technological emphasis: 1) A1FI - An emphasis on fossil-fuels (Fossil Intensive; 2) A1T - Emphasis on non-fossil energy sources; 3) A1B - A balanced emphasis on all energy sources.

A2. The plotlines and A2 family of scenarios are of a more divided world. The A2 family of scenarios is characterized by: A world of independently operating, self-reliant nations; Birth rates differ by regions resulting in continuously increasing global population; Regionally oriented economic development. Economic growth per capita differs by regions. Technological changes are more fragmentary and slow as compared with other plotlines.

B1. The plotlines and B1 family of scenarios are of a world more integrated, and more ecologically friendly. The B1 scenarios are characterized by: rapid economic growth as in A1, but with rapid changes towards a service and information economy; population rising to its peak in 2050 and then declining as in A1; reductions in material intensity and the introduction of clean and resource efficient technologies; an emphasis on global solutions to economic, social and environmental stability.

B2. The plotlines and B2 family of scenarios are of a world more divided, but more ecologically friendly. The B2 scenarios are characterized by: continuously increasing population, but at a slower rate than in A2; emphasis on local rather than global solutions to economic, social and environmental stability; intermediate levels of economic development; less rapid and more fragmented technological change than in A1 and B1. This scenario is oriented on environment conservation and social justice with the emphasis on local and regional level.

Climatic scenarios for Uzbekistan and upper watersheds of the Syrdarya and Amudarya river basins have been built upon basis of outputs from 20 Global Climatic Models (GCM) of combined circulation of atmosphere and ocean with use SCENGEN5.3 (Climate Scenario Generator for Vulnerability and Adaptation Assessments[8]). Some GCM for territory of Uzbekistan and upper watersheds of the Syrdarya and Amudarya rivers indicate large scattering of increase in average annual air temperatures and non-corresponding by sign (+/-) assessments of variations in the total annual precipitation amount. [9]

[8] Wigley, T.M.L. 2008: MAGICC/SCENGEN 5.3: Technical Manual, Tom Wigley, National Center for Atmospheric Research, Boulder, CO 80307. June 2008

[9] T.Yu Spectorman. Climate Change Scenarios for Territory of Uzbekistan and Upper Watersheds of Syrdarya and Amudarya rivers. Information on fulfillment by Uzbekistan obligations on UNFCCC. Climate Change, Reasons, Impacts And Response Measures, Issue № 9, Tashkent 2015, pp. 29-39.

Set of "the best" GCM has been identified on the basis of their successfulness indices analysis for plain and mountainous territories. Among "the best" are the following models: UKHADGEM, MPIECH-5, UKHADCM3, CCSM-30, GFDLCM20, CNRM-CM3 and MIROCMED.

The regional climatic scenarios consider three 20-year time intervals (2021-2040, 2041-2060, and 2071-2090 years). Spatial resolution of scenarios in grid nodes (cells) was 2.5x2.5 degrees, and period from 1980 to 1999, was adopted as baseline period.

The statistical downscaling method has been used for detailing information from grid cells to observation points[10]. As a result, the information base for climatic scenarios by 50 meteorological stations of Uzbekistan has been developed. It includes assessments of variations in average monthly, maximum and minimum air temperatures, total monthly and daily maximum precipitation amount, absolute maximum and minimum air temperatures, average monthly relative air humidity, water-vapour pressure and deficiency of air humidity. The statistical downscaling method has also allowed computing extreme values of specified probabilities (P_5, P_{10}, P_{90}, P_{95}) for scenarios conditions.

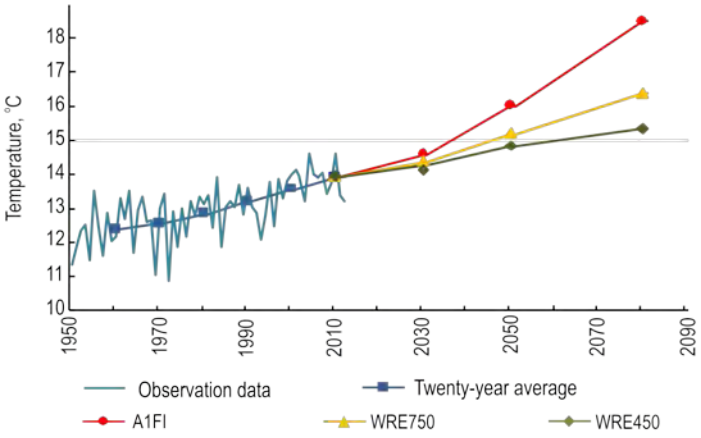


Figure 4.15 | *Probable Values of Increase in Average Annual Air Temperatures by Uzbekistan in Accordance with GHGs Emission Scenarios, Assuming Various CO_2 Concentrations in Atmosphere*

For assessment of changes in the region's water resources, air temperatureы and precipitationы variation scenarios have been developed for the upper watersheds of the largest Central Asian rivers – Syrdarya and Amudarya, including those located beyond boundaries of Uzbekistan. For this purpose additional data from 32 meteostations, located in CIS neighboring countries, have been used.

Average Annual Air Temperatures. Values of increase in average annual air temperatures, computed for territory of Uzbekistan, are presented in Figure 4.15. It is clear from the figure, that in near-term perspective the already observed trends towards increase in average annual air temperatures will be continued.

Features of the expected variations in average annual air temperatures by various regions of Uzbekistan and on average by upper watershed of the Syrdarya and Amudaryaa rivers in accordance with GHGs emission scenarios, assuming various CO_2 concentrations in atmosphere and changes in annual precipitation amount, are presented in Tables 4.2 and 4.3 respectively.

Table 4.2 | *Expected Increase in Average Annual Air Temperatures versus Baseline Period on Average by Uzbekistan, and Syradarya and Amudarya River Basins in Accordance with GHGs Emission Scenarios*

Regions	2021-2040			2041-2060			2071-2090		
	WRE450	WRE750	A1FI	WRE450	WRE750	A1FI	WRE450	WRE750	A1FI
Territory of Uzbekistan									
Plains in northern part of Uzbekistan	1.0	1.1	1.3	1.5	1.9	2.6	2.0	3.0	5.1
Piedmonts of western Tien– Shan mountains	1.1	1.2	1.4	1.7	2.0	2.9	2.2	3.3	5.5
Offspurs of western Tien – Shan mountains	1.0	1.1	1.2	1.5	1.8	2.5	1.9	2.9	4.8
Fergana valley	1.2	1.2	1.4	1.7	2.1	3.0	2.3	3.4	5.7
Plains in southern part of Uzbekistan	1.1	1.1	1.3	1.6	2.0	2.7	2.1	3.1	5.2
Piedmonts of Gissar – Alay mountain ridge	1.1	1.2	1.4	1.7	2.0	2.9	2.2	3.3	5.5
Offspurs of Gissar – Alay mountain ridge	1.0	1.1	1.2	1.5	1.8	2.5	1.9	2.9	4.9
Upper River Watersheds									
Syrdarya river basin	1.0	1.1	1.3	1.5	1.8	2.6	2.0	2.9	4.9
Amudarya river basin	1.1	1.1	1.3	1.6	1.9	2.7	2.1	3.1	5.3

[10] T.Yu. Spectorman. Methodology for Development of Climatic Scenarios for Territory of Uzbekistan. Thesis of Presentations to World Conference on Climate Change (29 September-3 October, 2003, Moscow), 520 p..

Table 4.3 | *Expected Variations in Total Annual Precipitation Amount against Baseline Period on Average by Uzbekistan and by Syrdarya and Amudarya River Basins in Accordance with GHGs Emission Scenarios*

Regions	2021-2040			2041-2060			2071-2090		
	WRE450	WRE750	A1FI	WRE450	WRE750	A1FI	WRE450	WRE750	A1FI
Territory of Uzbekistan									
Plains in northern part of Uzbekistan	98	98	98	97	97	96	97	95	91
Piedmonts of western Tien–Shan mountains	98	98	98	96	97	96	97	95	92
Offspurs of western Tien – Shan mountains	101	101	101	100	101	101	101	101	102
Fergana valley	101	101	101	100	102	102	102	103	105
Plains in southern part of Uzbekistan	96	95	95	90	92	89	92	88	80
Piedmonts of Gissar–Alay mountain ridge	96	96	95	93	93	90	93	89	82
Offspurs of Gissar – Alay mountain ridge	96	95	95	92	92	89	91	87	78
Upper River Watersheds									
Syrdarya river basin	102	100	100	99	100	99	99	99	99
Amudarya river basin	98	97	97	95	95	94	95	93	87

The highest values of increase in average annual air temperatures are possible in plain and piedmont territories, including Fergana Valley. To some extent lesser warming values are expected in mountainous regions.

Global warming within the basins of two above rivers is exerted differently. By values and rates of increase in average annual air temperatures difference between two river basins is insignificant. However, warming in the Amudarya river basin is to some extent higher. According to extreme GHGs emission scenario, by years 2071-2090, value of increase in average annual air temperatures may reach 5.3°C and 4,9°C in the Amudarya and Syrdarya rivers respectively.

In general, trend towards decrease in watering level of the Central Asian region (apart from some districts) is observed. Stronger trends towards decrease in *the total annual precipitations amount* are possible in the southern part of the region (by 18-22% up to 2071-2090 years for extreme GHGs emission scenario). Variations in the total average annual precipitation amount in time and by GHGs emission scenarios in upper watersheds of the Syrdarya rivers are insignificant. However, decease in precipitation amount by 13% is possible in the Amudarya river basin.

Intensification of air circulation along with climate warming is confirmed by model assessments of standard deviations, which indicated that due to climate change considerable variability of average annual air temperature and total annual precipitation amount are expected. More intensive climate warming in the upper watersheds of Amudarya river increases variability in the average annual air temperature significantly. Reverse picture is distinctive for the total annual precipitations amount, i.e. greater increase in variability of the total annual precipitation amount takes place in the upper watersheds of Syrdarya river.

Seasonal air temperatures. Minimum values of air warming are expected in spring, and maximum ones in summer, and then autumn and winter goes in descending order. Apart from winter season, evaluations by scenarios indicate increase in standard deviations of seasonal air temperatures. The highest increase is expected in June-August (see Figure 4.16).

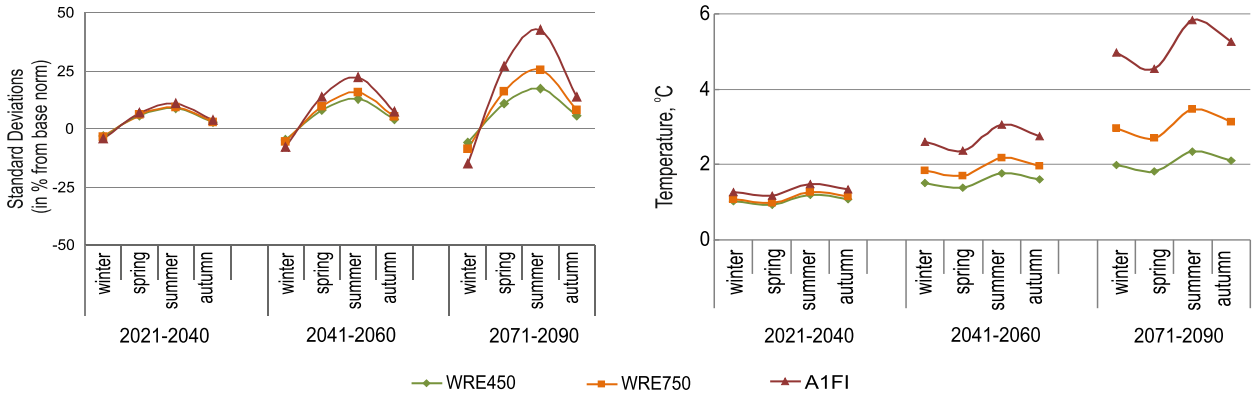


Figure 4.16 | *Probable Changes in Average Values of Standard Deviations (in % from base norm) of Seasonal Air Temperatures by Uzbekistan in Accordance with GHGs Emission Scenarios*

Variations in the standard deviations occur in accordance with GHGs emission scenarios and by year seasons: autumn processes shift towards winter and winter ones towards spring, and so on. Therefore, some decrease in variability of air temperature occurs in winter with its increase in the rest of seasons.

According to estimations increase in night (minimum) air temperatures will be higher than day (maximum) ones. However, day air temperatures during "heat waves" may reach very high values. With general intensive climate warming in future, probability of intensive waves of heat and cold will remain. This is indicated by rates of absolute monthly maximum and minimum air temperatures calculated for various scenarios (e.g. calculated maximum and minimum air temperatures for moderate GHGs emission scenario are 43.3 and -10.2°C respectively in 2071-2090 years).

Total Seasonal Precipitation Amount. Increase in precipitation amount in winter and its decrease in the rest of seasons are expected by all emission scenarios and time intervals for the northern part of Uzbekistan (northern plains, piedmonts and offspurs of the Tien - Shan mountains, and Fergana valley). Retention of the current rates of precipitation amount in winter and their decrease in the rest of seasons are expected for the southern part of republic (southern plains, piedmonts and offspurs of the Gissar – Alay mountain ridges).

For scenario WRE450 (stabilization of GHGs concentration at the level of 450ppm) insignificant variation in precipitation amount is expected in all territory of Uzbekistan. Small increase in precipitation amount (up to 10%) in winter, decrease by 11-22% in summer, and retention of practically current level of precipitation amount in spring and autumn are expected only by 2071-2090 years.

For scenario WRE750, increase in precipitation amount by 15% in winter and small decrease by 5% in spring are expected by 2071-2090 years in piedmonts and offspurs of the western Tien - Shan mountains. Current level of precipitation amount in winter will be retained in piedmonts and offspurs of the Pamir - Alay mountain ridges, with its possible decrease in spring by 15% against average values for 1980-1999. In summer values of decrease in precipitation amount by all territory of Uzbekistan exceed 20%.

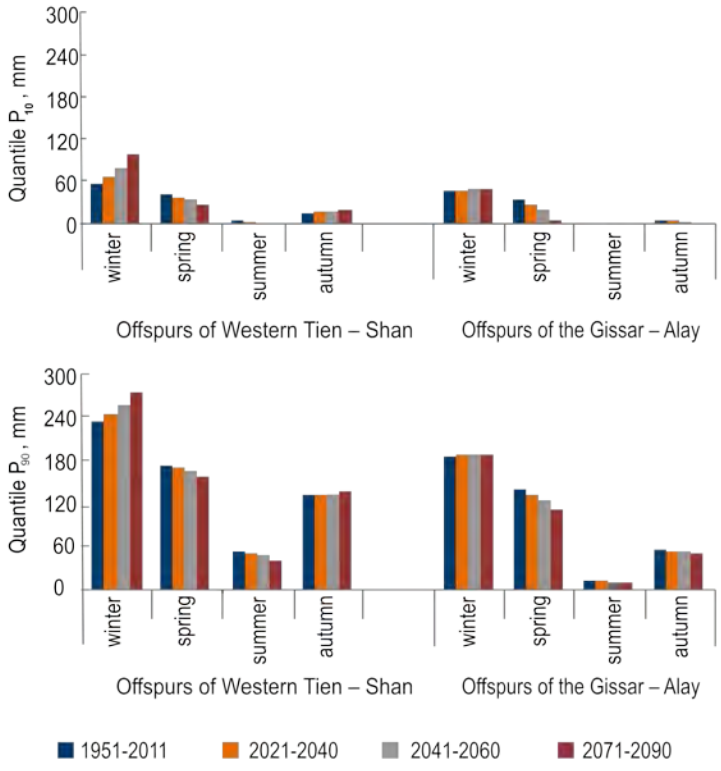


Figure 4.17 | *Probable Values of Quantiles P_{10} and P_{90} of Seasonal Precipitation Sums by Mountainous Territory of Uzbekistan for Extreme GHGs Emission Scenario (A1FI)*

For scenario with the extreme GHGs emission (A1FI) significant deformations of watering regime, including increase in variability during autumn and winter seasons, are possible. Similar trends have been observed for the upper watershed of Central Asian rivers.

Increase in precipitation amount variability during autumn and winter seasons implies serious changes in the regime of water resourced formation and increase in frequency of extremes. Increase in precipitation amount in winter and overall growth of its variability stipulate increase in daily maximum precipitation amount during cold period of year. By year 2041- 2060, with realization of various GHGs emission scenarios, range of increase in daily maximum precipitation amount in January may be 13-22% against 1980 – 1999 rate.

Values of P_{10} and P_{90} quintiles (minimum and maximum total seasonal precipitation amount, which will be observed once in 10 years) describe possible variations in precipitation amount in future. Variations in values of P_{10} and P_{90} quintiles for the total seasonal precipitation amount by mountainous territory of Uzbekistan for extreme scenario of GHGs emission are presented in Figure 4.17.

Analysis of precipitation scenarios by territory of Uzbekistan and river upper watersheds allow to make the following conclusion: climate change entails slight trend towards decrease in the total annual precipitation amount, but impacts significantly on intra-year regime of precipitation fallout. In some parts of the republic precipitation increase is possible in December-February, with its decrease throughout the republic in other months of year. In general, climatic scenarios, updated for the Third National Communication (TNC), indicate onset of more arid conditions in Uzbekistan and in the main rivers upper watersheds due to climate change.

The expected variations in *humidity parameters*, calculated for climatic scenarios, are less reliable than assessments of air temperature variations. In the conditions of Uzbekistan various local anthropogenic impacts (shrinking of the Aral Sea, existence of

irrigation systems, irrigated lands, and drainage water disposal lakes) disturbs uniformity of humidity observation data series. However, in the absence of local anthropogenic impacts, close correlation between average monthly air temperatures and air humidity is observed, which allowed carrying out background assessment of air humidity variations. The developed scenarios by territory of the republic reflect the general variation trends, stipulated by increase in air temperatures – increase in water-vapour pressure (absolute air humidity) and deficiency of air humidity. The highest increase in water-vapour pressure (in percentage) is possible in winter period (up to 20% by year 2071-2090, in accordance with extreme GHGs emission scenario). In summer external moisture inflow decreases, which increase correlation between moisture deficiency and air temperatures, as well as strengthen climate aridity that in turn increase water demands for irrigation. Assessments for future indicate increase in deficiency of air humidity in all year seasons.

Analysis of possible variations in air temperature and precipitation regimes on territory of Uzbekistan in accordance with soft and extreme scenarios indicates that stabilization of GHGs concentration at relatively low levels will allow reducing significantly climatic risks. For example, difference between values of average annual air temperatures for soft and extreme GHGs emission scenarios by territory of Uzbekistan is estimated in 3.6-4.1°C. For soft GHGs emission scenarios, even in the long-term perspective, retention practically the current precipitation rates with their moderate variability increase, is expected.

Due to small scatter of values of warming and precipitation variations by various GHGs emission scenarios, assessments of climate change for 2021-2040, may be considered as predicted and relied upon in planning for development of various sectors of economy.

Alternative scenario. For perspective assessment of water resources vulnerability and mudflow danger indices[11], it was also used results of dynamical downscaling of outputs from the global climatic model ECHAM-5 for moderate greenhouse gases emission scenario A1B with use of regional climatic model REMO.

4.2 Water Resources

4.2.1 Use of Water Resources in Current Conditions

Actually available for use water resources are completely determined by water content of the Amudarya and Syrdarya river basins in particular year. There are a number of international agreements and documents regarding water distribution and management of transboudary rivers between the countries.[12,13] Principles of regional water sharing and retention of the established water diversion limits are currently ensured by the Agreement on cooperation in area of joint management, use and protection of water resources from interstate sources, signed by heads of the countries of the Aral Sea basin in February 1992.[14] The Interstate Coordinating Water Commission (ICWC), represented by parity by five Ministers of water resources, is the body of five Governments, which performs functions of water resources management, maintenance of sustainability of natural processes on transboundary waters.[15]

Volume of water resources that may possess Uzbekistan in accordance with the interstate water sharing is identified in the volume of 59.2 km^3 in year with 90% probability. As pointed above, actual water intake from surface water courses depends on availability of water resources in particular year. Besides, surface water from large and small rivers, demands of water consumers are covered by operational supply of underground waters and reuse of drainage water flow. Total water consumption by Uzbekistan for 2014 in presented in Table 4.4 below.

Table 4.4 | *Distribution of Water Resources by Sources of Water Intake in 2014*

River Basins	Water Intake by Source, km^3				
	Total	including			
		From Main Rivers	From Small Rivers	From Underground Water	From Drains
Amudarya river	33.66	21.07	8.59	1.67	0.68
Syrdarya river	24.98	11.06	9.26	3.65	0.66
Total	56.64	32.13	17.85	5.32	1.34

Source: State water cadastre of the Republic of Uzbekistan, 2014

[11] UNDP. Profile of Climate Risks in Uzbekistan. – 2015. – 88 c. http://climatechange.uz/
[12] Updating Master Plan of Water Resources Use and Protection of Amudarya river - Tashkent, 1986.
[13] Correcting Note to " Updating Master Plan of Water Resources Use and Protection of Syrdarya river " - Tashkent, 1983.
[14] http://www.icwc-aral.uz/statute1_ru.htm
[15] http://www.icwc-aral.uz/index_ru.htm

In the current conditions Uzbekistan possesses on average 11.5 km^3 of surface runoff from internal rivers, 42.0 km^3 from transboundary rivers and 9.43 km^3 of reuse and underground waters. Limited water use for all water consumers is established on the principle of equal water supply.

Priority in water supply is as follows: (i) drinking and community/municipal water supply; (ii) industry; (iii) agriculture; (iv) water consumers approved by the special decision of government; (v) sanitary releases by irrigation systems and small rivers.

Data on the current use of water resources by sectors of Uzbekistan's economy are provided in Figures 4.18 – 4.19.

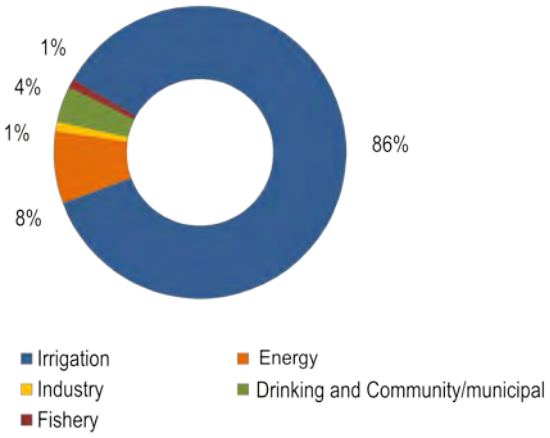


Figure 4.18 | *Water Consumption by Economy Sectors on Average for Period 1996-2013*

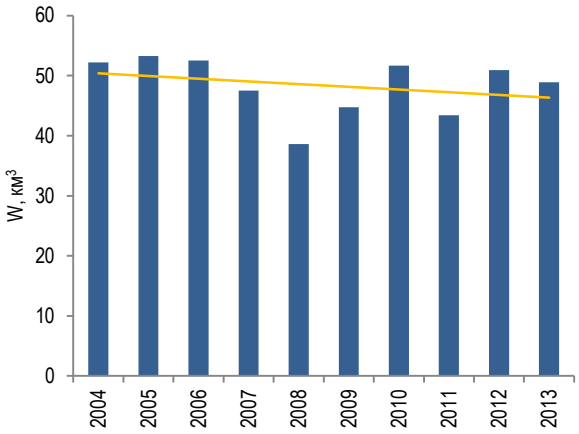


Figure 4.19 | *Change in Water Consumption for Irrigation for Period 2004-2013*

On average over the period 1996 – 2013, in the total water consumption share of irrigation was 86%, share of energy sector – 8%, share of drinking and community/municipal water supply – around 4%. Water consumption for irrigation depends directly on water availability for the current year. There is a trend towards some decrease in water consumption for irrigation (Figure 4.19) due to growth in land area under cereals and its decrease under technical crops, including such water consumptive crop as cotton, as well as due to intensive introduction of water saving technologies. In the current conditions (2004 – 2013) 48.17 billion m^3 of water per year on average is diverted for irrigation of around 4.2 million ha of agricultural lands.[16]

Life of people and the country's economy depend directly on availability of water resources, acute deficiency of which is caused not only by anthropogenic activities, but also by climatic factors. The on-going climate change (increase in air temperatures, decrease in area of glaciers and seasonal snow covers, reduction in precipitation amount, growth in variability of climatic features) has an adverse impact on regime of formation and volume of water resources in the region. Possible decrease in rivers runoff and intensive growth of population in Uzbekistan may increase demands for water and create bigger difficulties for retention of balance between available water supply and demand.

4.2.2 Climate change impact on water resources

Use of water resources, including water delivery regimes, irrigation schedules and redistribution of water between the economy sectors concerned, provision of information required for operation of hydropower stations, regulation of water releases from reservoirs are planned on the basis of hydro-meteorological forecasts of expected water availability in rivers. Currently in order to meet requirements of economy sectors, Uzhydromet prepares the short-term river runoff forecasts (discharges) and long-term river runoff forecasts on monthly timescale and for vegetation and dormant periods.

Methods of the long-term runoff forecasts of mountainous rivers are based on both wide spread statistical methods and methods of mathematical modeling. However, mathematical models for formation of mountainous rivers runoff and rainfall floods are not widely used in forecasting practice. Limited number of hydrological stations and difficulties in getting data from the neighboring countries are the great problem for assessment of variations in snow cover distribution in mountainous territories, as one of the most important component of water balance. For solution of this problem and replenishment of missing essential information, the remote sensing data and various mathematical models are used in Uzbekistan.

[16] Data from the Ministry of Agriculture and Water Resources, 2013.

There are currently a lot of researches on climate change impact on water resources. Calculation outputs from majority of them indicate decrease in the long-term average runoff of the Central Asian rivers[17] to one or another extent. The obtained runoff volumes and precipitation amount depend on GHGs emission scenarios, selected global climatic model (GCM) or set of models, methodology of interpretation of GCM outputs and approaches to runoff assessment. In particular, climate change impact on water resources had been assessed under implementation of the international projects, such as: "Water in Central Asia" (CAWA), "Climatic risks management", preparation of the World Bank Report[18], and others.

Within framework of TNC calculations have been made by three GHGs emission scenarios (WRE450, WRE750, A1FI) on the basis of averaging outputs from eight GCM, and for scenario A1B based on one GCM (See Chapter 4.1). Based on results of these calculations, climate change impact on conditions of glaciers, seasonal snow covers, and surface water runoff during vegetation period have been assessed.

Glaciers are the natural accumulators of fresh and ultra-fresh water, occupying second place after seasonal snow cover by their significance for feeding mountain rivers. Glaciers are considered as one of the most valuable natural resource. Glaciers melt during the hottest period of summer decreasing deficiency of rivers flow in the period of maximum water consumption for irrigation, when supply of seasonal snow in mountains is already depleted.

Figure 4.20 | *View of Waning Pakhtakor Glacier*

Climate warming impact on the upper watersheds of the Amudarya river basin (Pamir, Gissar-Alay, Hindu Kush) and Syrdarya river basin (Tien Shan) corresponds to the global trends, i.e. there is a general recession of glaciers: small size glaciers disappear, and large ones break down. Small glaciers with area less than 1 km^2, share of which is 80% from the total number of glaciers in this region, degrade most rapidly.[19,20]

According to international studies,[21,22] over period 1961-2012, glaciers in Tien Shan lost around 18 ± 6 % of their area and 27 ± 15 % of their mass. The lowest rates of mass loss had been revealed in the Central and North-eastern parts of the mountain system, and the highest ones – in the Eastern and Western Tien Shan. In all, as compared with period 1961-1990, over 2000-2010, ice reserves were decreased in the Syrdarya and Amudarya river basins by 21% and 17% respectively.[23]

Obsevations over glaciers conditions were commenced in 1960s. Three complete inventories of glaciers conditions were conducted during observation period. The last inventory was conducted by the NIGMI of Uzhydromet in 2010. Results are presented in Table 4.5.

Table 4.5 | *Results of Glaciers Inventory for Various Years*

River basin	Total glaciers area, km^2			Number of glaciers		
	1957	1978	2010	1957	1978	2010
Pskem river	119.80	106.13	102.52	211.00	260.00	262.00
Chatkal river	48.00		27.00			
Kashkadarya river	18.14	15.51	7.85	68.00	65.00	61.00
Surkhandarya river	70.37	59.20	47.82	289.00	285.00	290.00
Total	208.31	180.84	158.19	568.00	610.00	613.00

According to inventory data over observation period number of glaciers was increased by 8% with decrease in their total area. In all the total glaciation area in these river basins over period 1957-2010 was decreased by 50.12 km^2 or 24.1% from the initial glacier

[17] V.E. Chub. Climate Change and its Influence on Hydrometeorological Processes, Agro-Climatic and Water Resources of Republic of Uzbekistan. – Tashkent: NIGMI, 2007.
[18] World Bank. Reducing the Vulnerability of Uzbekistan's Agricultural Systems to Climate Change: impact assessment and adaptation options, 2013
[19] Third National Communication of the Republic of Tajikistan under the UN Framework Convention on Climate Change. – Dushanbe, 2014.
[20] Impact of climate change on water resources in Central Asia. Industry report. Eurasian Development Bank, August 2009.
[21] Farinotti, D., Longuevergne, L., Moholdt, G., Duethmann, D., Mölg, T., Bolch, T., Vorogushyn, S., Güntner, A., 2015. Strong Glacier Mass Loss in the Tien Shan over the past 50 years. Nature Geoscience, DOI: 10.1038/ ngeo2513.
[22] Analytical Note of CAWA project. About the Future of Water Resources Management in the Fergana Valley. Climate Change Scenarios, Water Resources and Socio-Economic Development. Edition 03/2015.
[23] Glacier Systems and Seasonal Snow Cover in Six Major Asian River Basins: Water Storage Properties under Changing Climate. IWMI Research Report 149, International Water Management Institute. – Colombo, 2013.

area (in 1957). In 2010, glaciers area within the territory of Uzbekistan for the same period was decreased by 41.63 km^2 or 29,5% as compared with the initial glacier area in 1957.

Decrease in glaciation area in some river basins was as follows:

- for the Pskem and Chatkal river basins glaciers area was decreased by 17,28km^2, or by 24%;
- for the Kashkadarya river basin – by 10,29km^2, or by 56,7%;
- for the Surkhandarya river basin - by 22,55km^2, or by 32,0%.

Dynamics of glaciation area change in the Pskem and Chatkal river basins (Western Tien Shan), and Kashkadarya and Surkhandarya river basins (Gissar-Alay) is illustrated in Figure 4.21. It is worth to mention that the abovementioned river basins are located in various climatic and orographic conditions. Therefore they have various rate of glaciations change (Table 4.6).

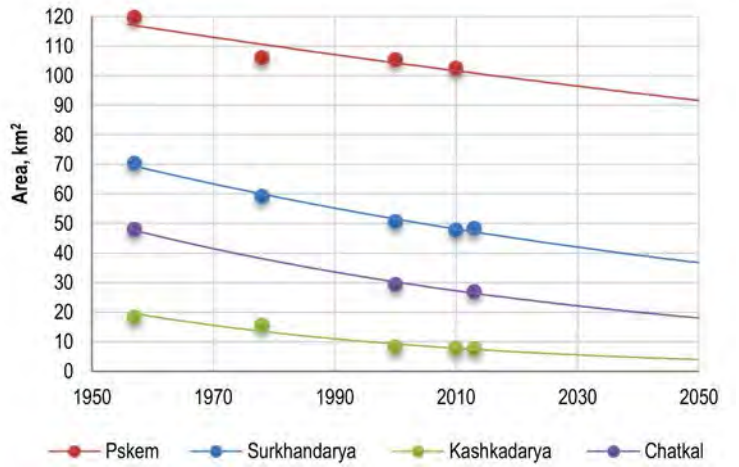


Figure 4.21 | *Dynamics of Glaciation Area Change in River Basins of Uzbekistan*

Table 4.6 | *Degradation Rate of River Basin Glaciations for Various Periods*

River basin	Rate of Glaciation Degradation, % per year	
	1957-1978	1978-2010
Pskem river	0.59	0.10
Kashkadarya river	0.69	1.65
Surkhandarya river	0.76	0.64

From comparison of glaciers degradation rates during two time periods (1957-1978 and 1978-2010) it is possible to come to the following conclusion: in the Pskem river basin glaciations is currently close to stationary conditions; decrease in rate of glaciers degradation by 12% is observed in the Surkhandarya river basin; rates of glaciers area shrinkage in the Kashkadarya river basin were increased by 2 times as compared with the initial period. Hence, glacier systems of various river basins strive to get into the equilibrium with the current climatic conditions taking into account existing orographic conditions. Small sizes of glaciers in these river basins stipulate high rate of glaciers response to climate change processes.

According to the last inventory, the total estimated volume of ice in glaciers of the Pskem, Kashkadarya and Surkhandarya river basins is 3.554 km^3, or 3.021 km^3 of water equivalent (with ice density of 0.85g/cm^3). The total volume of ice in glaciers located within territory of Uzbekistan equals to 2.106 km^3, or 1.790 km^3 in water equivalent.

Over period from 1957 to 2010, volumes of ice in glaciers were reduced as follows: by 0.844km3 (or by 24.3%) in the Pskem river basin; by 0.261km^3 (or by 67.4%) in the Kashkadarya river basin; and by 0.538km^3 (or by 40.1%) in the Surkandarya river basin.

Predictive estimates of changes in glaciers area of the Pskem, Chatkal, Kashkadarya and Surkhandarya river basins for perspective due to climate change have been made with use of statistical correlations between glaciations area and average annual air temperatures in the nearest high mountain meteostations. As a result of further model calculations, trends towards decrease in glaciers area have been received depending on the predicted increase in air temperatures by various GHGs emission scenarios (WRE450, WRE750, A1FI). Analysis of these results has indicated that depending on GHGs emission scenarios the following trends are probable in the nearest 30-50 years:

- with realization of moderate scenario of GHGs emission (WRE750) it is possible some increase in rates of glaciation shrinkage against current values;
- in case of extreme GHGs emission scenario (A1FI) rates of ice cover will be increased which may lead to their disappearance in the nearest future. First of all this will affect glaciers, located in the Kashkadarya abd Surkhandarya river basins;
- increase in intensity of mountain glaciation melt in the conditions of climate warming may initially lead to growth in vegetation flow of mountain rivers on account of increase in share of glacier melt feeding, and later on with shrinkage of glaciation to its reduction.

Snow cover is the main source if feeding for majority of rivers in the Aral Sea basin. One of the problems related to estimation of snow accumulation is unevenness of its distribution throughout mountainous territory. Relief impact on snow cover formation in river basins depends on their elevation extent. In mountainous river basins with rise in terrain elevation above sea level, the total annual precipitation amount increases along with increase in share of solid precipitations and decrease in air temperatures, which lead to

buildup of snow cover. Change in precipitation amount with elevation increase is of local nature, which is affected by orientation of mountainsides, degree of terrain shielding from moisture bearing air masses and other factors. All these factors complicate monitoring and assessment of snow accumulation and bring in considerable share of uncertainties in calculations and forecasts.

Snow accumulation in river basins is characterized by snow cover area and depth at different elevation belts. For calculation of snow accumulation in mountains the NIGMI of Uzhydromet had developed mathematical model of snow cover formation. The model had been used for estimating snow volumes for various river basins and plotting distribution curves of long-term average snow accumulation values by elevation belts.

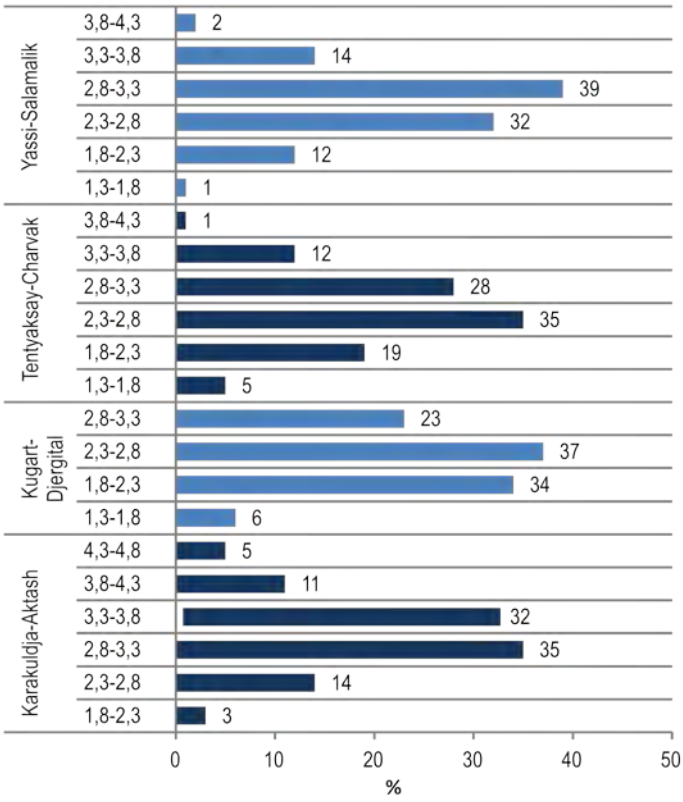


Figure 4.22 | *Distribution of the Long-term Average Annual Volumes of Snow Accumulation at the End of March by Elevation Belts for Mountainous Rivers of Uzbekistan*

Distribution of the long-term average annual volumes of snow accumulation by elevation belts (%), calculated by mathematical model developed in the NIGMI of Uzhydromet, is presented in Figure 4.22.

Within framework of the TNC preparation the quantitative evaluation of changes in snow accumulation for perspective has been carried out on the basis of the Uzhydromet's systematic observation data analysis. For monitoring of snow cover in the upper watersheds of Amudarya and Syradarya rivers and preparation of the long-term hydrological forecasts Uzhydromet actively uses not only ground-based observation data, but also data from the polar orbiting meteorological satellites of NOAA-17,19 series. The GIS technologies based system that by processing of satellite images allows to get information on snow cover in each considered river basin (as of the date of satellite image) have been developed in Uzhydromet (see Figure 4.23).

Analysis of data on snow cover, air temperatures and precipitation amounts in mountainous areas of river basins indicates their close correlation with rivers runoff during vegetation period. With lack of precipitations in winter period and increase in air temperatures in spring, snow cover area decreases sharply leading to considerable runoff reduction in vegetation period. Method of multiple linear regressions has been used for evaluation of snow accumulation vulnerability to climate change impact. For composition of equations of connection for each river basin, sums of precipitation amount and average monthly air temperatures in cold six months were considered as predictors and share of river basin rea with snow cover - as predictant.[24]

On the basis of obtained regression equations it had been made the long-term estimations of snow cover changes in river basins for three climatic scenarios (WRRE450, WRE750, A1F1), assuming various levels of CO_2 concentration in atmosphere. Example of the long-term snow cover estimation for the Kashkadarya river basin is provided in Figure 4.24. It indicates that with materialization of climatic scenario with high GHGs concentration more intensive decrease in snow cover area is observed in river basins.

The quantitative evaluations of changes in snow accumulation for the long-term perspective for moderate GHGs emission scenario (A1B), carried out with use of approach approbated within framework of the CAWA Project "Water in Central Asia" and presented in the publication[25], have also revealed trends towards decrease in snow accumulation in future. This corresponds with positive trends in air temperatures changes in accordance with moderate scenario. As an example the possible changes in estimated volumes of snow accumulation (for A1B scenario of GHGs emission) in the Kashkadarya river basin with clearly indicated negative trend, are presented in Figure 4.25.

[24] S.I. Klimov, Sh.T. Mukhtarov, O.A. Sergeeva. Use of Remote Sensing Data for the Long-Term Assessment of Flow of Mountain Rivers of Central Asia and its Results // Climate Change, Causes, Consequences and Responses. - Bulletin No 10. - Tashkent, 2016. - p. 35-40.

[25] UNDP. Profile of Climate Risks in Uzbekistan. – 2015. – 88 c. http://climatechange.uz/. – 2015. – 88 p. http://climatechange.uz/

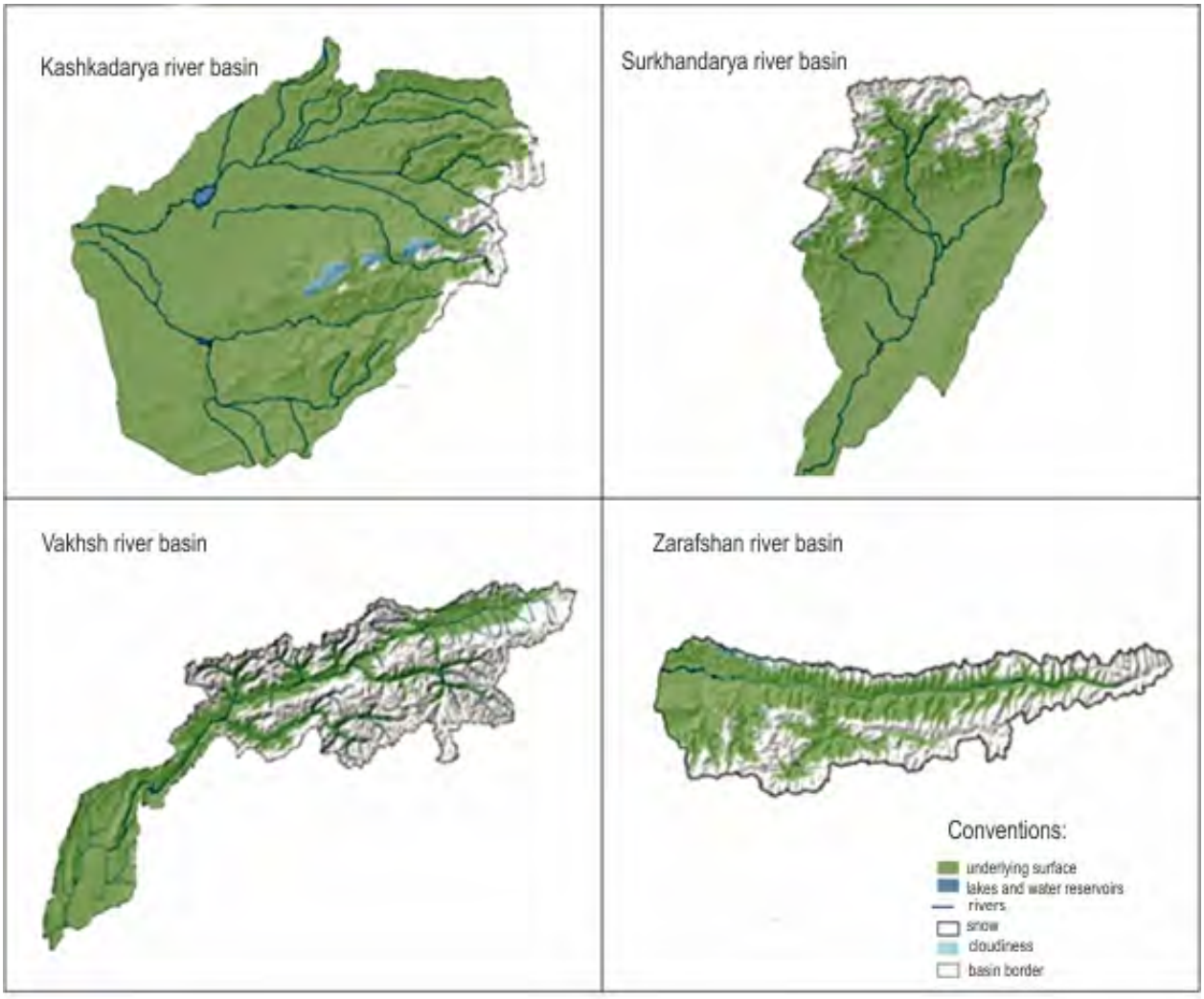


Figure 4.23 | *Maps of Snow Covers in River Basins Based on NOAA Data (as of 28.04.2015)*

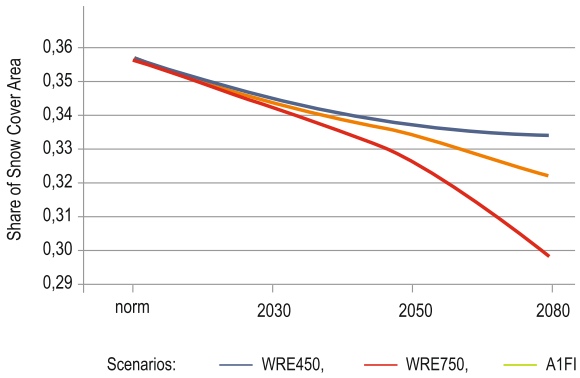


Figure 4.24 | *Variations in Share of Snow Cover Area in Kashkadarya River Basin by Various Climate Change Scenarios*

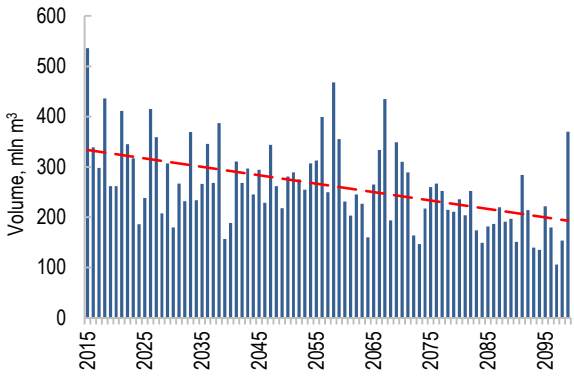


Figure 4.25 | *Estimation of Snow Accumulation for Long-term Perspective in Kashkadarya River Basin as of End of March*

Substantial decrease in area of snow cover is possible in the river basins located in the offspurs of the western Tien – Shan (the Ugam and Akhangaran rivers), including rivers on the north of Fergana valley (the Gavasay river) and offspurs of Gissar-Alay (the Kashkadarya and Surkhandarya rivers). The more lower an average elevation of river watershed, the more intensively goes decrease in snow cover area.

Runoff of the Amudarya and Syrdarya rivers is characterized by the substantial inter-annual variations. In dry year (with 90% probability) the total runoff of Amudarya and Syrdarya rivers may be less by 23 km^3 than in average year by water availability. As indicated by observation data series, groups of wet years interchange with low water availability periods, with may last for several

years (Figure 4.26). Increase in variation of precipitation amount due to climate change may raise variability in runoff of rivers within of the Amudarya and Syrdarya river basins.

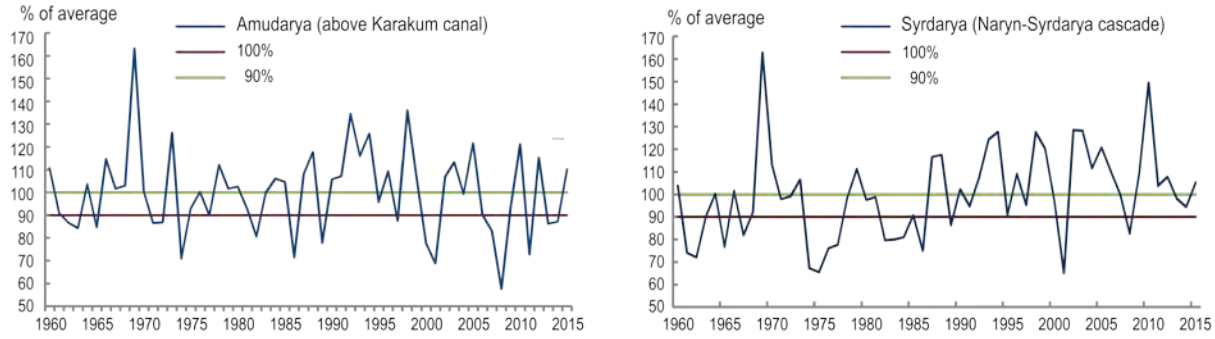


Figure 4.26 | *Variations in Long-term Annual Runoff of Amudarya and Syrdarya Rivers (in % from average)*

River runoff in vegetation period. For evaluation of variations in vegetation river runoff for perspective two methodological approaches are used: (i) based on statistical methods; and (ii) with use of runoff formation models in basins of mountainous rivers. Use of statistical methods provides possibility to assess runoff values for perspective based on historical and current observation data and determining factors. Methods of long-term evaluation of mountainous rivers runoff are based on approximate solution of water balance equation on a basis of statistical relationships between runoff and precipitation amounts/air temperatures. Availability of essential input data for analysis and statistical significance of revealed relationships had allowed to identify river basins with possibility to estimate long-term vegetation runoff in accordance with the adopted greenhouse gases emission scenarios (Table 4.7).

Decease in runoff during vegetation period is observed by all scenarios and time intervals (Figure 4.27). The highest runoff decrease in percentage is expected in small rivers.

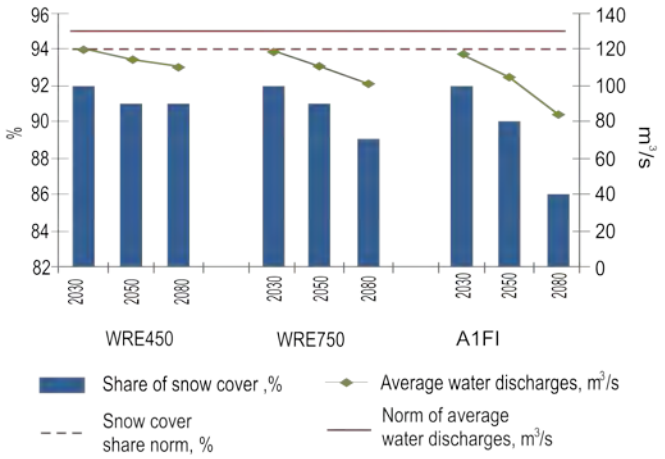


Figure 4.27 | *Variations in Share of Snow Cover Area in Pskem River Basin and Average Water Flow over Vegetation Period by Various GHGs Emission Scenarios*

Runoff decrease is also indicated by evaluations carried out with use of models for runoff formation in mountainous river basins, which take into account snow accumulation by elevation belts in separate basins, inflow of rain, snowmelt and glacier melt waters. In Uzhydromet the abovementioned set of models is used in form of automated (computer-aided) information system for hydrological forecasting[26] in aid of long-term prediction of runoff and assessment of current and future conditions of water resources. Modeling runoff data series in monthly and 10-day timescale has been made based on the outputs of the global climatic model ECHAM-5 for greenhouse gases emission scenario A1B[27] with use of the regional climatic model REMO. Assessment has indicated that climate change by this scenario will also lead to decrease in available surface water resources (Table 4.8), despite some increase in the total annual precipitation amounts indicated by the ECHAM-5 model.

Assessments, carried out with use of various methodological approaches for the moderate scenarios of GHGs emissions (WRE750 and A1B), indicate mainly consistent results: in the nearest 40-50 years as a result of climate warming insignificant decrease in vegetation runoff against norm may be observed in the region's rivers, apart from small rivers in piedmont areas. Probable changes in runoff of this period are estimated within natural variability. In the long-term perspective with materialization of extreme greenhouse gases emission scenario due to intensive reduction in snow/glacier resources, the considerable changes may occur in river basins, such as: decrease in runoff of some rivers in the Amudarya river basin is possible by 7-22%, that of in the Syrdarya river basin – by 5-42% (Tables 4.7, 4.8).

[26] Yu.M. Denisov, N.A. Agaltseva, A.V. Pak. Automated Methods of Flow Forecasting in Central Asian Mountain Rivers. - Tashkent, 2000
[27] UNDP. Profile of Climate Risks in Uzbekistan. – 2015. – 88 p. http://climatechange.uz/

Table 4.7 | *Variations in Rivers Vegetation Runoff (% from base norm) in Accordance with Various GHGs Emission Scenarios (evaluation based on statistical methods)*

River/Gage Station	Base Norm 1980-1999 (m^3/s)	Vegetation Runoff (% from base norm)								
		WRE450			WRE750			A1FI		
		2030	2050	2080	2030	2050	2080	2030	2050	2080
Syrdarya River Basin										
Pskem - Mullala	128	94	89	86	93	87	79	92	82	66
Akhangaran - Irtash	37	87	83	79	87	80	72	86	75	58
Chatkal - Khudoidodsay	195	99	98	99	99	98	97	99	97	95
Ugam - Khodjikent	34	92	89	86	92	86	79	91	82	67
Gavasay – Gave village	10	93	87	83	92	84	74	91	78	58
Amudarya River Basin										
Vakhsh - Komsomolabad	988	99	98	97	99	98	96	99	96	93
Kashkadarya - Chirakchi	25	94	91	90	94	90	86	93	88	78

Table 4.8 | *Estimation of Vegetation Runoff in Rivers (in % from norm) in accordance with GHGS Emission Scenario A1B*

River Basin	River/Gage Station	Norm 1961-1990 (m^3/s)	Average Water Flows in Vegetation Period, in % from norm			
			2020	2040	2060	2080
Syrdarya river	**Chirchik river – Akhangaran district**					
	Akhangaran - Irtash	35	97	96	95	94
	Pskem - Mullala	126	98	97	96	94
	Chatkal - Khudoidodsay	180	99	96	93	90
	Rivers of southern slope of Fergana mountain ridge					
	Karakuldja - Aktash	38	98	96	94	92
	Yassi - Salamalik	37	100	98	96	94
	Rivers of northern slope of Alay mountain ridge					
	Kurshab - Gulcha	25	99	97	96	95
	Tar - Chalma	82	96	93	90	87
Amudarya river	**Kashkadarya river basin**					
	Kashkadarya - Varganza	6	94	89	83	78
	Kashkadarya - Chirakchi	21	97	88	80	72

Scenarios of precipitation variations with low reliability introduce sufficiently large uncertainty in evaluation of water resources availability for perspective. According to the base scenarios (based on averaged outputs of 8 global climatic models), the total annual precipitation amounts for upper watersheds of the Syrdarya river are changed insignificantly in time, within 4% versus current level. Change in the total annual precipitation amounts in the Amudarya river basin is more significant. It is possible decrease in precipitation amounts by 4 to 13% (with materialization of extreme GHGs emission scenario).

However, even with increase in precipitation amounts (evaluations on the basis of model ECHAM-5) decrease in water resources volume of the Aral Sea basin in vegetation period is possible. Response of water resources to climate change comes out first of all in decrease in share of snowmelt runoff and short time increase in share of glacier melt runoff, which also will start decreasing along with recession of glaciers. Growth in variability of precipitations and increase in share of liquid precipitations in rivers feeding are expected by all GHGs emision scenarios. This will lead to enhancement in river runoff variability.

Intra-year runoff distribution is closely enough related to elevation of river basins. Rivers with watershed located at low elevations, which fed by seasonal snow cover melt, are characterized by early passing high water (from March to June). Rivers with watershed located at high elevations, which fed by melting high mountain seasonal snow cover, longstanding snow patches and

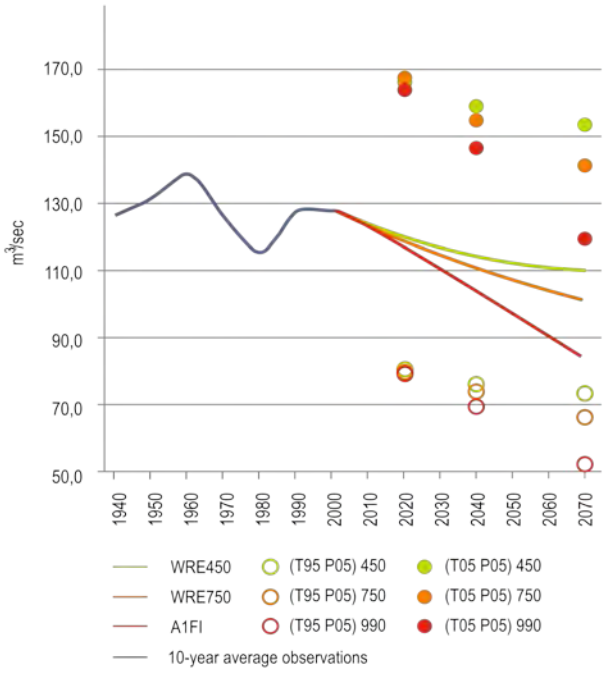


Figure 4.28 | *Assessments of Probable Extreme Values of Vegetation Runoff in Pskem River Basin by Various Climate Change Scenarios*

glaciers have maximum flow in July-August. In these rivers peak of high water will be shifted to more earlier dates due to more earlier increase in air temperatures.[28] Therefore it is possible to expect decrease in rivers flow in the second half of vegetation period.

Assessment of extreme rivers runoff. Assessment of variability and probability of climatic anomalies occurrence, such as extreme droughts, is very important for water use planning and governing in agriculture and water management, and other economy sectors.

Results of assessment of probable extreme values of vegetation runoff by 5% and 95% quantiles of air temperatures and precipitations (very arid and warm; very humid and cold) with materialization of three GHGs emission scenarios for the Pskem river basin are presented in Figure 4.28. The results indicate increase in variations amplitude with more high growth rates of GHGs concentrations.

Intra-year variations in rivers runoff and lengthy low water periods will complicate use of water resources in economy sectors.

4.2.3 Water Availability Problems

The predicted climate change may have substantial impact on development and sustainability of irrigated agricultural production. According to the updated climatic scenarios the expected increase in air temperatures in arid zone will stipulate growth in evapotranspiration from agricultural fields and increase in water demands for irrigation. The probable decrease in availability of water resources will lead to arise a number of problems associated with meeting water demands for agriculture and population, being especially acute during dry years.

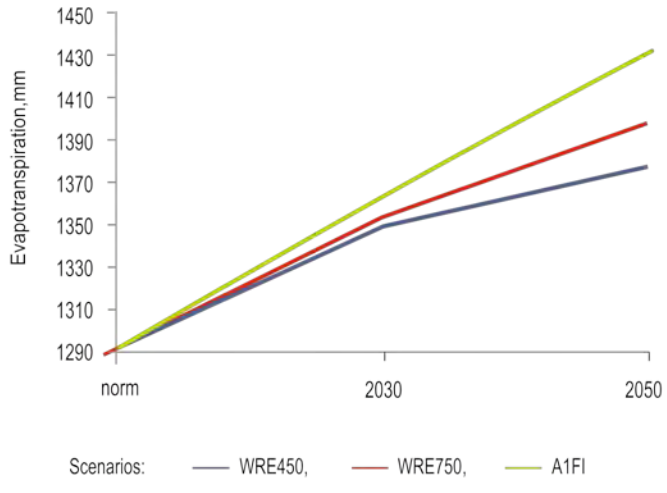


Figure 4.29 | *Trends in Evapotranspiration Change by Uzbekistan on Average*

Expected changes in crops evapotranspitation. Values of evapotranspiration calculated by adopted climatic scenarios with use of the CropWat[29] software by the Penman-Monteth method have indicated growth in evapotranspiration rates against base norm in period 1980-1999 (Figure 4.29).

By 2030, the expected increase in value of average annual evapotranspiration will be 57-73 mm versus base norm for 1980-1999 with minimum difference between various scenarios; by 2050, increase in value of average annual evapotranspiration will vary in range of 85-140mm depending on scenario.

Schematic maps (Figure 4.30) illustrate spatial distribution of the observed average annual evapotranspiration for the base climatic period (1980-1999) and its assessments by scenario WRE450 by 2050. The Figure indicates that even with materialization of soft scenario of GHGs emission considerable increase in areas with high evapotranspiration rates is possible.

Estimations of the total evapotranspiration of

[28] V. Chub, A. Savitskiy, M. Schlueter, R. Taryannikova, N. Agaltseva. Current and Future Impacts of Climate Change on River Runoff in the Central Asian River Basins.
[29] http://www.fao.org/nr/water/infores_databases_cropwat.html

agricultural crops, made in the Second National Communication, has indicated that increase in the total evapotranspiration values from fields of cotton, alfalfa, vegetables and tree plantations was of a similar order. Growth in the total evapotranspiration values from winter wheat fields was less intensive.

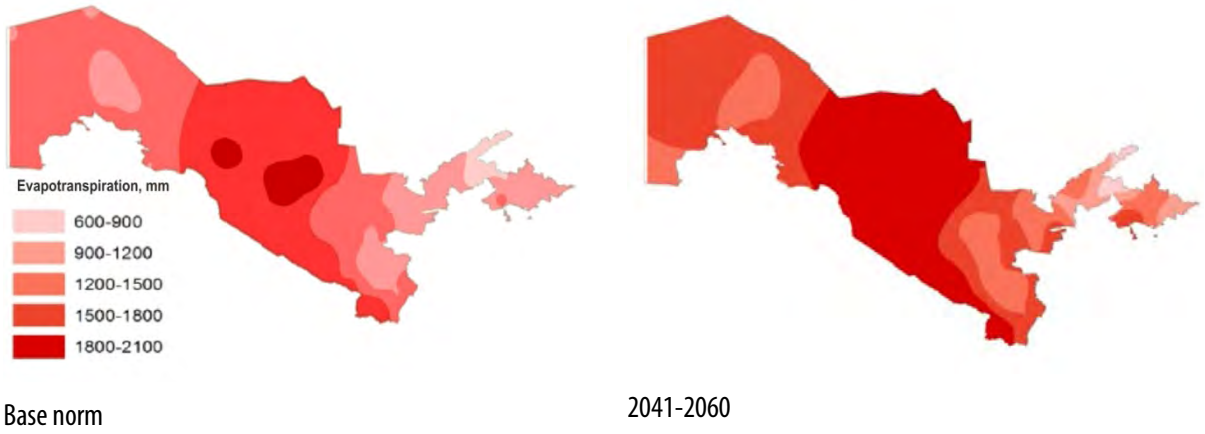


Figure 4.30 | *Schematic Maps of Spatial Distribution of Average Annual Evapotranspiration Values for Base Climatic Period and Forecast Period by Scenario WRE450*

Results of studies carried out under preparation of the TNC (Figure 4.31) in general confirm trends revealed in the SNC.

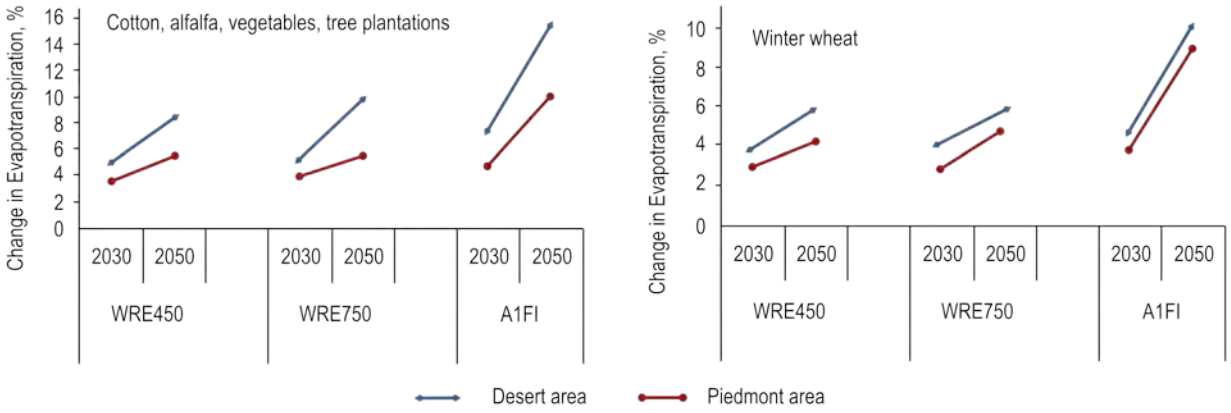


Figure 4.31 | *Average Increase in Crops Evapotranspiration Volumes (in % from base norm) in Accordance with GHGs Emission Scenarios*

According to estimations made in the TNC, the evapotranspiration values from fields of *cotton, alfalfa, vegetables, melons and tree plantations* located:

- in desert and steppe areas are expected to be increased by 5-7% by 2030 and by 8-15% by 2050 versus climatic norm;
- in piedmont areas are expected to be increased less intensively, by 3.5-6.5% by 2030, and by 4.0-12% by 2050.

Increase in evapotranspiration values from fields of winter wheat depending on materialized scenario:

- in desert and steppe areas the evapotranspiration values will be increased by 3.5-4.5% by 2030, and by 5.5-10% by 2050;
- in piedmont areas - by 2.5-3.5% by 2030 and by 4-10% by 2050.

Maximum increase in evapotranspiration value is attributed to the extreme scenario of GHGs emission A1FI.

Expected Changes in Crops Irrigation Norms. Crop water requirements in climate change conditions have been estimated on the basis evapotranspitation calculations taking into account soil conditions and crops biological features. Changes in irrigation norms by agro-climatic zones will depend on geographical location and expected climatic conditions. According to calculations, irrigation norms for the majority of crops (*cotton, alfalfa, vegetables, tree plantations)* will be increased by 5.8-7.3% by 2030, and by 9.7-15.0% by 2050.

As an example, the probable increase in irrigation norms for cotton and winter wheat, growing in the desert and piedmont areas, is illustrated in Figure 4.32.Increase in irrigation norms by various climatic scenarios will be:

a) for cotton and other crops:

- growing in desert and steppe areas by 5,0-7,2% by 2030, and by 8,4-15,2% by 2050;
- growing in piedmont area by 3,7- 4,9% by 2030, and 5,7- 9,9% by 2050;

6) for winter wheat:

- growing in desert and steppe areas by 7,2-9,7% by 2030, and by 12,7-18,5% by 2050;
- growing in piedmont area by 8,1- 9,8% by 2030, and 14,0- 21,6% by 2050.

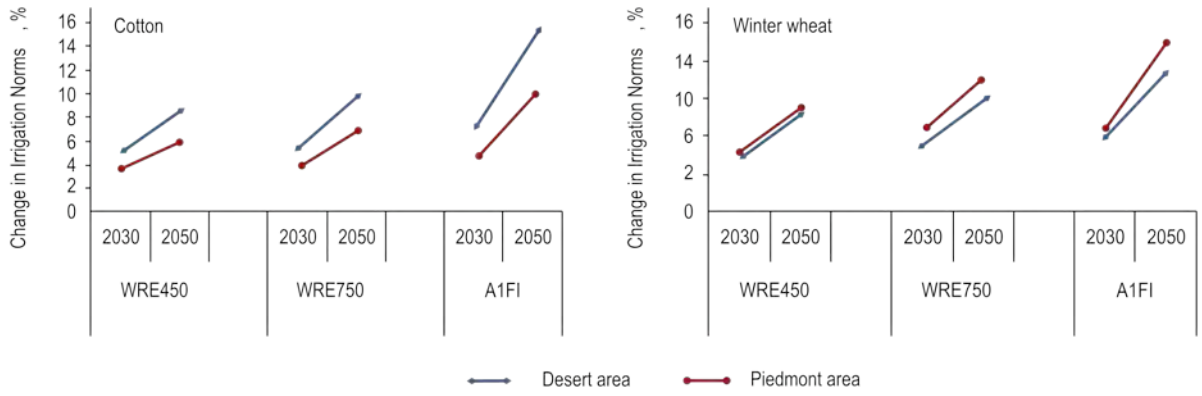


Figure 4.32 | *Probable Increase in Irrigation Norms (in % from base norm) for Cotton and Winter Wheat by Agro-climatic Zones*

Based on geographical location and expected climatic conditions, climate change impact on value of crops irrigation norms will vary by agro-climatic zones. For cotton dynamics of increase in irrigation norms is expected to be more intensive in desert and steppe areas, and for winter wheat – in piedmont areas.

Expected irrigation water deficiency. The expected increase in water demands for crops irrigation will occur on background of decrease in precipitations and rivers runoff, which will unavoidably entail increase in water deficiency.

Assessments of future demands for water, carried out by the World Bank experts by WEAP model (Water Evaluation and Planning System)[30], have indicated that already now water demands for irrigation do not meet completely.

Deficiency in water resources will be increased considerably in the conditions of climate change and population growth. By 2040s the total irrigation water deficiency in the Amydarya and Syrdarya river basins may be equal to 8% with materialization of low impact scenario, 15.4% with materialization of medium impact scenario, and reach 33,5% with materialization of high impact scenario (Table 4.9).

Table 4.9 | *Assessment of Irrigation Water Deficiency by 2040, Depending on Climatic Scenarios*

River Basin	Irrigation Water Deficiency by Scenarios of Climate Change Impact		
	Low Impact	Medium Impact	High Impact
Syrdarya river, eastern part of basin	11.6	17.5	51.6
Syrdarya river, western part of basin	1.9	4.7	34.4
Amudarya river basin	8.7	17.8	28.9
Total by river basins	8.0	15.3	33.5

Source: William R. Sutton.. [et al.] (2013).

In general, climate warming impacts on irrigated agriculture of Uzbekistan include:

- increase in crops irrigation norms;
- increase in irrigation water deficiency;
- enhancement of air droughts and extremely high temperatures impacts and decrease in yields of the current crop varieties as a consequence.

Issues of water sharing management, water use planning and adaptation measures for irrigated agriculture have been considered in Chapter 4.3.4.

In dry years water deficiency impacts will be especially severe. These impacts are already clearly visible in the extremely years, becoming more frequent in the recent ten years.

[30] William R. Sutton…[et.al.], IBRD/WB. Reducing the vulnerability of Uzbekistan's agricultural systems to climate change: impact assessment and adaptation options, 2013.

4.3 Agriculture

Agriculture is one of the priority sectors in economy of Uzbekistan. It plays a key role in maintenance of social and economic stability, employment and well-being of population, self-sufficiency and food security of the country. Agriculture produces essential foodstuff commodities and raw materials for industry.

Feature of the country's agriculture is its extremely high dependence on irrigation. Crop husbandry production and considerable part of livestock production (apart from karakul sheep raising on desert pastures) are mainly produced on irrigated lands. Irrigated agriculture consumes over 90% from the total volume of water consumed in the country. Currently agriculture faces with acute shortage of water and limitation of highly productive agricultural lands.

Agriculture is inseparably related to climate and as compared with other economy sectors is the most vulnerable to climate changes, such as changes in regime of air temperatures, precipitations, rivers runoff, droughts, outbursts of animal and crop pests and diseases, which create serious problems for development of agriculture and threaten food security. Therefore, timely development of measures and actions of adaptation to climate change impacts is one of the urgent and important tasks for agriculture.

4.3.1 Vulnerability of agro-climatic resources to climate change impacts

Trends observed. The agro-climatic resources describe possibilities of climatic system to provide development of agricultural production. Expediency of growing new crops, formation of optimal cropping pattern, probable crop yields are estimated on the basis of agro-climatic resources of particular territory. The on-going climatic changes entail changes in the main agro-climatic indices, such as:

- dates of stable transition of average daily temperature over 5°C, 10°C, 15°C in spring and autumn, which characterize beginning and end of vegetation period of various crops;
- duration of period between dates of average daily temperature transition over 5°C (vegetation period), over 10°C and 15°C (periods of active vegetative growth and crop development stages);
- sum of effective air temperatures above certain thresholds (5°C, 10°C, 15°C), describing heat availability of vegetation period;
- dates of first frosts in autumn and last ones in spring, limiting vegetation period for plants;
- frequency of high air temperatures, adversely impact on crop yields;
- moisture deficiency, which in general describes demand for irrigation, etc.

Analysis of the on-going trends of agro-climatic variables changing over period from 1950 to 2013, has been carried out on the basis of Uzhydromet observations data. The results of analysis[31] indicate shifting in dates of stable transition of average daily air temperature over 5°C, 10°C, 15°C in spring and autumn towards winter throughout entire territory of Uzbekistan. Over the considered period stable transitions of average daily air temperature over 5°C, 10°C, 15°C in spring begun to come up by 5-11 days earlier, and by 5-11 days later in autumn. Shifting dates of stable transition of average daily air temperature over 5°C had entailed increase in vegetation period duration (Figure 4.33). On average by Uzbekistan rates of increase in duration of vegetation period are 3 days over 10 years.

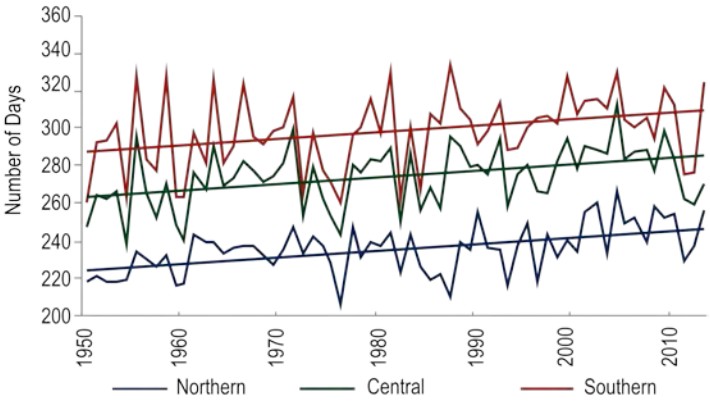


Figure 4.33 | *Change in Duration of Vegetation Period by Various Parts of Uzbekistan's Territory*

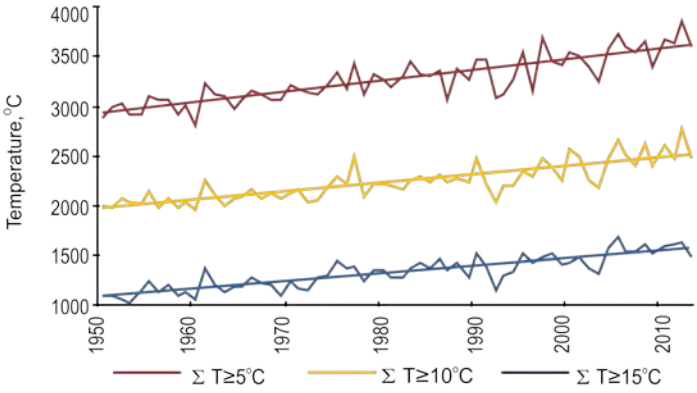


Figure 4.34 | *Change in Sums of Effective Air Temperatures above 5°C, 10°C and 15°C in Chimbay meteostation (northern part of Uzbekisztan)*

[31] T.Yu. Spectorman, M.A. Plotsen. Climate Change Impact on Agro-Climatic Resources of Uzbekistan's Territory // Climate change, reasons, impacts and response measures. – Bulletin No. 9. – Tashkent, 2015. – p. 40-52.

Analysis of changes in sums of effective air temperatures above 5°C, 10°C and 15°C indicates their considerable increase throughout entire territory of Uzbekistan. The trends revealed are statistically significant ($\Delta Tr/\sigma>1,5$)[32]. On average by the republic sums of effective temperatures above 5°C, 10°C and 15°C have been increased by 68°C, 53°C and 38°C respectively over every 10 years. In the north of Uzbekistan (the Republic of Karakalpakstan) this trend is more pronounced with increases of 95°C, 69°C, 64°C respectively (Figure 4.34), that of in the central and southern provinces is 69°C, 59°C, 37°C, and in the piedmont rainfed zone is 32°C, 17°C, 11°C respectively.

Increase in duration of vegetation period along with heat supply rise is the positive factors for increasing productivity of heat-loving crops, such as cotton. Trend towards increase in effective temperatures in the northern part of Uzbekistan assumes optimization of conditions for growing cotton, since thermal resources are limiting factor for its growing. Shifting in date of stable transition of average daily air temperature over 5°C in spring back toward winter has positive impact on growth of natural vegetation on pastures and rainfed crops. Earlier beginning of vegetation period falls on moister spring period that allow to plants to use efficiently precipitations moisture.

Possible changes in heat supply during vegetation period. In aid of evaluation of changes in heat supply, the agro-climatic indices have been calculated for the base period (1980-1999), current one (1994-2013) and predictive ones (2021-2040, 2041-2060, 2071-2090) in accordance with the GHGs emission scenarios (WRE450, WRE750, A1FI). [33,34] According to climate change scenarios, increase in variability of air temperatures is expected for Uzbekistan. This will entail gradual shifting dates of stable transition of average daily air temperature over 5°C, 10°C and 15°C towards earlier dates and later dates in autumn.

By 2080s (2071-2090), the soft GHGs emission scenario (WRE450) assumes shift in date of stable transition of average daily air temperature over 5°C in spring (beginning of vegetation period) by 11 days only, which is comparable with the current variability of this index (8-17 days depending on geographical location of meteorological station).

Change in duration of vegetation period by plain territory of Uzbekistan up to 2041-2060 may remain within natural variability, observed currently. The average duration of vegetation period of 291 days by 2050s (by GHGs emission scenario WRE450) was exceeded already in 1971, 1981, 1992, 1999, 2001, 2002, 2004 and 2009. Soft scenario assumes in fact retention of existing conditions up to 2071-2090.

With materialization of moderate scenario WRE750, already by 2050s change in duration of vegetation period will exceed its currently observed variability. The average duration of vegetation period calculated for this scenario (297 days) was exceeded only in 2004 and 2009. In general, dates of stable transition of average daily air temperature over 5°C, 10°C, 15°C, indicating beginning and end of vegetation period, as well as duration of periods between these dates, are slightly sensitive to climate change.

Most likely evaluation of changes in heat supply by 2030s (2021-2040) may be considered as climatic forecasts, since differences between GHGs emission scenarios are less than natural variability of indices under consideration.

Expected changes in sums of effective temperatures. Integrated indices of thermal resources are more sensitive to climate change. This is confirmed by the statistically significant trends, revealed from observation data (Figure 4.34), and by assessments of changes for perspective (Table 4.10) in accordance with scenarios of growth in global concentrations of CO_2 in atmosphere.

Table 4.10 | *Base Norms of Sums of Efficient Air Temperatures above 5oC, 10oC and 15oC and Assessments of Their Changes in Accordance with GHGs Emission Scenarios (in % from base norm 1980-1999)*

Criteria	Norms		2021-2040	2041-2060			2071-2090		
	1980-1999	1994-2013	Predictive Estimates	WRE450	WRE750	A1FI	WRE450	WRE750	A1FI
Averaging by meteorological stations of Uzbekistan, apart from southern provinces									
5°C	3511	3694	8-10	12	15	21	16	24	43
10°C	2404	2547	10-12	14	18	26	20	30	53
15°C	1462	1548	13-17	20	24	34	26	38	71
Averaging by meteorological stations of southern provinces of Uzbekistan									
5°C	4094	4291	8-10	13	15	22	17	25	44
10°C	2926	3058	9-12	14	17	25	19	28	50
15°C	1863	1987	13-16	19	23	33	24	38	67

[32] Progress report to CCl on statistical methods. WMO-TD. - № 834. - p. 1997-115

[33] T.Yu. Spectorman, Climate Change Scenarios for Territory of Uzbekistan and Upper Watersheds of Amudarya and Syrdarya Rivers // Climate change, reasons, impacts and response measures. – Bulletin No. 9. – Tashkent, 2015. – p. 29-39.

[34] T.Yu. Spectorman, M.A. Plotsen. Climate change impact on agro-climatic resources of Uzbekistan's territory // Climate change, reasons, impacts and response measures. – Bulletin No. 9. – Tashkent, 2015. – p. 40-52.

Increase in sums of effective air temperatures, expected by climatic scenarios in the southern provinces of Uzbekistan, are percentage-wise comparable with similar values for the northern territories.

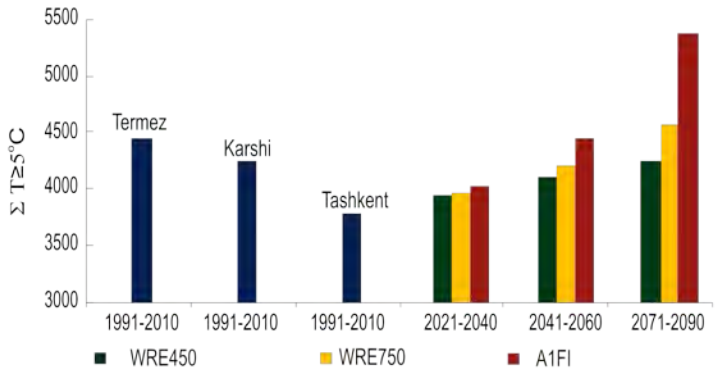


Figure 4.35 | *Comparison of 20-year Average Sums of Effective Air Temperatures above 5°C for* Southern *Meteorological Stations of Uzbekistan (Karshi, Termez) with Data and Scenario* Assessments *for Tashkent Meteorological station*

Already by 2030, increase in sums of effective air temperatures may exceed by 1.5-2 times the currently observed variability. Change in sums of effective air temperatures above 5°C by territory of Uzbekistan is illustrated in Figure 4.35. Heat availability conditions during vegetation period in the Tashkent province will in due course of time come close to conditions of Kashkadarya province, and later on to those in Surkhandarya province. Conditions in mountainous areas will come close to those on the plain lands.

Estimated increase in sums of effective air temperatures indicates possibility for expanding area for growing thermophilic crops and vegetation towards north of Uzbekistan and in mountainous areas.

New heat availability conditions will require revision and correction of the current cropping pattern, zoning new crop species and varieties and optimizing their distribution for retention of crops productivity.

Expected change in moisture deficiency. Moisture deficiency is the important agro-climatic factor in the conditions of irrigated agriculture. It depends on climate conditions and is taken into account in calculation of irrigation norms and water duty zoning of irrigated lands. Climatic moisture deficiency is difference between evaporation rate and precipitation amount.[35] Changes in evaporation rates for perspective over periods April-September have been calculated by empirical equation, used for Uzbekistan[36,37], on the basis of monthly data from 50 meteorological stations. Moisture deficiency increases consistently throughout entire territory of the country for all GHGs emission scenarios, and in all it repeats rates of increase in sums of effective air temperatures.[38]

Increase in moisture deficiency by 11-14% *on average* by Uzbekistan versus base period is expected by 2021-2040. By 2041-2060, according to the *soft* scenario of GHGs emissions (WRE450) increase in moisture deficiency will not exceed 17%, and with materialization of the *extreme* scenario of GHGs emissions (A1FI) it may exceed 30%, which indicate probable considerable enhancement of climate aridity at high climate warming rates.

However, change in moisture deficiency has been evaluated on the basis of data from meteorological stations and therefore reflects local conditions. In the areas with intensive irrigation it may be observed increase in relative air humidity and decrease in air temperatures. Therefore, the obtained values of changes in moisture deficiency in warm half-year by climatic scenarios are most likely overestimated for irrigated lands.

Expected change in number of days with high air temperature. Number of days with high air temperature, unfavorable for agricultural crops, estimated by climatic scenarios, will be useful for evaluation of possible crop yields losses. The developed climatic scenarios comprise assessment of maximum mean air temperatures, absolute maximum monthly temperatures, as well as their 90% quantiles (values observed once in 10-year time). Assessments indicate which extreme air temperatures may be observed in Uzbekistan with materialization of every GHGs emission scenario (Table 4.11).

High air temperatures adversely impact plants growth and development. Degree of this impact depends directly on value and duration of this stress. According to the regional studies[39,40], unfavorable impacts on agricultural crops may be observed starting from air temperatures above 35°C.

[35] Yu.I Sukharev, Justification for Irrigation Regimes of Agricultural Lands // Bulletin of the Russian Academy of Agricultural Science: Scientific/Theoretical Magazine. – M, 2010 - ISSN 0869-3730. 2010, No2, - p. 33-34.

[36] N. N. Ivanov. Landscape and climatic zones of the globe. – L., 1948.

[37] G.M. Khasankhanova, Crop Water Requirements – Uzgipromeliovodkhoz, 1999 (Project A – 2 GEF, Participation in water saving). http://www.cawater-info.net/bk/improvement-irrigated-agriculture/files/khasankhanova.pdf.

[38] T.Yu. Spectorman, M.A. Plotzen. Climate Change Impact on Agro-Climate Resources of Uzbekistan's Territory // Climate change, reasons, impacts and response measures. – Bulletin No. 9. – Tashkent, 2015. – p. 40-52.

[39] F.A. Muminov, Kh.M. Abdullaev, Agro-climatic resources of Uzbekistan. – Tashkent: SANIGMI, 1997.

[40] F.A. Muminov, Weather, climate and cotton. – Len.: Hydrometizdat, 1991. – 191 p.

Table 4.11 | *Assessment of Changes in 90% Quantiles of Maximum Air Temperatures (°C) in July by Uzbekistan on Average in Accordance with GHGs Emission Scenarios*

Periods	Scenarios		
	WRE450	WRE750	A1FI
2021-2040	43.0	43.2	43.4
2041-2060	43.6	44.1	44.8
2071-2090	44.2	45.2	47.6

Considerable increase in number of days per year with air temperature above 35°C (Figure 4.36) is observed in Uzbekistan. As of already now number of such days per year is on average about 80 days in the south, around 60 days – in the north and more than 40 days in the central and piedmont areas.

The most unfavorable conditions are developed at air temperatures above 39°C. Number of days with air temperature above 39°C for the base and future periods in accordance with GHGs emission scenarios are presented in Table 4.12.

The estimation indicated that over the period from 1950 to 2013, due to climate warming the agro-climatic resources of Uzbekistan have undergone to considerable changes. In accordance with the climatic scenarios for the long-term perspective it is expected increase in intensity of changes in agro-climatic variables on a background of increasing their variability.

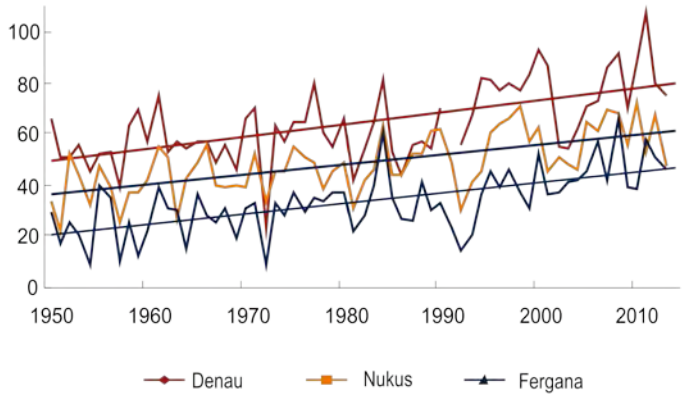


Figure 4.36 | *Change in Number of Days with Air Temperature above 35°C by Northern (Nukus* meteorological *station), Central Piedmont (Fergana meteorological station) and Southern (Denau meteorological station) Provinces*

Table 4.12 | *Base Norms of Number of Days per Year with Air Temperature Above 39°C and Their Number by Various Territories of Uzbekistan (averaged by plain meteostations) in Accordance with GHGs Emission Scenarios*

Regions	1980-1999	2021-2040	2041-2060			2071-2090		
		Predictive Estimates	WRE450	WRE750	A1FI	WRE450	WRE750	A1FI
Lower reaches of Amudarya river, Karakalpakstan	10	16-18	19	22	26	22	28	41
Khorezm province	10	19-21	22	25	29	25	32	45
Kyzylkum desert	29	36-38	39	42	46	42	50	64
Central piedmont territories	7	14-17	18	21	27	22	29	43
Fergana valley	3	5-7	9	12	17	14	20	34
Kashkadarya river valley	17	25-27	29	31	37	32	39	54
Surkhandarya river valley	25	33-35	35	39	45	40	49	62

Sums of effective air temperatures, describing thermal resources, and moisture deficiency for entire territory of Uzbekistan, turned out to be the most sensitive to climate change. By 2050, with materialization of the extreme scenario of GHGs emission, moisture deficiency may be increased by more than 30%.

According to the studies available in the country and evaluations received, by already 2030, in many regions, especially in the southern regions of Uzbekistan, the average number of days with air temperature over 39°C may reach critical level for currently growing crops. In these conditions crops will experience thermal stress at the extremely high temperatures during vegetation period, which is very dangerous with increasing moisture deficiency.

On the basis of analysis of future change in agro-climatic resources it is expected several synergistic effects on agriculture. The predicted risks of decrease in agricultural productivity may be ranked as follows:

i. increasing moisture deficiency will stipulate growth in crops demand for irrigation, but shortage of water resources may lead to water stress to crops and therefore, to decrease in yields;
ii. increase in number of days with high air temperatures on a background of decrease in soil moisture content may also lead to considerable yield losses;
iii. increase in sum of effective air temperatures and duration of vegetation period will require revision and correction of the current cropping pattern for getting maximum benefits from increase in heat availability;
iv. variability in dates of vegetation period beginning may significantly reduce crops productivity due to untimely implementation of crop operations.

4.3.2 Climate Change Impact on Main Crops, Pastures, Cattle Breeding

The main, economically significant crops growing on irrigated lands are winter wheat and cotton, which occupy 68% of the total arable land area on average. Perennial vegetation is presented by orchards and multipurpose decorative tree plantations. The rest of irrigated land area is occupied by annual crops, such as fodder, vegetables, melons, potato and other crops.

According to data from the Goskomzemgeodezkadastr rainfed agriculture is concentrated in foothill plains, piedmont and low mountains of the Tien Shan and Pamir Alay on areas of 790 thousand ha, or 18.3% from the total area of all arable lands. Only 28.4% of rainfed area is provided with stable precipitations. The rest part is located in zones of non-provided or semi-provided with natural moisture with the total annual precipitation around 250-350mm. In such conditions value of maximum possible yield is limited by the degree of moisture availability for crops. Therefore, crops husbandry on rainfed lands is low productive, with unstable crop yields, main of which are winter wheat and barley. Farmers in their practice use just a few measures for retention and efficient use of limited supply of natural moisture on rainfed lands. Often in unfavorable years yields do not compensate seeds cost.

Climate change impacts on crops productivity. Agricultural crop yields depend to considerable extent on variations in weather/climatic conditions. For example, in the most vulnerable regions of the country (the Khorezm province and Karakalpakstan) losses of cereal from 2000-2001 drought were 14-17%, losses in production of crops with more lengthy vegetation period were from 45 to 75%. According to data of the Regional Review[41], the total losses were estimated in the amount of USD130 million, or 2.4% from agriculture share in the GDP.

The predicted increase in air temperatures and crops evapotranspiration will facilitate growth in crop water requirements, which in the conditions of decrease in available water resources is the additional limitation factor for maintenance of productivity and profitability of irrigated agriculture.

Cotton. Probable changes in agro-climatic resources in the main cotton growing areas will lead to increase in duration of vegetation period by 11-19 days, growth in summer and autumn air temperatures. In general, especially in the northern regions conditions for cotton bolls formation, ripening and opening will be improved. This will enable increase in yields and improvement of fiber quality.

However, increase in number of days with abnormally high air temperatures may lead to decrease in cotton yields in some districts of the Bukhara, Kashkadarya, Tashkent and other provinces. Adverse impact on development of cotton, especially in the conditions of soil moisture shortage, has so called *ballast* temperatures (above 39ºC). Yield losses due to impact of ballast temperatures will be especially considerable on the south of cotton growing regions and may reach 27-35%.[42]

Cereals. It is assumed that cereal will be grown mainly on irrigated lands, as it is now. Productivity of *winter wheat* grown on irrigated lands is considerably higher compared with rainfed lands. Such proportion will be retained in future since no increase in precipitation amount is expected in the main winter wheat growing rainfed areas.

As it is now, variations in cereals yields on rainfed lands will be identified by agro-climatic conditions during vegetation period (such as balance of temperatures, total precipitation amount and its spatial and temporal distribution). Increase in frequency of high air temperatures and decrease in the total precipitation amount in non-provided with natural moisture rainfed areas will lead to decrease in yields of cereals by 30-35%. In the most unfavorable years yield losses will be higher than these values.

Growing of cereals on irrigated land decreases significantly yields variability. Increase in CO_2 concentration in atmosphere will facilitate productivity growth. Currently the average air temperatures during winter cereals development stages "sowing-germinating-tillering" are below optimal values, and above in periods after tillering. The expected increase in air temperatures in autumn-winter-spring period, and growth in content of CO_2 in general will be favorable for formation of winter cereals yields, although increase in summer air temperatures will has adverse impact.

[41] FAO. Drought. Situational Analysis by Uzbekistan. VA-12-LAND&WATER-UZB(2013), 2013.
[42] F.A. Muminov. Weather, Climate and Cotton. – L.: Hydrometeoizdat, 1991. – 191 p.

The most probable impact from increase in average air temperatures on *winter cereals*, growing on rainfed lands in low mountains will be decrease in their productivity, associated with increase in total evapotranspiration, accelerated plants development and reduction in period of yield formation. Decrease in precipitation amount will strengthen unfavorable impact of air temperatures increase.

Other crops. Rice production will depend on availability of water in the main rice growing regions: the Republic of Karakalpakstan, Tashkent and Syrdarya provinces. Potato, vegetables and melons are grown throughout the entire territory of Uzbekistan. Establishment of an average daily air temperatures at the levels of + 6ºC, + 12ºC, and + 15ºC is considered as beginning of vegetation period for potato/cabbage, tomatoes, and melons and water melons respectively. Shift in dates of spring frosts occurrence back towards winter is favorable for early ripening vegetables, potato and melons varieties, since it allows planting these crops in earlier dates due to predicted spring warming. This together with increase in duration of vegetation period by 10-15 days (up to 25 days by the extreme scenario) will facilitate productivity growth.

Alfalfa, the most important fodder and land fertility improving crop, is well adapted both to cold year period and high air temperatures in summer. With the optimal water availability, increase in duration of vegetation period and CO_2 content in air will facilitate growth in alfalfa productivity.

Orchards and vineyards occupy considerable land area and are located in the piedmont areas predominantly. Pome and stone fruit trees and walnuts relatively easy tolerate cold winters. However, winters in some piedmont areas and in the north of Uzbekistan are too cold for vineyards. The expected increase in winter air temperatures will allow expanding land area under vineyards on account of development of new piedmont land areas and decreasing in area of winter frost-protected vineyards. It is expected that increase in summer air temperatures will have positive impact on sugar content in grapes.

Possible crop yield losses. In perspective, if water deficiency will not allow to full extent meet the increased crop water requirements it is expected decrease in yields of main crops (Figure 4.37).

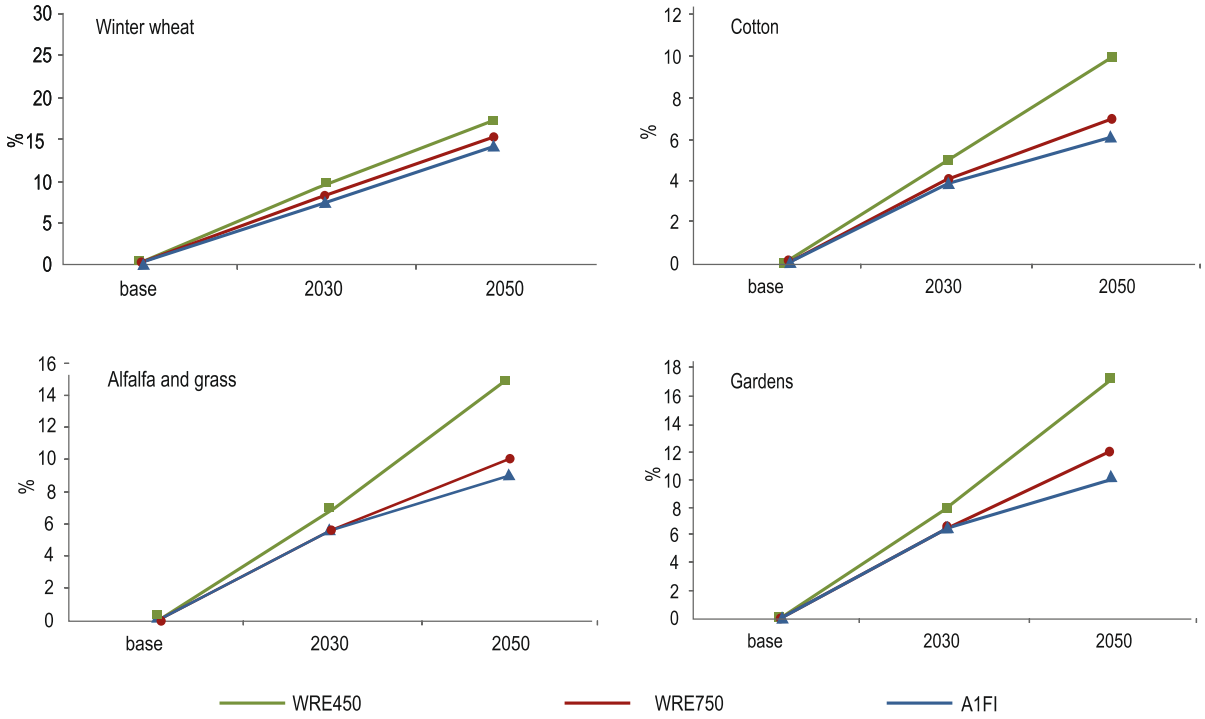


Figure 4.37 | *Yield Losses (in % from base norm) from Insufficient Water Availability in Accordance with GHGs Emission Scenarios*

Based on calculation results the following average yield losses are expected:

- *cotton* – by 4-5% and 6-10% by 2030, and 2050 respectively;
- *winter wheat* – by 7-9% and 14-17% by 2030, and 2050 respectively;
- *alfalfa/grasses* – by 6-7% and 9-15% by 2030, and 2050 respectively;
- *orchards* – by 6-8% and 10-17% by 2030, and 2050 respectively.

According to estimation of the World Bank (2013) the expected combined impact of three stress factors (direct impact of changes in air temperatures and precipitation amounts, increase in water demands, and decrease in water supply) on crop yields by three climatic scenarios is presented in Table 4.13 below.

Table4.13 | *Combined Impact of Climate Change on Crop Yields by 2040-2050 by Climatic Scenarios, %*

	Desert and Eastern Steppe			Desert and Western Steppe			Piedmonts, South-western Part			Piedmonts, Eastern Part		
	L	M	H	L	M	H	L	M	H	L	M	H
Alfalfa	-2	-2	-33	-13	-16	-28	-13	-17	-28	-24	-1	-39
Fruits	-13	-12	-49	-23	-22	-39	-20	-25	-42	0	-18	-63
Cotton	-11	-10	-36	-19	-20	-31	-16	-21	-32	-3	-17	-49
Potato	-11	-10	-41	-12	-21	-37	-19	-23	-37	0	-16	-57
Tomato	- 8	-9	-45	-21	-23	-38	-14	-24	-40	-2	-18	-56
Winter wheat	-1	-2	-40	-13	-20	-32	-17	-21	-43	-19	-7	-42

Source: William R. Sutton…[et.al.]. IBRD/WB. Reducing the vulnerability of Uzbekistan's agricultural systems to climate change: impact assessment and adaptation options, 2013.
Note: Indication of climate impact scenarios ("L" –low impact, "M" – medium, "H" – high)

Assessment of climate change impact on pastures and cattle breeding sector. Climate change affects cattle breeding sector through decrease in pastures productivity, change in grazing conditions, worsening of physical conditions of animals and formation of forage supply.

Current conditions of grassland farming and pastures. Grassland farming is mainly concentrated in desert pastures (81.3%), productivity of which is 0.1-0.27 t/ha of dry matter. Productivity of high mountain pastures with cattle grazing in spring-summer and low mountain pastures with all-year-round grazing is slightly higher and may reach 0.35-0.73 t/ha of dry matter.[43] In favorable years yield of pasture vegetation is doubled, and in unfavorable ones it decreases by 2-3 times. In years with minimum yields the pressure on pastures increases especially. Cattle breeding sector is developing rapidly. Cattle number is growing, which entails increase in pressure on pastures, overgrazing, decrease in forage productivity and degradation of vegetation.

Expected changes in pastures productivity for 2030-2050. The predicted climate change towards warming will impact yields of pasture vegetation and cattle grazing conditions. Increase in air temperatures by 2050 will lead to shift in date of vegetation period beginning back towards winter by 8-10 days (and by 15 days by the extreme scenario). As a result, vegetation period will be shifted towards moister year period with intensive precipitations (March-April). This will create more favorable conditions for development of pasture vegetation. In the years with precipitation amount above norm and increase in air temperature by 2-4°C intensive vegetation growth and increase in yields by 0.1-0.2 centner/ha will be observed. In the years with precipitation amount within norm, increase in air temperature will practically have no effect on pasture yields. In dry years increase in air temperatures will have adverse impact on pasture vegetation, aggravated by cattle overgrazing.

The predicted increase in air temperatures will be more pronounced in winter period. Shifting in dates of stable transition of air temperature over 0°C towards later time in autumn and earlier dates in spring will shorten duration of winter period in southern and eastern parts of desert areas and in semi-desert zone by 2-3 decades, in central part of desert areas – by 2 decades and in northern parts – by 1 decade. Increase in air temperatures by 2050 will lead to formation of vegetative winters. Vegetative growth of ephemeral plants, started in autumn, will be continued in winter period. However, winter vegetative growth will not facilitate better development of vegetation in spring, and therefore, yields of ephemeral pastures may be decreased. Increase in air temperatures in warm half year along with decreased water availability will worsen conditions for formation of forage supply and create difficulties for the cattle breeding sector.

Thermal stress impact on health of animals and grazing condition. Along with feeding regime for animals, the important factor influencing productivity of cattle breeding is meteorological conditions, which identify thermal stress on animals, their immunity to diseases, development and weight increment. Considerable change in usual living environment for animals leads to overheating or overcooling of their organisms. This is especially important for the grassland farming, when animals all-year-round are grazing in the open air.

The expected increase in air temperatures will aggravate the already observed enhancement of thermal stress on animals in summer period, because it will be increased not only degree of stress, but also number of abnormally hot hours per day. The most important feature for assessment of grazing conditions is number of hot days with prolonged impact (more than 6 hours) of high air temperatures. With increase in air temperature by 1-3°C number of such days may rise by 0.4-1.2 days in 10 days against the current

[43] CACILM, SLM-IS. Second Annual National Report on the Status of Land Degradation, 2009. – 42 p.

level. Increase in duration of impact of unfavorable hot conditions with entail decrease in animals weight increment, and from certain moment even weigh losses.[44]

On the other hand, increase in air temperatures will make winter period shorter and warmer. This will create more favorable conditions for cattle overwintering.

However, changes in temperature regime, precipitation amount and air humidity may stipulate outbursts of various plants and animals diseases, as well as propagation of certain pest varieties, e.g. acridoid grasshoppers. During outbursts of mass reproduction, locusts damage agricultural crops, natural pastures and other vegetation. Therefore, probably in future pasture vegetation and crops will be subjected to impact of pathogenic flora and fauna.

Hence, as a result of climate change impact it will be observed further decrease in pastures productivity, increase in thermal stress to animals and other associated problems, solution of which will require financial inputs.

4.3.3 Response Measures and Adaptation Priorities

High vulnerability of agriculture and water resources management sector to climate change has identified selection of priorities, main directions and set of measures for adaptation to future climate impacts.

Growing pressure on water resources is stipulated by climatic, hydrologic and socio-economic changes. Uzbekistan is attributed to a zone of risky agriculture, since over 90% of crop yields are produced on irrigated lands. Therefore, decrease in runoff of rivers in the Amudarya and Syrdarya river basins will enhance competition for water between developing sectors of economy, which may constitute a threat to the country's food security and environment.

Adaptation of agriculture to deficiency in water and land resources in climate change conditions and intensive population growth is the important component of Uzbekistan's policy. The key task in covering domestic demand for foodstuff is to increase efficiency of use of available water and land resources without threat to sustainable functioning of vital ecosystems.

The described below measures and actions, reflected in the Development plans and strategies, and aimed at improvement of land and water resources management, increase in agricultural lands productivity, as well as water saving policy, may increase considerably the adaptive capacity of the country.

Agricultural policy of the Government is aimed at liberalization and deepening economic reforms through further implementation of institutional transformations, expanding rights and economic independence of agricultural producers, development of Water Users Associations.

Figure 4.38 | *First International Horticultural Fair*

Due to recurrent occurrence of dry years over the recent period, stable growth in world market prices for food commodities, as well as for further increase in volume and assortment of food crop production in the republic, improvement in meeting population demands for foodstuff, and eventually increase in rural population incomes and welfare, the government corrected the priorities in favour of food crops production on the areas for cotton.[45] The unified system for growing, production and procurement of horticultural products is forming; volume of these products export is increasing and expanding. It was established the state order for procurement of horticultural products, potatoes, melons and grapes.

Over the last 10 years more than 25 legislative acts have been adopted aimed at support to development of reforms and transformation in agriculture and water resources management sector, improvement in land and water resources use and overcoming impacts of dry years and facilitating sustainable land management. The main regulatory legal acts, facilitating development of agriculture are presented in Table 4.14.

[44] Centre of Hydrometeorological Service at Cabinet of Ministers of the Republic of Uzbekistan. Assessment of Climate Change by Territory of Uzbekistan, Elaboration of Methodological Provisions on Assessment of Natural Environment Vulnerability. – Issue No.5, 2002.

[45] Decree of the President of the Republic of Uzbekistan No. UP-4041, dated 20 October 2008 "On Measures for Optimization of Crop Areas and Increasing Food Crops Production"

Table 4.14 | *Main Regulatory Legal Acts in Area of Agriculture Development*

Documents	Content
"Land code of the Republic of Uzbekistan" (dated 01 July 1998) Law of RUz "On private farm" (No.602-I, dated 30 April 1998) Law of RUz "On dekhkan farm" (No. 604-I, dated 30 April 1998)	It is identified the legal framework for establishment and operation of new economy entities in agriculture, oriented on radical changes in production, economic and labor relations in agriculture, and speeding up process of formation of real property owners
Decree of CM No.PKM-290, dated 21 June 2003 "On improvement of activities of Ministry of agriculture and water resources of the Republic of Uzbekistan" Decree of CM No.PKM-320, dated 21 July 2003 "On improvement of water resources management"	Transition from administrative territorial to river basin based two level irrigation management with introduction of market relations at all levels of water use
Decree of the President No UP-3932, dated 29 October 2007 "On measures for radical improvement of system for ameliorative land rehabilitation" Decree of the President No PP-817, dated 19 March 2008 :On state program for ameliorative improvement of irrigated lands for period 2008–2012"	Formation of system and integrated approach to implementation of measures for improvement in productivity of irrigated lands through construction and rehabilitation of I&D infrastructure, decreasing problems of soil salinization and water logging. Establishment of Fund for ameliorative improvement of irrigated lands under the Ministry of finance
Decree of the President No PP-842, dated 21 April 2008 "On additional measures on incentive for increasing cattle population in households of private and dekhkan farms and expansion of livestock production"	Decree is aimed at increase in number of cattle heads in aid of ensuring population employment and foodstuff supply. Conditions for lending lax credits and tax and customs benefits for cattle breeding farms had been identified.
Decree of the President No UP-4478, dated 22 October 2012 "On measures for further improvement activities and development of private farming in Uzbekistan"	Improvement of economic independence and financial sustainability of private farms, provide encouragement to farmers in rational use of land and water resources, increase in level of mechanization and profitability on account of introduction of the advanced technologies, as well as creation and development in rural areas new enterprises and services sector.
Decree of the President No PP-1958, dated 19 April 2013 "On additional measures for increasing efficiency of ameliorative irrigated land improvement and rational use of water resources "	The Governmental program for improvement of ameliorative conditions of irrigated lands and rational use of water resources for 2013-2017, was approved. Implementation of the Program will lead to increase in soil fertility and crop yields
Decree of the President No PP-2460, dated 29 December 2015 "On measures for further reformation and development of agriculture for period 2016-2020"	Decrease over the period 2016-2020 of land areas under cotton by 170.5 thousand ha and under cereals by 50 thousand ha in favor of food crops. Efficient development of horticultural sector on account of introduction of intensive technologies, drip irrigation systems, selection of new crop varieties with use of advanced biotechnology methods
Decree of the President No PP-2520, dated 12 April 2016 "On measures for improvement of system for procurement and use of horticultural products, potato and melons"	Formation of integrated system for growing, production and procurement of horticultural products, increase in volumes and assortment of exported horticultural products. Establishment of the state order for procurement of horticultural products, potato, melons and grapes.

Water management policy. According to the current legislation of the Republic of Uzbekistan, state management of water resources is carried out by the Cabinet of Ministers, Ministry of Agriculture and Water Resources (MAWR), Uzhydromet, State Committee for Nature Protection and local governmental authorities under supervision of the Oliy Majlis commission.

MAWR develops and implements the unified agro-technical and investment policy aimed at modernization and sustainable development of agriculture and water management sectors, as well as improves and introduces the advanced technologies in agricultural production.

Water relations are regulated by the package of laws adopted by the Government of the Republic of Uzbekistan right after gaining of independence in 1991, as well as by mechanisms of their implementation. Water management policy of Uzbekistan is aimed at rational use and protection of water resources, increase in efficiency of guaranteed water delivery and provision of necessary services to communities and natural ecosystems by allocation of resources for reconstruction, operation and maintenance of existing infrastructure. Solution of problem with water deficiency and necessity for water saving is one of the main priority of water policy being implemented in accordance with the Law "On water and water use" and a number of Governmental Decrees (Table 4.15).

Table 4.15 | *Main Governmental Documents related to Development and Improvement of Water Management Sector*

Date and number	Governmental Documents
Law of RUz No 837-XII, dated 06 May 1993	"On water and water use" (edition of 25 December 2009)
Law of RUz No.240, dated 25 December 2009	" On amendments to some legislative acts of the Republic of Uzbekistan in context of deepening economic reforms in agriculture and water management sectors"
Decree of the President of RUz No.UP-3932, dated 29 October 2007	"On measures for radical improvement of system for irrigated lands amelioration"
Decree of the President of RUz No.UP 4478, dated 22 October 2012	"On exemption of legal entities that introduced drip irrigation system from unified land tax for 5 years related to land plot part with drip irrigation system"
Decree of the President of RUz No.PP-718, dated 31 October 2007	"On establishment of Fund for ameliorative improvement of irrigated lands under the Ministry of Finance"
Decree of the President of RUz No.PP-1958, dated 19 April 2013	"On measures for further irrigated lands improvement and rational use of water resources for period 2013-2017"
Decree of the Cabinet of Ministers of RUz No. PKM-385, dated 3 August 1993	"Temporary order for limited water use in the Republic of Uzbekistan"
Decree of the Cabinet of Ministers of RUz No. PKM-290, dated 21 June 2003	"On improvement of activities of Ministry of agriculture and water resources"
Decree of the Cabinet of Ministers of RUz No. PKM-320, dated 21 July 2003	"On improvement of water resources management in the Republic of Uzbekistan"
Decree of the Cabinet of Ministers of RUz No. PKM-82, dated 19 March 2013	"On approval of provision on water use and consumption in the Republic of Uzbekistan"
Decree of the Cabinet of Ministers of RUz No. PKM-176, dated 21 June 2013	"On measures for efficient introducing and financing drip irrigation system and other water saving irrigation technologies"
Decree of the Cabinet of Ministers of RUz No. PKM-41, dated 25 February 2014	"On additional measures for provision of settlements with quality drinking water"

Currently in aid of ensuring proportional, stable and guaranteed water delivery the principles of integrated water resources management (IWRM) are actively introducing, which enabling increase in water use productivity, growth of population incomes, enhancement and conservation of environment.

Basis for reformation of water management sector is confirmed by the Decrees of the Cabinet of Ministers of RUz about transition from administrative/territorial to more flexible basin water resources management with introduction of market relationships at all levels of water use. According to these Decrees it had been established ten Basin Irrigation Systems Administration (BISAs) and Main Canals Administration (MCA) in Fergana valley, comprising the Dispatch Center and 52 Irrigation System Administrations (ISAs). Inter-basin runoff redistribution is used for improvement of water availability in regions with water deficiency. E.g. part of districts located in the Kashkadarya river basin receive water through canals from Zerafshan river; lands located at the downstream reaches of the Zerafshan river are irrigated by water from Amudarya river through the Amu-Bukhara irrigation system.

The most important component of institutional reforms and reorganization in water sector is establishment of Water Consumer Associations (WCA), which is rather new, vitally important type of non-governmental organization for operation and maintenance of on-farm irrigation and drainage systems. There are currently 1,502 WCAs with the total service area of over 3.7 million ha in Uzbekistan.[46]

Establishment of the Fund for ameliorative improvement of irrigated lands under the Ministry of finance is the most important mechanism for facilitating efficient use of land and water resources and increasing agricultural production. The Fund's proceeds (USD100 million annually) are used for implementation of measures envisaged by the Governmental program for ameliorative improvement of irrigated lands for periods 2008-2012 and 2013-2017. This Program envisages implementation of set of measures on account of internal sources of financing for the total amount of 1,780,555 million Soum, including state budget funds (56%), O&M organizations of MAWR (21%), WCA and private farms (20%), and credits and own money of commodity producers (3%).[47]

The country implements such managerial measures as diversification of agricultural production with transition to low water consumptive crops and limited water use, aimed at rational and efficient use of water resources.

[46] Data from the Ministry of Agriculture and Water Resources, 2016.

[47] Sh.R Khamraev. The report "Water Resources of Uzbekistan in Overcoming Destabilizing Factors on the Basis of Innovation and International Eater Law." – Regional Internationla Conference "Towards the 6th World Water Forum". – Tashkent, 2011.

Instead of water consumptive crops, such as cotton, rice and alfalfa, it was increased land area under less water consumptive crops, i.e. cereals, melons and others. If at the beginning of 1990s around 50% of irrigated lands was occupied by cotton, currently share of cotton in cropping pattern is 35.8%, which allowed decreasing water intake in the country from 64 to 52 km^3 per year.[48]

Policy and activities aimed at drought control. As indicated by studies, climate warming is accompanied by increase in duration and frequency of droughts, threatening food and ecological security. Therefore, development of system for droughts management and mitigation of their impacts is required in order to prevent extensive damages to economy and population. In Uzbekistan measures for drought control are carried out as response to crisis situations. Risks management and Droughts early warning system, including set of measures for impact mitigation and prompt response are in development stage. There are sufficiently developed organizations in Uzbekistan (Ministry of Emergency Situations, Uzhydromet, MAWR, etc.), and established scientific base. Uzbekistan is responsible for creation of sub-regional droughts early warning system.

In 2007, Uzbekistan has proposed to create on the basis of this system the *Central Asian Regional Center for Drought Control*, which was supported by the Secretariat and GM UNCCD, OSCE and CA countries. The Center is the advisory and consultative body on issues of drought monitoring, forecasting, creation of early warning systems and ensuring readiness to drought. In 2011-2015, it was implemented the regional UNDP project *"Climate Risks Management"*, aimed at improvement of local communities' possibilities for adaptation to climate change. The droughts early warning system (DEWS) for Uzbekistan was developed under this Project. This DEWS has became a pilot model for CA countries.[49]

In 2013, Uzbekistan supported the provisions of joint WMO, UN CCD and FAO Program document "National Policy for Drought Control".[50] Implementation of such program approach will allow shifting focus from response measures (actions in crisis situation) to preventive measures, ensuring decrease in vulnerability and readiness to drought. This will facilitate and attract more attention to development of droughts monitoring and forecasting systems with the aid of specialized hydro-meteorological and agro-meteorological observations.

Measures and activities. Within the framework of annually approved Investment program, which is implemented on account of allocations from the centralized capital investments and financing from Fund for reconstruction and development, the priority projects are being implemented, including in agriculture and water resources management sector, and production processing. Currently, more than 100 projects and sectoral programs have been accomplished or being implemented in Uzbekistan, which are aimed at rational use of land and water resources, and combating land desertification, degradation and salinization. The total amount of technical assistance funds, allocated by the international institutions and donors during last 10 years is more than USD210 million.

Rehabilitation of irrigation and drainage infrastructure, financed by the Amelioration Fund, has allowed to improve ameliorative conditions of irrigated lands on the area of more than 1.2 million ha, and decrease soil salinity degree on the land area of over 750 thousand ha, which led to decease in water consumption for soil leaching and increase in main crop yields by 8.0-8.5%.[48] Implementation of plans for transition to drip irrigation on account of state financing and lax crediting for farmers has ensured introduction of this irrigation method on land area around 10 thousand ha. For further development of this technology in 2013-2017, it is additionally planned to introduce it on the land area of 25 thousand ha, including new intensive orchards and vineyards.

Under the World Bank investment Project: "Drainage, Irrigation and Wetlands Improvement" 2005-2010, in the Republic of Karakalpakstan it was implemented such technical solution as closedown of the Beruniy pump station and re-orientation of Beruniy collector for gravity flow of drainage water to the Aral Sea. This solution facilitated improvement of water quality on the Amudarya river and provided benefits to water users and natural ecosystems of Priaralie. Implementation of this Project is the actual contribution of the Government of Uzbekistan in fulfillment of the bilateral Agreement, signed with the Republic of Turkmenistan on 16 January 1996, regarding joint and rational use of water resources of the Amudarya river.

From 2006, the Program for assistance to Central Asian countries in implementation of the UN Convention to Combat Desertification operates in Uzbekistan - *the Central Asian Countries Initiative for Land Management (CACILM)*. CACILM is 10-year Program of projects and activities aimed at strengthening and promoting approaches and practice of the *Sustainable Land Management (SLM)* and adaptation of agriculture to climate change impact.[51] The national and multilateral projects have been accomplished and being implemented in Uzbekistan. These projects are financed by donor funds (GEF, ADB, UNDP, GM UNCCD, GIZ) – members of Strategic partnership agreement CACILM.

[48] R. Mamutov. Improvement of Water Resources Management System in Uzbekistan and Development of Water Saving Technologies – Main Administration of Water Management of MAWR of RUz, 2011.

[49] UNDP Regional Drought Management Project, Uzbekistan, 2012-2014.

[50] V.E. Chub, U. Abdullaev, G. Khasankhanova and R. Taryannikova. Assessing Vulnerability to Agricultural Drought: The Case Study of the Uzbekistan. High Level Meeting on National Drought Policy (HMNDP) «Towards More Drought Resilient Societies». Session 5: Drought Vulnerability and Impact Assessment, 11-15 March 2013, Geneva, Switzerland.

[51] CACILM. Supplement to National Framework Program of the Republic of Uzbekistan. – Tashkent, 2009. – 148 p.

Works are carried out in order to improve control over water use: the Provision on order for issue of permit for special water use or water consumption[52] was approved by the Decree of the Cabinet of Ministers of the Republic of Uzbekistan in 2013. Measures for enhancement of ecological disaster zone are reflected in the Integrated program for mitigation of the Aral Sea disaster impacts, rehabilitation and socio-economic development of Priaralie Region for 2015-2018.[53]

Efforts of the governmental scientific and research institutes are aimed at development of scientific basis for rational use and protection of land and water resources, approach of science to production and introduction of resources saving technologies of irrigation and crops husbandry. As a result of conducted studies, it has been developed and approbated the improved technologies of furrow irrigation (discrete, surge, counter, alternate, stepped irrigations, with use of auxiliary irrigation facilities, mulching of furrow surfaces, etc.), which ensuring water saving and increasing irrigation efficiency.

In aid of innovative development of agriculture, funds allocated to agricultural science, have been increased by 15%. Creation of the intensive type cotton varieties, retaining their potential features and fiber quality in the condition of reduced water availability and soil salinization, is the strategic direction in the national selection science. Currently the new cotton varieties "C-6541", "Namangan-34", "Turon", "Guliston", "C-2510", "Istiklol-13", "Shodiyona", "Surkhon-102" and others are being introduced into production. 27 new wheat varieties have been included in the state register, and 29 varieties selected for adaptation. All these varieties are resistant to diseases, pests and droughts. The Scientific and research institute (SRI) of crop husbandry of Uzbekistan carries out studies on improvement of crops germplasm. More than 100 varieties of vegetable crops, provided by the World crop husbandry center (including soybean, green gram, pepper) have been tested. Implementation of program for domestication of wild-growing halophytes and salt resistant plants has been commenced in the Central part of Kyzykum desert.

Examples of good practice in SLM for adaptation to climate change. The most efficient and acceptable technologies and approaches, adapted in Uzbekistan under the CACILM program with support from the international donors, are collected and documented to make them available for replication and large-scale use. These technologies are grouped by the following directions: improvement of irrigated land fertility, prevention of erosion, improvement of crops sowing and land tillage methods, agricultural afforestation, water demand management, improvement of pasture productivity/forage production, capacity building of land users and environmental education.[54] Approaches and technologies, which are the most indicative examples of adaptation in various land use systems, are included in the WOCAT[55] world database (Table 4.16).

Table 4.16 | *Approaches and Technologies of the Republic of Uzbekistan included in WOCAT Database*

Technology Description		
Land improvement in arid conditions through establishment of pistachio plantations GEF Small Grants Program (SGP / GEF), 2009 *http://cdewocat.unibe.ch/wocatQT/qt_summary.php?qt_id=614*	 Adyr lands of Uzbekistan	 Pistachio plantation on adyr land
Use of artesian mineralized water *Samarkand institute of Karakul Sheep Raising and Desert Ecology (Component "ICARDA Studies 2007-2009")* *http://cdewocat.unibe.ch/wocatQT/qt_summary.php?qt_id=616*	 General view of artesial well and halophyte field, irrigated from well	

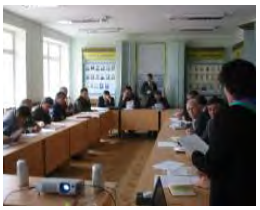
[52] Decree of the Cabinet of Ministers of RUz No. PKM-171, dated 14 June 2013, "On Approval of Order for Issue of Permit for Special Water Use or Water Consumption" // Law Book of RUz, 2013, No 25, p. 325; 2015, No 1, p. 9

[53] Decree of the Cabinet of Ministers of RUz No. PKM-255, dated 29 August 2015, "On Integrated Program for Mitigation of the Aral Sea Disaster Impacts, Rehabilitation and Socio-Economic Development of Priaralie Region for 2015-2018" // Law Book RUz, 2015, No 35, p. 469; 2016, No 9, p. 91

[54] ICARDA/IFAD/CACILM. Technologies and Approaches to Sustainable Land Management in Central Asia. – 2015.

[55] WOCAT – World Review of Approaches and Technologies

Table 4.16 Continued

Technology Description	
Agricultural afforestation of degraded arable lands *Project of UNSCO/ZEF (Bonn), 2002-2012.* *http://cdewocat.unibe.ch/wocatQA/SummaryApproach.php?selected_id=386*	   a) b) c) Plot condition: a) initial, б) after 2 years, в) after 7 years.
Rotation of pastures in desert regions of Uzbekistan *UNDP-GEF/Government of RUz Project "Achievement of Ecosystem Sustainability on Degraded Lands in Karakalpakstan and Kyzylkum Desert" (2008-2011)* *http://cdewocat.unibe.ch/wocatQT/qt_summary.php?qt_id=615*	  a) б) a) Inspection of cattle watering well, b) Sheep stock on allocated part of pasture
Field Farmer Schools (FFSs) in irrigated zone *FAO TCP/UZB/2903 Project "Integrated Management for Sustainable Use of Saline and Gypsum-Bearing Soils" (2002-2004.)* *http://cdewocat.unibe.ch/wocatQA/SummaryApproach.php?selected_id=393*	   Three stages of FFSs creation: a) Development of training programs; b)Train the trainer for FFSs; c) Trainings for farmers
Community managed forestry in Karakalpakstan *UNDP/GEF Project "Conservation of Tugay Forests and Strengthening Protected Nature Territories* in Amudarya River Delta in Karakalpakstan", 2007 *http://cdewocat.unibe.ch/wocatQA/SummaryApproach.php/selected_id=386*	  Rehabilitation of degraded forest plots by local community

Source: WOCAT – World Review of Approaches and Technologies

4.3.4 Adaptation Measures in Agriculture and Water Resources Management Sectors

In all, the governmental policy and regulatory and legal framework reflect issues of agriculture adaptation to climate change, measures for combating desertification, land degradation and drought control. However, approaches and arrangements for planning and incentive provision are not sufficiently flexible, implemented not to the full extent, insufficient resources are allocated for regeneration and maintenance of productivity of rainfed hayfields, pastures, forests, especially in the areas affected by droughts and desertification.

To increase sustainability of agriculture to future climatic threats it is proposed 4 priority directions of activities, comprising set of institutional, technical, economical and environmental measures. The main objective of adaptation measures is to create such agricultural production systems, which will be able to operate in the climate change conditions without substantial change in their initial conditions. Certain financial inputs, mobilization of efforts and purposeful cooperation of all the parties concerned will be required in order to overcome future crisis situations.

The following technical and technological adaptation measures and actions have been distinguished as priority ones: improvement of water use, introduction of water saving technologies, rational use of land and water resources, rehabilitation/upgrading irrigation and drainage infrastructure, crops diversification and selection of new crop varieties, introduction of new innovative agro-

technologies, and agricultural afforestation. Improvement and rational use of pastures, and new pedigree animal breeds will allow ensuring sustainability of cattle breeding to unfavorable climatic conditions and retaining its productivity. Hence, with certain inputs the country's agriculture is capable for adaptation to and overcoming the adverse impacts of climate change. Target tasks and measures by these priority directions are presented in Table 4.17 below.

Table 4.17 | *Priority and Adaptation Measures in Agriculture*

Target Task	Measures and Actions	Perspective
Priority 1. Improvement of legal and institutional framework, planning and integration of adaptation issues into development plans		
Strengthening of institutional and human capacity, and knowledge transfer system	Development of program for institutional support to measures of adaptation to climate change	S-M
	Establishment of informational/analytical center on adaptation, sustainable land and water resources management, exchange of information and technologies transfer	S-M
	Preparation of package of training modules in legislation in area of adaptation and its introduction through the state training programs	S-M
Integration of adaptation issues into national and sectoral development plans and programs	Development/preparation of national action program for adaptation to climate change	S-M
	Upgrading existing sectoral development programs and plans	S
	Strengthening of national, regional and international inter-sectoral relations and cooperation	S-M
	Development of incentive system for farmers and local communities for involvement in process of SLM technologies	S-M
Priority 2. Establishment of climate resistant systems of agricultural production		
Development of scientific studies in area of agriculture adaptation to climate change	Selection/genetic works for breeding crop varieties and animal species tolerant to extreme climatic conditions	S-M
	Improvement of monitoring, forecasting and warning methods of various earliness about dangerous weather phenomena and droughts	S-M
Introduction of advanced agro-technologies and approaches	Introduction of advanced agro-technologies for land tillage: minimum and zero soil tillage	L
	Development of agricultural afforestation and agroforestry	M
	Phytomelioration and other methods of severely degraded pastures regeneration	S-M
	Rotation of pastures, maintenance of normative load on pastures	S
	Use of measures ensuring mitigation of extreme weather conditions on organism of animals	S
	Replacement of low productive cattle breeds by pedigree breeds	M-L
Improvement in efficiency of irrigation water use	Accumulation of rain waters and construction of reservoirs for accumulation and storage of surface runoff	S
	Rehabilitation and upgrading of irrigation and drainage infrastructure and pump irrigation systems	S
	Introduction of integrated water resources management at all levels of water use	S
	Use of drainage and underground waters	S-M
	Introduction of water metering system and improvement of water distribution between water users	S
	Introduction of improved furrow irrigation methods	S
	Broad introduction of water saving irrigation methods (drip irrigation, sprinkler irrigation)	M-L
	Correction of water use norms with use of scientifically based programs (CROPWAT, ISAREG) and compliance with normative irrigation regime	S
Economically expedient cropping pattern	Selection of economically expedient cropping pattern, correction of planting dates	S
	Introduction of new drought and salt resistant crops Development of halophyte plants growing	M
	Formation of agrophytocenosis, scientifically based selection of plant communities	M
Improvement of hydro-meteorological service	Development of network for hydro-meteorological and agro-meteorological monitoring for improvement of droughts forecasting	M
	Introduction of early warning system about unfavorable weather conditions	M
	Development of snow cover monitoring. Expansion of satellite data use and introduction og GIS technologies for rivers runoff forecasting.	

Table 4.17 Continued

Target Task	Measures and Actions	Perspective
Priority 3. Mitigation of land degradation associated with the Aral Sea drying up		
Rehabilitation of ecosystems in the Aral Sea basin taking into account requirements of local communities	Support to stabilization of dried sea bottom and the Amudarya river delta, preservation of biodiversity and protection of aquatic ecosystems and wetlands	S-M
	Establishment of wind protection tree belts for mitigation of wind erosion, salt and dust storms	M-L
	Improvement of conditions for development of fishery and support to alternative sources of income	S-M-L
Priority 4. Involvement of public/communities in implementation of adaptation measures		
Capacity building, improvement public / communities awareness about climate change	Development of program for public/communities participation and information about issues of climate change and adaptation measures	S
	Development of system for demonstration of advanced experience in nature resources management (training courses, seminars, round tables)	S
	Development of educational programs for targeted groups (school graduates, students, teachers, women, NGOs, mass media)	S
	Implementation of programs for training of farmers	S
	Maintenance and development of possibilities for use existing internet resources, creation of electronic knowledge libraries	S-M

Notes: S- short-term perspective, M- medium-term perspective, L –long-term perspective.

4.4 Dangerous Hydrometeorological Phenomena

Results of a number of studies indicate that global warming lead to enhancement of climate extremeness and increase in number of dangerous hydro-meteorological phenomena. Evidences of close correlation between anthropogenic climate change and growth in frequency and intensity of abnormally hot periods, heavy precipitations, floods and other dangerous hydro-meteorological phenomena, leading to climatic disasters, are provided in the Fifth IPCC Assessment Report.

Uzhydromet carries out the systematic observations and registration of dangerous hydrometeorological phenomena in Uzbekistan since the end of 19th century. Archives and database of these observations are the basis for preparation of the chapter "Dangerous hydro-meteorological phenomena in the annual State Cadastre of zones with increased natural danger.

The most extensive phenomenon for Uzbekistan in terms of territory coverage, affecting all groups of population, is drought, which may lead to considerable economic losses and decrease in production of food crops. Amongst the most dangerous local hydro-meteorological phenomena are avalanches and mudflows, which cause significant economic damage and loss of people's life.

Due to unevenness of precipitations distribution and complicated orography, risks of dangerous hydro-meteorological phenomena occurrence vary by the country's territory and depend on rates of climate change. In general, value of risk is identified by probability of dangerous phenomenon occurrence and scale of its negative impacts. Adoption of preventive measures will decrease risk of dangerous hydro-meteorological phenomena. In Uzbekistan due to its high climatic vulnerability, climate change will be accompanied by increasing risks of occurrence of droughts, "heat waves", heavy rains, floods and mudflows.

Assessments of probable dangerous hydro-meteorological phenomena variability on background of increasing air temperatures have been carried out within framework of the SNC preparation and under implementation of the technical assistance projects and scientific studies. Results of these studies are the basis for below analysis of climate change impact on frequency and scale of dangerous hydro-meteorological phenomena by the country's territory with use of various climatic scenarios.

4.4.1 Drought

Drought is characterized by high air temperatures with small precipitation amount. During drought the prolonged lack of precipitation in combination with high air temperatures and decrease in air humidity leads to disturbance of plants water balance and causes their suppression or demise. Droughts are also accompanied by decrease in volume of available water resources and deterioration of their quality, recession of groundwater table. At the same time demand for water increases, especially for irrigated agriculture.

Territory of Uzbekistan is attributed to arid zone due to sharp climate continentality and large number of sunny days in year. It experiences severe deficiency of moisture: difference between evaporation rate and precipitation amount during vegetation period (April-September) varies by plain territory from 1,470mm (Kyzylkum desert) to 870mm (Fergana valley).[56]

[56] - T.Yu.Spectorman, Plotzen M.A. Climate Change Impact on Agro-Climatic Resources of Uzbekistan // Climate Change, Reasons, Impacts And Response Measures, Bulletin № 9, Tashkent 2015. pages 40-52.

Three types of drought are observed in Uzbekistan:

Hydrological drought is extreme water shortage during vegetation period that occurs due to acute deficiency in precipitation in the upper watershed of rivers and increased air temperatures in January-March.[57] This type of drought is the especially dangerous threat to the country's development.

Atmospheric or meteorological drought is characterized by the long and considerable shortage of precipitation compared with norm, increased air temperatures and high deficiency in air humidity. Such conditions may be observed on the territory of Uzbekistan in spring and practically during the entire summer period.

Soil drought is a phenomenon, when soil rooting depth is desiccated to such extent that causes crops suppression or demise. During soil drought moisture deficiency in plants is stipulated by discrepancy between plants moisture demand and its availability in soil.

According to studies carried out in the country,[58,59] over the recent time, it is observed rather high frequency of droughts occurrence, which impact practically all sectors of economy. Agriculture is the most vulnerable to drought economy sector, since more than 90% of crop yield is produced on irrigated lands. Share of population living on the drought subjected territories is around 75% from the total population size.[60,61]

Hydrological drought occurs with decrease in water inflow to water bodies and courses. Low water in rivers of Uzbekistan is formed with low precipitation amount in the rivers' upper watersheds and increased air temperatures during snow accumulation period. As the hydrological drought indices for the conditions of Uzbekistan are adopted:

- probability of runoff over vegetation period (April-September),
- value of water equivalent in snow cover in mountains as of end of February and March.[56]

As dry years are considered the ones with water flow probability of 90% and less from norm (the long-term average values).[62]

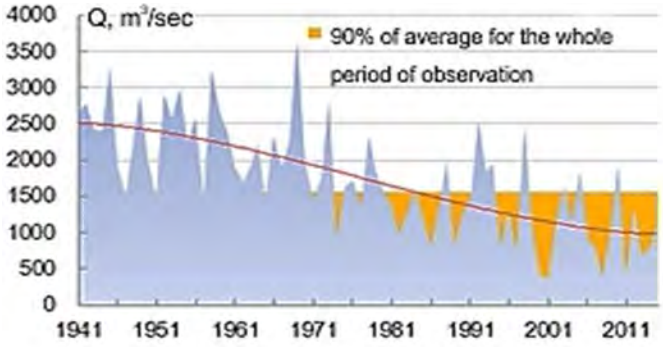


Figure 4.39 | *Change in Average Vegetation Runoff of Amudarya River at Tuyamuyun Gage Station*

Climate warming in the Syrdarya and Amudarya river basins is accompanied by increase in abnormally dry and hot periods affecting processes of forming and melting seasonal snow cover and glaciations, and therefore, frequency in occurrence of dry years and droughts. This is especially obvious in the lower reaches of Amudarya river, where impact of natural factors is aggravated by strong anthropogenic effect. In Figure 4.39 as an example it is demonstrated the long-term variation in water flow during vegetation period at Tuyamuyun gage station, which illustrate inflow of water to lower reaches of the Amudarya river. Yellow color indicates years, when average vegetation runoff was below 90% probability over the entire observation period. From this Figure it is clear that over the recent two 10-year periods the Khorezm province and Republic of Karakalpakstan are under constant threat of drought.

Climate change impact on frequency of dry years. Analysis of expected climate change impact on water resources has indicated considerable increase in risks of formation extreme shortage of water and droughts in Uzbekistan.

For the territory of Uzbekistan and river upper watersheds all climatic scenarios indicate probability of considerable increase in average annual and seasonal air temperatures, slight trends towards decrease in the total annual precipitation amount (some increase in winter and considerable decrease in other seasons) and substantial enhancement of inter-year variability[63] of both air temperatures and precipitation amounts.

Strengthening inter-annual variability of air temperatures and precipitations on background of intensive climate warming will stipulate general runoff reduction and enhancement of its variability, especially in small river basins. Assessments of probable extremely low values of river flow during vegetation period by 2050, obtained by quantiles for air temperature and precipitation in rivers upper watersheds (very warm and dry) for moderate GHGs emission scenario WRE750[64] are presented in Table 4.18.

[57] Chub V.E. Climate Change and its Impact on Potential of Natural Resources of the Republic of Uzbekistan – Tashkent: Uzhydromet, NIGMI, 2007. – 252 p.
[58] Drought. Situational analysis by Uzbekistan. VA-12-LAND&WATER-UZB, 2013.
[59] UNDP, Profile of Climate Risks in Uzbekistan – 2015. – 88 p. http://climatechange.uz/
[60] State Statistics Bulletin on Agriculture and Economy – Tashkent, 2011.
[61] CACILM. Supplement to National Framework Program of the Republic of Uzbekistan. – Tashkent, 2009. – 148 p
[62] Shultz V.L. Rivers of Central Asia. – L.: Hydrometeoizdat, 1965.
[63] Spectorman T.Yu Climate Change Scenarios for Territory of Uzbekistan and Upper Watersheds of Syrdaray and Amudarya Rivers. // Climate Change, Reasons, Impacts and Response Measures, Bulletin № 9, Tashkent 2015. pages 29-39.
[64] Klimov S. I., Mukhtarov Sh. T., Sergeeva O. A. Use of Remote Sensing Data for Long-Term Assessments of Mountain River Runoff in Central Asia // Climate Change, Reasons, Impacts And Response Measures, Bulletin № 10, Tashkent 2016. pages 35-40.

Assessments of rivers runoff for extreme GHGs emission scenario A1B using hydrological models of runoff formation in mountainous rivers indicate trend towards decrease in snow accumulation in the basins of mountainous rivers and considerable increase in frequency of dry years occurrence in future (Figure 4.40).[65] It should be noted that GHGs emission scenarios WRE750 and A1B pertain to moderate ones.

Due to expected decrease in rivers runoff and increase in water consumption in all sectors of economy (Chapters 4.2 and 4.3) and intensive growth of population, risks of formation extreme shortage of water and droughts in Uzbekistan will be increased considerably. In regions, located in lower reaches of rivers of the Amudarya river basin (Republic of Karakalpakstan, Khorezm and Bukhara provinces) hydrological droughts will be observes more frequently due to their remoteness from upper watersheds and many-year practice of intensive water use. Districts that depend on water supply from small rivers will turn out to be the most vulnerable ones.

Atmospheric drought is a consequence of heat waves and result of lengthy warming up and desiccation of air masses above vast areas of Central Asian deserts (Karakum, Kyzylkum deserts). High air temperatures, considerable increase in evaporation from open water surface, irrigated lands and pastures, and plants evapotranspiration are observed in days with atmospheric drought. Regular recurrence of such phenomena leads to high salts concentration in soil, increase in groundwater mineralization and desiccation of topsoil.

Daily air humidity deficiency scale ("slight" deficiency – more than 50-60 hPa, "moderate" – 61-70 hPa, "severe" – 80-90 hPa[66]) has been adopted for territory of Uzbekistan as index of drought intensity. Analysis of air humidity deficiency variations by meteorological stations of Uzbekistan indicates increase in area of outspread of this dangerous phenomenon.

Currently the largest number of days with droughts (more than 40 days) is observed in the Navoi, Bukhara, Kashkadarya and Surkhandarya provinces (Figure 4.42 – Current situation).

In summer period the rather close statistical relationship (Figure 4.41) between air temperatures (T_{max}) and humidity values (D) is observed in deserts and adjacent territories, which allows to assess possible changes in deficiency of air humidity in accordance with the climatic scenarios.

Table 4.18 | *Assessment of Extremely Low Vegetation Runoff (% of norm) by Uzbekistan's River with Materialization of WRE750scenario*

River - Station	Norm, m³/sec	2041-2060, %
Chatkal river – Khudoydodsay	195	57
Pskem river – Mullala	128	55
Akhangaran river - Irtash	36,0	64
Ugam river - Khodjikent	34,2	62
Surkhandarya river – Shurchi	99,6	70
Kashkadarya river – Chirakchi	24,6	34

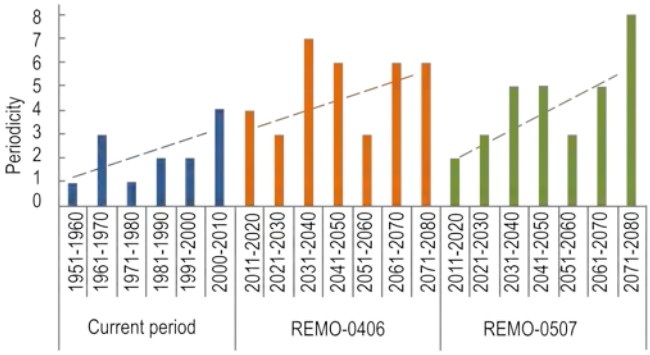


Figure 4.40 | *Variation in Frequency of Dry Years Occurrence in*

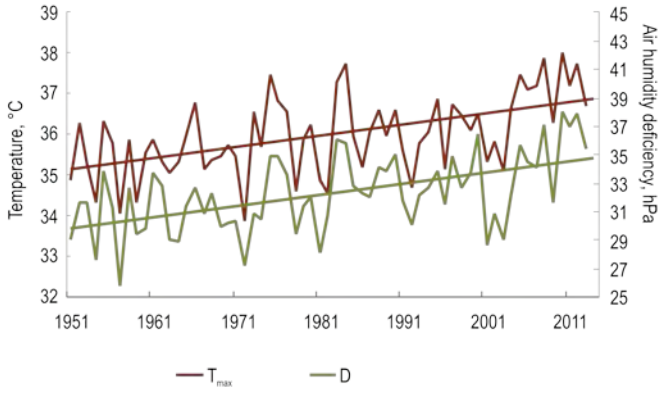


Figure 4.41 | *Variation in Average Maximum Air Temperatures and Air Humidity Deficiency during Summer Season in Tamdy Meteorological station (correlation coefficient between data arrays is 0,89)*

Based on the revealed correlations the schematic maps illustrating distribution of number of days with atmospheric drought have been plotted for future periods (2021-2040, 2041-2060, 2070-2090) by three climatic scenarios, assuming various levels of carbon dioxide concentration in atmosphere.

Schematic map of distribution by territory of Uzbekistan number of days with atmospheric drought for moderate greenhouse gases emission scenario WRE750 is presented in Figure 4.42 below.

[65] UNDP. Profile of climate risks in Uzbekistan – 2015. – 88 p. http://climatechange.uz/

[66] Chub V.E. Climate change impact on hydro-meteorological processes, agro-climatic and water resources of the Republic of Uzbekistan. –Tashkent. NIGMI, 2007

Current situation

Scenario WRE750, 2041-2060

Figure 4.42 | *Schematic Maps Illustrating Distribution of Number of Days with Air Humidity Deficiency D ≥ 50 hPa in Current Situation and by 2050, for Moderate GHGs Emission Scenario WRE750*

Land use map has been used for analysis of risks associated with increase in land areas subjected to atmospheric drought. Risks of atmospheric drought for arable lands, meadows and pastures have been considered.

Geoinformational analysis of spatial distribution of atmospheric drought obtained from data of climatic scenarios has indicated that area of agricultural lands (Table 4.19, Figure 4.43) with air humidity deficiency over 50hPa during 40 and more days may be increased.

As indicated by regional studies[67], large number of days with high air temperatures (above 35°C) on background of atmospheric drought lead to considerable decrease in crop yields in southern and central areas of Uzbekistan.

Table 4.19 | *Shares of Agricultural Land Areas Subjected to Atmospheric Drought during 40 and more Days per Year by Various Greenhouse Gases Emission Scenarios*

Land Use Type	Land Area Subjected to Atmospheric Drought during 40 and more Days per Year, %									
	1970-2010	WRE450			WRE750			A1FI		
		2030	2050	2080	2030	2050	2080	2030	2050	2080
Arable Lands	6	15	26	39	16	35	71	20	60	89
Meadows, Pastures	11	17	22	31	17	28	50	20	43	73

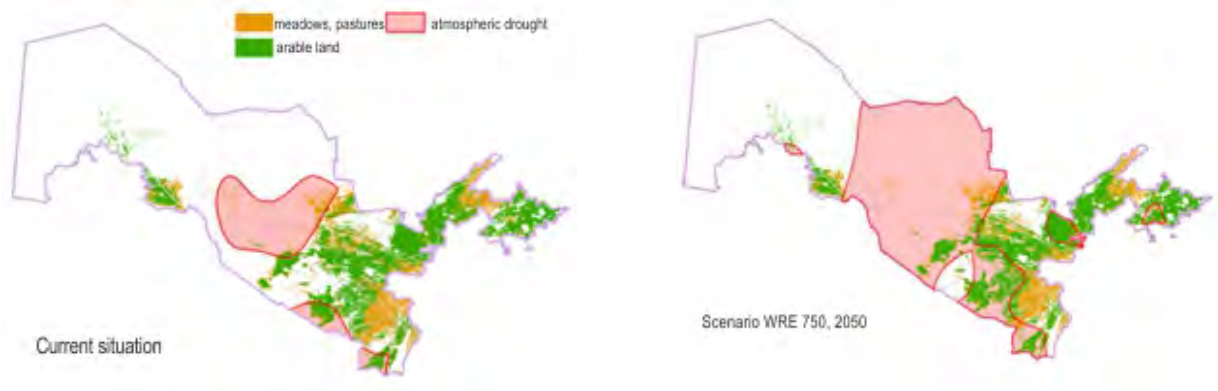


Figure 4.43 | *Schematic Maps Illustrating Risks of Atmospheric Droughts for Agricultural Lands in Current Situation and for Moderate Scenario of GHGs Emission WRE750*

From assessment results of changes in frequency of air temperatures above 35°C and 39°C, presented in Chapter 4.3.1, it follows that by territory of Uzbekistan even with materialization of soft greenhouse gases emission scenario WRE450, already by 2050s increase in frequency of air temperatures above 39°C by 1.5-2 times versus base period (1980-1999) is possible.

[67] Muminov F.A., Abdullaev Kh.M. Agroclimatic Resources of the Republic of Uzbekistan – Tashkent. SANIGMI,, 1997. – 178 p.

4.4.2 High Air Temperatures and "Heat Waves"

According to the IPCC assessments, one of the main risks of climate change that most likely Uzbekistan will face is the mortality risk associated with hot weather, indicator of which is frequency of heat waves occurrence.[68,69] In all year seasons the heat waves are accompanied by change in atmospheric pressure, which worsen health conditions of people suffering from cerebrovascular diseases. In summer period on background of stable hot weather the heat waves turn out to be "heat waves" dangerous for human health. Change in number of day with "heat waves" in Tashkent for long-term period, presented in Figure 4.44, indicates its considerable variations and high variability. Increase in number of days with "heat waves" is observed throughout the entire territory of Uzbekistan, with especially high increase rates in the Aral Sea littoral zone (Chapter 4.1), as well as in the Fergana valley and piedmont areas of western Tien Shan (Figure 4.44).

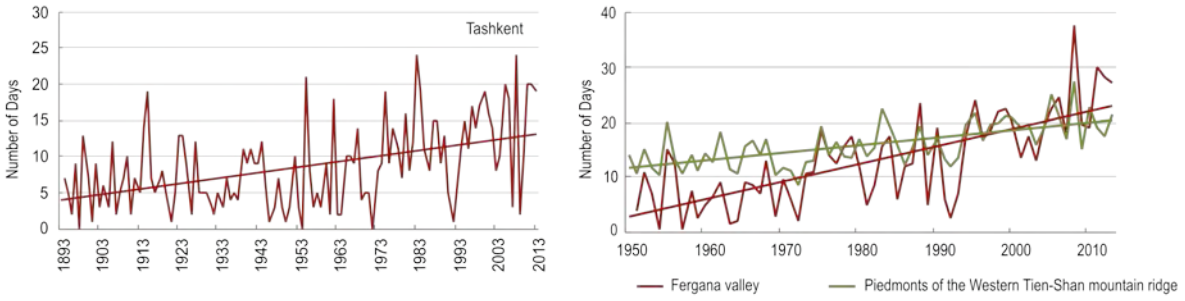


Figure 4.44 | *Temporal Variation in Number of Days with "Heat Waves" in June - August Estimated for Tashkent, Fergana Valley and Piedmonts of Western Tien Shan*

Frequency of "heat waves" varies by territory of Uzbekistan. E.g. in the southern part of Uzbekistan and in desert areas, where norms of maximum air temperatures are close to 40°C, risks of dangerous for human health "heat waves" occurrence are maximal.

Number of days with high air temperatures is index of dangerous "heat waves" occurrence. According to requirements set by economic entities and design institutes, air temperature ≥ 40°C irrespectively to its duration is considered as dangerous phenomenon in Uzbekistan. Currently, frequency in number of days with air temperatures ≥ 40°C by territory of Uzbekistan is mainly 5-10 days per year, that of in desert area is 18-25 (Tamdy and Buzaubay meteostations), and in the south of the country it reaches 34 days (Termez meteostation).

Assessments of variation in number of days per year with air temperature above 40°C for the moderate greenhouse gases emission scenario WRE750 are presented in Figure 4.45. They indicate considerable increase in land area in Uzbekistan with high frequency of air temperatures, considered as dangerous phenomena.

Current situation

Scenario WRE750, 2041-2060

Figure 4.45 | *Schematic Maps Describing Variation in Number of Days per Year with Air Temperature above 40°C in Current Period and by 2050 for Moderate Greenhouse Gases Emission Scenario WRE750*

Adaptation measures for mitigation of adverse impact of "heat waves" and high air temperatures on human health and agriculture are described in Chapters 4.5 and 4.3 respectively.

[68] WMO-TD № 1205. Report of the CCI/CLIVAR Expert Team on Guidelines on Climate Change Detection, Monitoring and indices (ETCCDMI), Geneva, Switzerland, 2004.
[69] Periods of Severe Heat: Threats and Response Measures. Series "Health and Global Environment Change", Publication of the World Health Organization, 2005. – 122 p.

4.4.3 Mudflows and Floods Phenomena

Table 4.20 | *Distribution of Mudflow Occurrence by Provinces for 1977-2013*

Province	Mudflows Number (%)
Namangan	23
Fergana	16
Surkhandarya	10
Samarkand	13
Tashkent	11
Andijan	5
Kashkadarya	8
Djizak	8
Navoi	3
Syrdarya	1
Bukhara	0
Uzbekistan	**100**

Risks of mudflows and floods occurrence in the main mudflow dangerous areas, located in mountainous river basins, increase due to current climate changes and development of mountainous and piedmont territories.

Observations of mudflows are carried out more than 120 years. However systematic mudflow observations and forecasting were commenced in Uzhydromet only in second half of last century. Forecasts of mudflows are based on methods that use atmosphere radiosounding data (air temperature and humidity on the standard constant pressure surfaces). Sum of precipitations over 3 days prior date of forecasting is used as characteristic of slopes moisture content. Forecasts of mudflow danger and floods occurrence are prepared with advance time from 12 hours to 3 days by river basins.

From 1900 to 2013 on the territory of Uzbekistan it was registered about 3,300 cases of the mudflows (Figure 4.46, Table 4.20), 85% of them are associated with storm activity.

According to long-term observations in Uzbekistan amongst the zones with risks of mudflows and catastrophic floods occurrence are the lowest parts valleys (river channels, plain floods and terraces), as well as piedmont and low mountain areas.

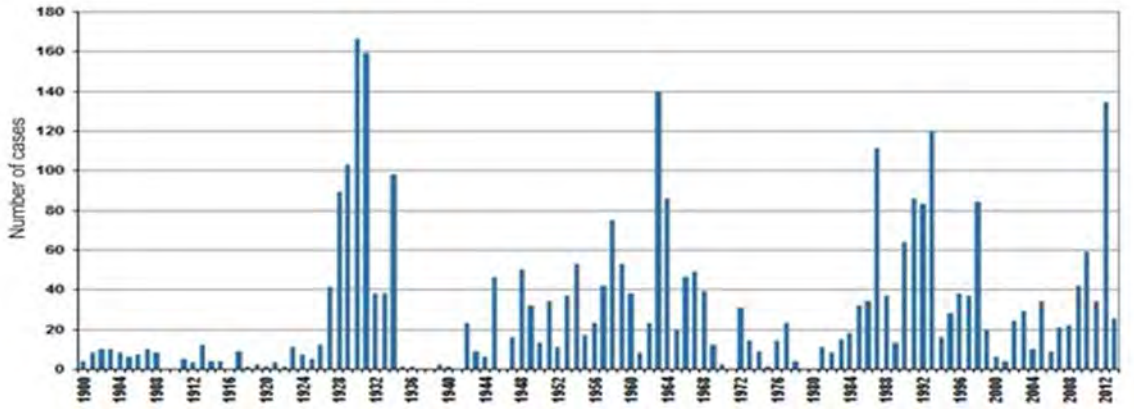


Figure 4.46 | *Number of Mudflows Occurrence Registered in Uzbekistan over Period 1900-2013*

Average number of mudflows occurrence per year in Uzbekistan over observation period 1900-2013 is 32. However, during recent 30 years number of mudflows occurrence was increased up to 42 occurrences per year.[70]

It should be noted that simultaneous formation of mudflows in 20 and more sais (gullies) is possible in Uzbekistan. Mudflows cause considerable damage and are sometimes accompanied by human live losses (Figure 4.47).

The most mudflow dangerous are those areas in Fergana valley, where 44% of all mudflows were registered. Formation of mudflows on the mountainous territories of the adjacent countries with their discharge into plain lands of Uzbekistan is distinctive for the Fergana valley. Most often mudflows recur within the Namangan province, where they occur almost every year.

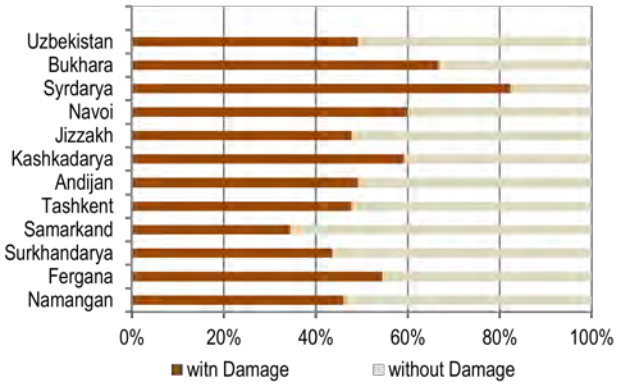


Figure 4.47 | *Share of Mudflows Occurrence Accompanied by Damages in Uzbekistan over Period 1977-2013*

[70] Systematized registration of mudflows occurrence was begun in 1977

Mudflow formation process depends on precipitations intensity and duration, air temperature, soil moisture contentment, depth of snow cover, etc.

Falling out liquid precipitations in form of cloudburst and continuous rains in piedmont and mountainous areas of Uzbekistan are mainly observed in period from March to May. This creates conditions for formation of mudflows. The most severe mudflows are formed by imposition of rainfall runoff on top of snowmelt runoff.

Figure 4.48 | *Consequences of Mudflows/Floods Phenomena in Uzbekistan*

Distribution of mudflows by the territory of Uzbekistan is presented in Figure 4.50a. The most frequently mudflows occurrence is registered in the westward and south-westward open valleys of the Kuramin, Ugam, Pskem, and Chatkal mountain ridges of Tashkent province (zones 1, 2 on the map); on the south-eastern slopes of Chatkal mountain ridge in Namangan province (zones 7,8), where the highest number of mudflows occurrence is registered; on the western slopes of Fergana mountain ridge (zone 3), and on the northern slopes of Alay mountain ridge (zones 4-6) (Andijan and Fergana provinces). Quite frequently mudflows are observed: on the north-western slopes of Zerafshan mountain ridge in the Samarkand province, on the south-western slopes of Zerafshan mountain ridge in the Kashkadarya province (zone 18), on the western slopes of Gissar mountain ridge (zone 25) and the Baisuntau mountain ridge (zones 23, 24); on the northern slopes of the Turkisat mountain ridge (zones 11, 13, 9) in the Djizak province; on the slopes of the Nuratau, Aktau, Karatau mountain ridges in the Navoi, Samarkand and Djizak provinces (zones 10, 12, 14-16, 19-22). In the Surkhandarya province mudflows were registered on the southern slopes of Gissar mountain ridge (zone 28), eastern and south-eastern slopes of the Baisuntau mountain ridge (zones 26-27) and on the western slopes of the Babatag mountain ridge (zone 29).

Geoinformational analysis has allowed to rank the territory of Uzbekistan by frequency of mudflows and to reveal the most vulnerable administrative districts (Figure 4.49b). More than 800 settlements and economy facilities/infrastructure are located in the zones subjected to mudflows occurrence. More than half of population lives in the administrative districts, where mudflows were observed some time, and 22% of the country's population live in districts with high frequency of mudflows occurrence (7.0-0.6%)/

Intra - annual distribution of mudflows indicates that mudflow dangerous period is observed in Uzbekistan from March to July (83% of the total mudflows occurred), and the most dangerous months are April-May. In the cold year season, mudflows are almost not formed, which is associated with low air temperatures, when in mountainous areas solid precipitations predominantly fall. However, sometimes mudflows may be observed in the southern provinces (Surkhandarya, Kashkadarya and others). As a rule, in July mudflows are formed along the thunderous cloudbursts. Due to unevenness of orography of the territory of Uzbekistan, distribution of precipitations is also uneven with temporal shifting of mudflow peaks between various administrative provinces (Figure 4.49).

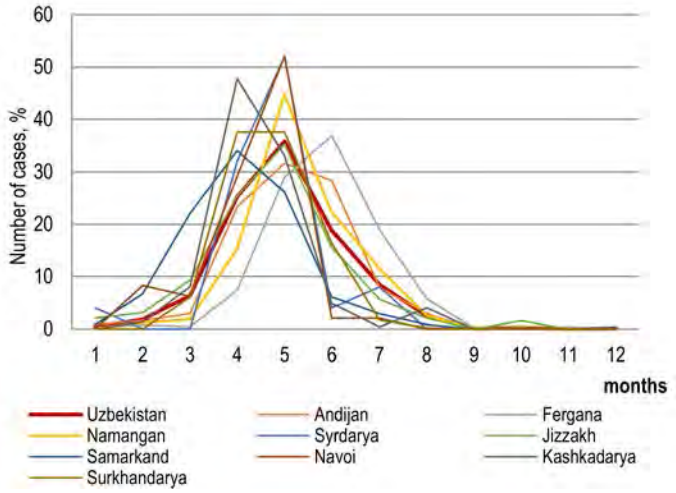
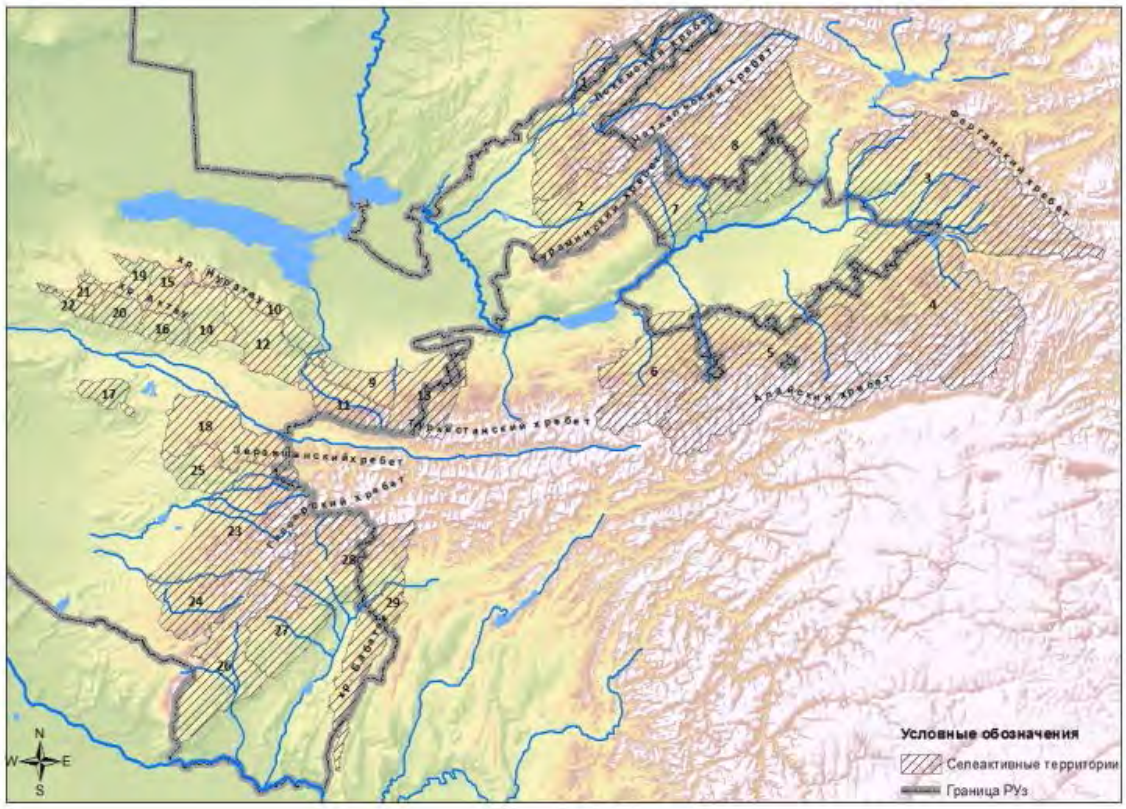


Figure 4.49 | *Intra-annual Distribution of Mudflows by Provinces for Period 1900-2013*

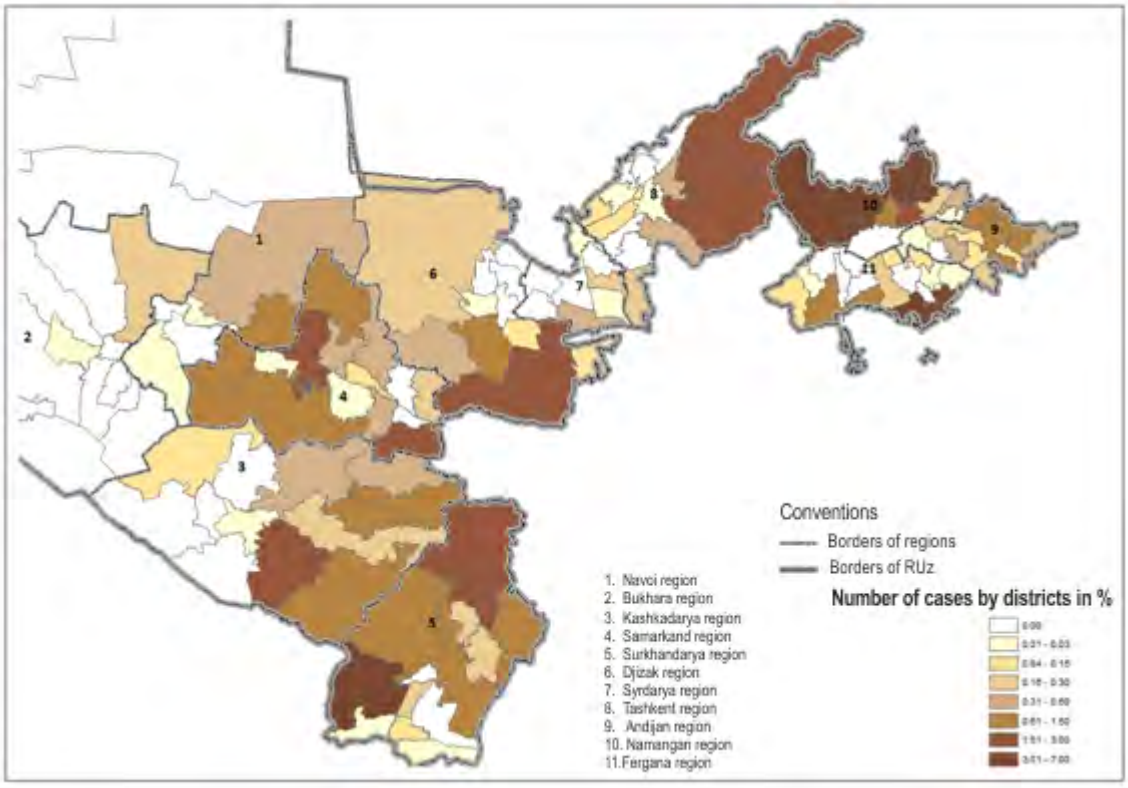
Assessment of mudflow risks for perspective. Data on mudflows frequency and precipitations have been selected as the main input parameters for assessment of current and future mudflow risks on the territory of Uzbekistan.

The above presented assessments of climate change impact on precipitations in accordance with GHGs emission scenarios (see Chapter 4.1) have indicated increase in precipitation amount in winter within piedmont areas on background of their variability growth.[71]

[71] T.Yu Spectorman. Climate Change Scenarios for Territory of Uzbekistan and Upper Watersheds of Syrdarya and Amudarya Rivers. Information on Fulfillment by Uzbekistan Obligations on UNFCCC. Climate Change, Reasons, Impacts and Response Measures, Issue № 9, Tashkent 2015, pp. 29-39.



a)



b)

Figure 4.50 | *(a) Spatial Distribution of Mudflow Dangerous Zones by River Basins; (b) and by Administrative Districts*

This stipulates increase in maximum daily precipitation amount in cold year period by all scenarios, and as a consequence increase in frequency of floods and mudflows occurrence in future. So, with materialization of the extreme GHGs emission scenario, increase in maximum daily precipitation amount in January may be equal to 20% by 2060, and may reach 40% by period 2071-2090 compared with norms (Figure 4.51).

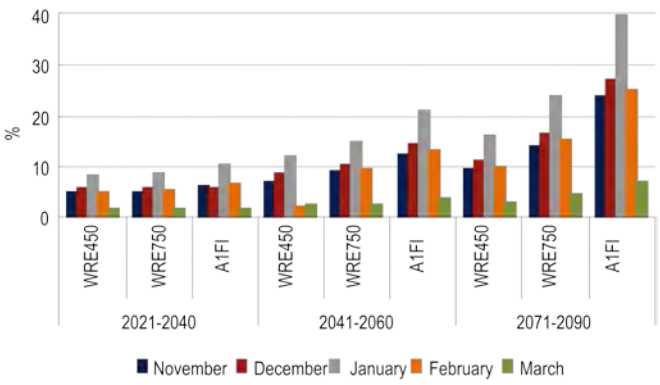


Figure 4.51 | *Increase in Maximum Daily Precipitation Amount (% from base norm) in Piedmonts and Offspurs of Western Tien Shan by GHGs Emission Scenarios*

Mudflow risks by the climatic scenarios have been assessed within framework of the UNDP/Uzhydromet Project "Climate Risks Management". For assessment of mudflow risks for perspective, the outputs of global climatic model ECHAM5 for the moderate GHGs concentration scenario in interpretation of the regional climatic model REMO0406 and data on precipitation in piedmont and mountainous parts of Uzbekistan have been used.[72] According to the adopted scenario, increase in the total annual precipitation amounts in piedmont and mountainous parts of Uzbekistan is expected for periods 2000-2030, 2030-2050 and 2050-2080 by 10.9%, 11.2% and 11.5% respective versus base period (1971-2000). As a result of climate change and population growth, the total mudflow risks will be increased by 1.74, 2.45 and 4.19 times by 2030, 2050 and 2080 respectively.

In general, by the entire territory of Uzbekistan mudflow risk will be increasing. The expected rise in air temperatures will facilitate: (i) growth in duration of mudflow dangerous period (number of mudflows at the end of winter and beginning of spring: in February – March) on account of growth in fraction of liquid precipitations and (ii) increase in maximum discharge of mudflows on account of increase in variability of precipitations and their daily maximum.

Breakthrough dangerous lakes. With shrinkage of glaciations, observed in the recent time, in place of receded glaciers the ridges of frontal moraines and stagnant ice are formed. With intensive melting of seasonal snow cover and ice in summer time melt-water is accumulated between those ridges forming temporary lakes. Number and sizes of these lakes undergo to significant changes year by year. Such lakes may breakthrough with collapse of ice or moraine cofferdams, leading to onset of floods or mudflows, sometimes of catastrophic nature. This has happened many times in the upper reaches of rivers with considerable glaciations area, which flow into Fergana valley from the northern slopes of Alay and Turkistan mountain ridges.

For example, the catastrophic flood in 1998 in Shakhimardan river was formed as a result of breakthrough of three moraine lakes, formed at the frontal moraine of the Archabashi glacier (Kyrgyzstan) in upper reaches of tributary of the Shakhimardan river flowing into Fergana valley. This catastrophe has led to death of people[73] and huge destructions.

Moment of breakthrough of glacier and moraine lakes is practically impossible to predict. However, it is possible to reveal districts, where such floods are possible, and to identify periods, when their occurrences are the most probable. As a rule this is the hot summer time, when glacier and moraine lakes are overfilling with melt-water.

Along with studies of lakes conditions and identification of potential risk it was conducted analysis of high mountain lakes distribution by the territories of Uzbekistan and neighboring countries, breakthrough of which threatens territory of the republic. As a result, 16 river basins have been distinguished comprising 315 lakes. These are basins of

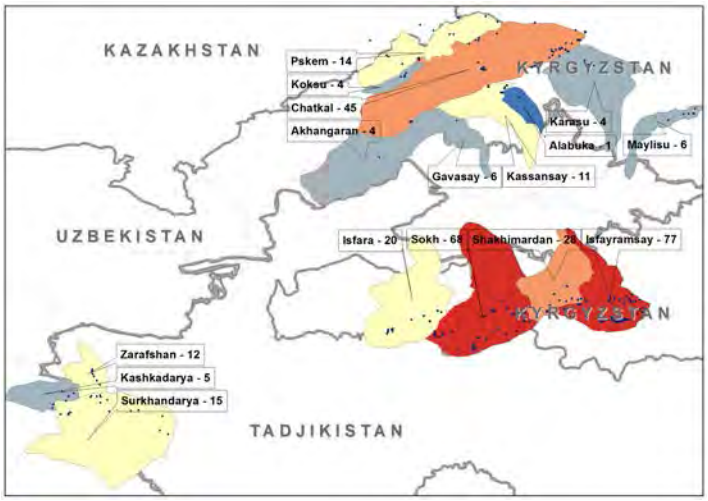


Figure 4.52 | *Map of Breakthrough Dangerous Lakes Locations Threatening to Territory of Uzbekistan*

[72] UNDP. Profile of climate risks in Uzbekistan – 2015. – 88 p. http://climatechange.uz/

[73] Oigster S., Djumaeva S., Tzimermann M. Swiss Strategy for Restriction on Natural Disasters in Central Asia 2004–2008. Dushanbe: Publication of the Swiss Agency for Development and Cooperation, 2008. – 28 p.

the Pskem, Koksu, Chatkal, Akhangaran, Mailisu, Gavasai, Kassansai, Alabuka, Karasu, Isfairamsai, Shakhimardan, Sokh, Isfara, Zarafshan, Kashkadarya and Surkhandarya rivers. The largest number of lakes is located in the following river basins: Isfairamsai with 77 lakes, Sokh with 68 lakes, and Chatkal with 45 lakes (Figure 4.52).

Uzhydromet assesses and monitors conditions of high mountain glacier and rock-dammed lakes on the territory of Uzbekistan. The obtained results are regularly submitted to the Ministry of emergency situations and other bodies concerned.

Climate warming will obviously increase risks of probability of catastrophic floods occurrence. As a result of increase in air temperatures in the mountainous areas it is expected:

- increase in probability of moraine lakes formation in place of receded glaciers, small lakes may be formed on glaciers body, and englacial caverns will be filled with melt-water;
- growing threat of lakes overfilling and breakthrough danger of small lakes in periglacial zones with unstable dams.

With materialization of scenarios leading to increase in precipitations, processes of land slide on slopes and in river valleys are intensified, which also increases probability of formation of temporary lakes and breakthrough floods.

It should be noted that as a rule mudflow dangerous territories are attributed to the zones of intensive industrial and agricultural production with high density of population. In case of mudflow or catastrophic flood occurrence losses may amount to sums that are considerably higher than costs of monitoring, forecasting and construction of protective structures.

4.4.4 Avalanches

Snow avalanche is one of the dangerous nature phenomenons, typical for mountainous areas of Uzbekistan, which threatens human lives and complicates considerably economic activities in these areas. Avalanches are formed as a result of disturbance of snow cover stability under influence of its internal processes and external impacts. The main factors of avalanche formation are meteorological conditions, volume of snow accumulation on mountainsides, physical conditions of snow cover and morphology of mountain slopes.

All mountainous areas of the country are avalanche dangerous to various degrees, since an average steepness of mountain slopes exceeds 25-27° practically everywhere, and depth of snow cover may reach 50cm even in arid zone. The main zone of avalanche danger is located in the range of altitudes from 1,400 to 2,900 mamsl. Avalanche dangerous period varies with terrain elevation. The main avalanching is observed in the zone below 2,000-2,300 mamsl in January – March, in zone 2,300-3,000 mamsl from March to April, and above 3,000 mamsl in April - May.

Avalanche activities by mountainous territory of Uzbekistan vary depending on relief rightness, snow accumulation conditions and peculiarities of temperature regime in winter period. The general characteristics of avalanche activities in Uzbekistan is presented in Table 4.21 below.[74]

Table 4.21 | *General Characteristics of Avalanche Activities in Uzbekistan*

River Basin	Altitudinal Limits, mamsl	Slope Steepness Limits, °	Total Number of Avalanches	Maximum Volume, '000 m³
Aksu, Keles rivers	1660-3590	22-47	951	800
Chirchik river	1800-3320	27-46	40747	2300
Akhangaran river	1850-2950	26-43	8654	6000
Right bank tributaries of Syrdarya river	2050-3220	28-46	2494	6400
Left bank tributaries of Syrdarya river	2240-3770	28-48	4530	600
Zarafshan river	1535-4050	25-54	319	600
Kashkadarya river	1730-3350	21-50	3441	1000
Surkhandarya river	1430-4180	24-56	4955	1000

Avalanche Dangerous Territories

It should be noted that extent of awareness about avalanche regime varies by territory of the republic. Beside districts with meteostation observations (such as the Dukantsay, Kyzylcha, Kamchiksay, Naurazgan and Chimgansay river basins), there are some unexplored districts, although data of occasional and aerial visual surveys suggest their intensive avalanche activities, such as the Kashkadarya and Surkhandarya river basins.

[74] V.E. Chub. Climate Change and its Influence on Hydrometeorological Processes, Agro-Climatic and Water Resources of Republic of Uzbekistan. – Tashkent: NIGMI, 2007.

The largest areas subjected avalanche danger are located in the Tashkent, Namangan, Kashkadarya and Surkhandarya provinces.

The avalanche research stations (ARS) of Uzhydromet carry out avalanching observations. As a result of long-term observations analysis, the general trends and relations between avalanching and meteorological conditions (sum of precipitations and average monthly air temperatures) have been identified.

A number of maps for provinces subjected to avalanche danger have been plotted, including the Tashkent, Fergana, Namangan, Andijan, Surkhandarya, Samarkand and Kashkadarya provinces. In the vicinity of Kamchik mountain pass, which is attributed to the zone with high degree of avalanche danger, it was designed and constructed the avalanche protection structures: galleries on tunnel portals, snow-retention shields on slopes in zones of avalanche formation, avalanche catching dams along roads at slope sides, and avalanche breakers in zones of minimum avalanche moving speed before roads.

Analysis of available avalanche observation data has indicated trend towards decrease in their number, e.g. the average annual number of avalanches observed over the period 2000-2015 in Kamchik ARS was 26, with trend towards their annual decrease by -0.97 per year (Figure 4.53).

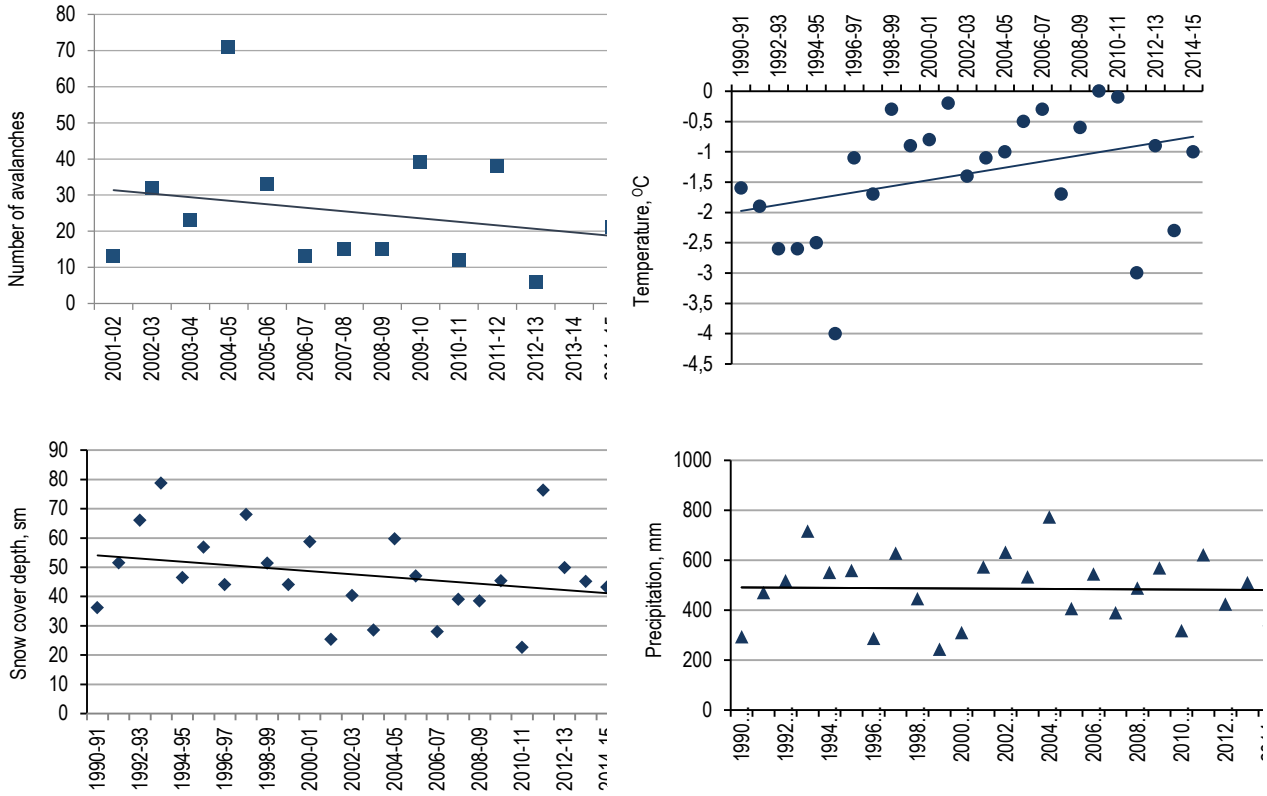


Figure 4.53 | *Long-term Trends in Number of Avalanches, Average Snow Cover Depth, Air Temperatures and Precipitations over Avalanche Activities Period in Kamchik Avalanche Research Station*

It was identified the general trends and relations between avalanching and sum of precipitations and average monthly air temperatures. Increase in air temperature entails rise in snow cover temperature leading to increase it stability on mountain slopes. Even ample snow falls on a background of warm temperatures rarely brought about avalanching. Increase in air temperatures leads to decrease in temperature gradients in snow layer, slowdown recrystallization process, formation of aeration layers, and therefore prevents avalanching. Practically all empirical methods of avalanche danger forecasts, associated with precipitation fallout, indicate that increase in air temperatures decreases probability of avalanche occurrence.[75]

Assessments of avalanche danger in Uzbekistan for perspective have been carried out under a number of studies (SNC, "Climate Risks Management" Project, etc.). According to these studies all experts agree that no increase in avalanche danger is expected due to climate change. In particular, the previously obtained results indicate probable decrease in avalanche occurrence risk by approximately 1.2-1.3 times by 2030-2050, and more than 2 times by 2080, depending on GHGs emission scenario.[76]

[75] A. M. Soldatov, S.R. Grupper. Long-Term Variations in Avalanche Danger in Chimgansay River Basin // NIIGMI Papers– Tashkent: 2007. – Issue 8 (253).

[76] Semakova E. R., Trofimov G.N. Avalanche Regime of Uzbekistan's Mountainous Zone in Climate Warming Conditions (by example of some river basins of Western Tien Shan) // Climatic scenarios, assessment of climate change impact. - Bulletin №6. – Tashkent: SANIGMI, 2007. - pages 71-77.

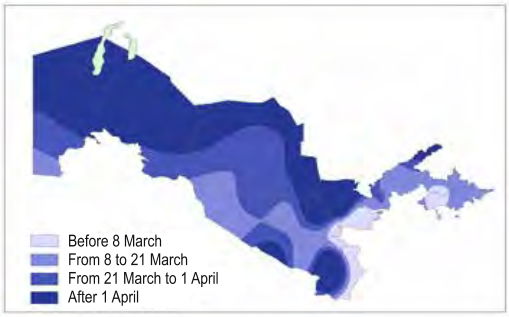
However, with the general trend towards decrease in avalanche activities, in extremely snowy winters threat of avalanching occurrence will remain very high. This is especially distinctive for the upstream reaches of Akhangaran river. It should be noted that in view of intensive population growth, expansion of economic activities, development of tourism and recreation zones in perspective up to 2050, avalanche risks remain. This indicates necessity for systematic observations and adoption of preventive measures.

4.4.5 Frosts

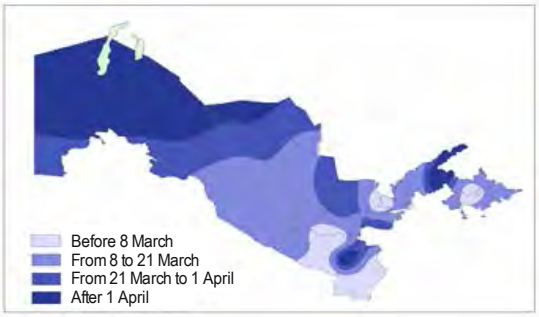
Information about frosts is needed for evaluation of frost-danger for particular territory, optimization of cropping pattern, agro-climatic assessment of crops growing conditions in various regions of the republic, identification of crop planting and germinating dates, assessment of probability of plants loss in spring and autumn time.[77] Overall picture and forecasts of distribution by territory of Uzbekistan of average dates of last spring air frosts are schematically presented in Figure 4.54 below.

Late spring frosts are the most dangerous for agriculture. For assessment of climate change impact on variations in frosts occurrence threat by territory of Uzbekistan:

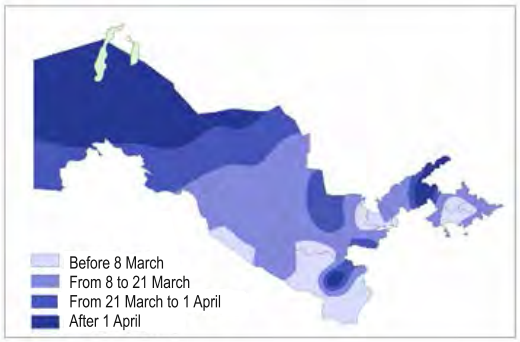
- relationship curves between dates of last spring frosts and data on minimum air temperatures by 50 meteorological stations of Uzbekistan have been plotted;
- dates of the latest spring frosts have been calculated from the data on climatic scenarios for future periods (up to 2030, 2050 and 2080);
- schematic maps of distribution of late spring frosts beginning by three climatic scenarios WRE450, WRE750, A1FI have been developed.



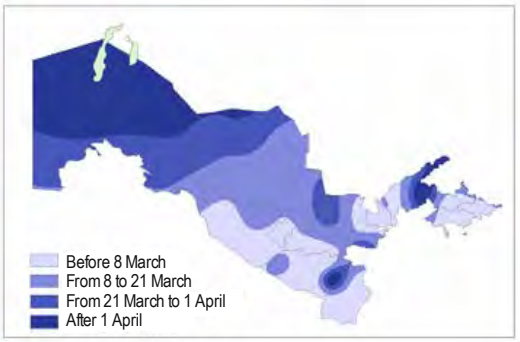
Current situation



Soft scenario (WRE450)



Moderate scenario (WRE750)



Extreme scenario (A1FI)

Figure 4.54 | *Schematic Maps of Probability Distribution of Average Dates of Last Spring Air Frosts Occurrence for Baseline Period and by 2050 in Accordance with Various GHGs Emission Scenarios*

Analysis of calculations indicates that as a result of climate change dates of the latest spring frosts will be shifted to more northern and mountainous regions of the republic. This will entail shift in dates of last spring frosts to earlier time and therefore increase in duration of vegetation period and decrease in risk of negative impact of this phenomena on agriculture.

[77] Dangerous Hydrometeorological Phenomena in Central Asia / Edited by A.D. Djuraev, S.G. Chanysheva, O.I. Subbotina – Len.: Gidrometeoizdat, 1977. – 336 p.

4.4.6 Dangerous Hydro-meteorological Phenomena Risks Management

Assessments, carried out within the framework of the TNC preparation have indicated that climate change may lead to increase in risks of dangerous hydro-meteorological phenomena occurrence (droughts, mudflows, avalanches, "heat waves", etc.), which are accompanied by social and economic damages, and sometimes by human life losses. This will require preparing and taking preventive measures for adaptation to changing conditions.

The State system of preventing and acting in emergency situations has been established and operate efficiently in Uzbekistan. This system combines administrative bodies, resources and facilities of republican and local authorities, enterprises, and organizations, which entrusted with implementation of response measures to emergency situations, associated with inter alia climate and weather change. The system comprises the following agencies and ministries: Ministry on Emergency Situations, Center for Hydrometeorological Serviceat at the Cabinet of Ministers of the Republic of Uzbekistan (Uzhydromet), Ministry of Health, Ministry of Agriculture and Water Resources (MAWR), State Committee for Nature Protection (Goskompriroda) and others. Functions and actions of these institutions are well-defined. Basis for activities of the State system of preventing and acting in emergency situations is assessments and forecasts of Uzhydromet.

Authority of the State system for preventing and acting in emergency situations comprises the following main tasks:

- fulfillment of the governmental policy, development and implementation of regulatory legal acts in area of country's population and territory protection from emergency situations in times of peace and war;
- prediction of possible emergency situations on territory of the republic, assessment of their socio-economic impacts;
- development and implementation of target and integrated scientific and technical programs aimed at prevention of emergency situations, ensuring population safety, diminishing risks from dangerous technologies and enterprises, increasing stability of operation of economy sectors and various institutions;
- ensuring permanent readiness of administration bodies, forces and facilities intended for prevention and liquidation of emergency situations;
- collection, processing, exchange and distribution of information regarding country's population and territory protection from emergency situations;
- preparation of population and staff of administration bodies, forces and facilities for actions in emergency situations.

Drought early warning system. Special attention is paid in the country to establishment and development of system for early warning/preventing dangerous hydro-meteorological phenomena, especially drought as phenomenon causing the most serious negative impacts. Besides, in the Fifth IPCC Assessment Report it is noted that the main predictable risk for the Central Asian region associated with climate change is the "increased risk of water and foodstuffs shortage as a result of drought".

The pilot Drought Early Warning System (DEWS) has been established and being developed in Uzhydromet. This system is a tool for assessing, monitoring, warning and decision making in regard to probability of water shortage and droughts occurrence in the Amudarya and Syrdarya river basins. The basis of Drought Early Warning System is computer-aided informational system for hydrological forecasting, developed by the NIGMI of Uzhydromet for assessment of water resources based on the regional mathematical model of mountainous rivers runoff formation.[78],[79] The model describes complete cycle of runoff formation and comprises three interrelated blocks: model of snow accumulation in mountainous river basin, including water inflow from snowmelt and rains; model of formation of water inflow from glaciers melt; and model of runoff transformation. The computer-aided system allows analyzing large volumes of hydro-meteorological information, including snow accumulation data, water inflow from snow and glaciers melt, and rainfalls, calculate runoff hydrographs and prepare long-term and seasonal runoff forecasts for vegetation periods (Figure 4.55).

Within framework of the UNDP/Uzhydromet Project "Climatic Risks Management in Uzbekistan", the DEWS has been approbated on territory of the Kashkadarya province of Uzbekistan.[80]

The degree of expected water shortage and drought is the criterion for adoption of certain action plans for mitigation of probable drought impacts. Reliability of forecasts should be sufficiently high, because in case of large-scale drought huge agricultural land area will be subject to crop yield losses risks. Besides, on the basis of forecasts governmental authorities may correct strategy for management of available water resources, which will require considerable expenses.

Therefore, there is a need for further development of DEWS on the basis of studies and research works in the following areas:

- studies of the potential drought impacts on agricultural lands depending on its severity (with use of WEAP type models and others) and development of criteria for assignment of danger level to expected drought;

[78] V.E. Chub, N.A. Agaltzeva, A.V. Pak Drought Early Warning: Problems and Solutions // 3rd International Conference on Regional Cooperation in Transboundary River Basins – Dushanbe, 2005. – p.21-22

[79] N.A. Agaltzeva, Drought in Uzbekistan: problems, early warning and impacts mitigation // Ecological Bulletin No.9. – 2012. – p.27-32

[80] UNDP. Profile of climate risks in Uzbekistan. – 2015. – 88 p. http://climatechange.uz/

- development and approval of response action plans to expected decrease in water availability depending on drought severity for each province of the republic;
- development and dissemination of output products (special reviews and hydro-meteorological forecasts by river basins/provinces, adapted for farmers, comprising assessment of water availability, meteorological conditions and recommendations for crops irrigation regime);
- organization of trainings for water resources users at various levels, including local authorities and farmers.

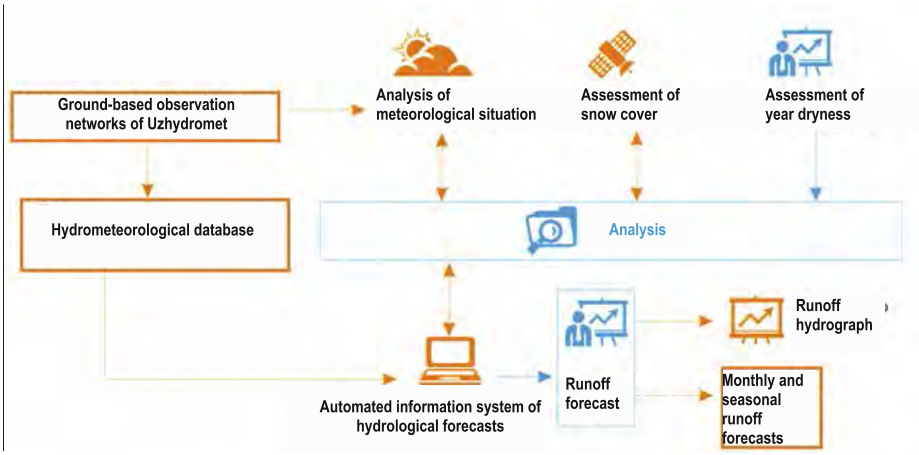


Figure 4.55 | *Diagram of Drought Early Warning System (DEWS)*

Measures aimed at reduction in risks of mudflows, floods and avalanches occurrence. Integrated measures for protection of residential buildings and national economy infrastructure from mudflows and avalanches are used in Uzbekistan. It is first of all, the system for monitoring and warning about dangerous natural phenomena (such as mudflows, floods and avalanches). Department for monitoring and forecasting of dangerous natural phenomena, and hydrological and avalanche gage stations are operating in Uzhydromet. It is also maintained the State cadastre of dangerous hydro-meteorological phenomena and prepared daily forecasts of rivers flow. The operative information about probability of mudflows, floods and avalanches occurrence is submitted to the Ministry of Emergency Situations and other agencies concerned, as well as to population.

Based on survey results of mudflow dangerous districts, risks of mudflows and floods occurrence in sites of mass people recreation (such as health-improvement camps for children, hotels, ski trails, etc.), are being assessed. Construction of the hydro-technical protective structures, such as mudflow debris reservoirs, mudflow conduits, dams, and anti-avalanche structures is carried out as protection measures.

The current strategy and specific measures on diminishing risks of mudflow and flood phenomena are reflected in the "Program for Stabilized and Safe Water Discharge through Water Courses of the Republic of Uzbekistan for 2014-2015, and for Perspective up to 2020", approved by the Decree of Cabinet of Ministers of the Republic of Uzbekistan.[81] The objective of Program is protection of population, social facilities and economy sectors infrastructure from the negative impacts of mudflows and flood dangerous phenomena. The Program envisages construction of protective structures, relocation of some infrastructure objects from zones of danger, repair and strengthening waterworks, roads, power supply lines, and gas pipelines on account of the state budget, ministries and agencies own resources, the Republican road fund under the Ministry of Finance and other sources. The following organizations are involved in these activities:

- Ministry of agriculture and water resources;
- Khokimiyats (Administrations) of provinces;
- JSC "Uzbekistan temir yullary" (Uzbek railroads);
- JSC "Uzbekenergo".

The Decree of Cabinet of Ministers of the Republic of Uzbekistan No. PKM-242, dated 24 August 2011, "On Further Improvement of State System for Prevention and Actions in Emergency Situations" to the great extent complies with objectives of the Climate Risk Management, ensures legal basis, identifies functional obligations and order of interaction between institutions.

There is an apparent interrelation between measures for prevention of climate change, adaptation to it and Climate Risk Management in the overall process of undertaking adequate actions against adverse impacts of climate change. Therefore they should be considered in close coordination taking into account priorities.

[81] Decree of Cabinet of Ministers of the Republic of Uzbekistan No. PKM-13, dated 21 January 2014 "On approval of Program for Stabilized and Safe Water Discharge Through Water Courses of the Republic of Uzbekistan for 2014-2015, and for Perspective up to 2020". // Law Book of RUz, 2014, No 4, p. 49

Adaptation measures for reduction in risks and negative impacts of mudflows, floods and avalanches occurrence. Taking into account considerable spatial and temporal variability of nature phenomena, stipulating climatic risks, and complication of task to manage these risks, measures and actions described in the UNDP Profile of climate risks may be considered as priority ones.[82]

Development and improvement of monitoring and forecasting the dangerous nature phenomena is the key element in Climate risks management. Lack of adequate monitoring for timely warning is the general constraining factor in development and enhancement of the early warning system about dangerous climatic phenomena. Amongst the main measures and requirements for monitoring improvement are:

- expansion of ground-based network of hydro-meteorological observation stations in mountainous zone, including monitoring of breakthrough dangerous lakes, maintaining databases, regular updating of reference materials;
- development and use of monitoring methods of dangerous hydro-meteorological phenomena based on remote sensing data;
- carrying out the applied studies with use of advanced GIS technologies and high resolution satellite images;
- plotting large-scale maps of nature phenomena danger and revealing zones with increased risk.

Staff capacity building in the conditions of increasing flow of scientific and technical information is one of the priority tasks for further development of Climate Risk Management system. Currently in the conditions of uncertainty associated with climate change and necessity for seeking methods and approaches to minimize climate change and dangerous climatic phenomena impacts on the country's economy and ecosystems there is a need for constant improvement in specialists' professional and educational level.

Population awareness raising in issues of climate change, climatic risks management and adaptation to climate change is also the priority task.

Improvement and expansion of system for insurance of population's property and health from natural disasters may mitigate economic impacts of the dangerous hydro-meteorological phenomena.

Possibilities for insurance of dangerous hydro-meteorological phenomena risks. The most efficient and well-developed financial mechanism for mitigation of dangerous nature phenomena and catastrophes impacts is insurance. Availability of well-developed insurance systems makes countries more sustainable to negative impacts of climate change.

The insurance market is on the upswing in Uzbekistan. Currently more than 30 companies operate on this market. However, the only company, specializing in insurance against risks in agriculture is JSC "Uzagrosugurta", which provides to agricultural producers the affordable and suitable for their demands insurance services (around 40 types). The main types of agricultural insurance include: voluntary crops insurance against replanting; voluntary crops insurance against yields shortfall; voluntary orchards and vineyards insurance against yields shortfall; voluntary livestock insurance, etc. The insurance risks are damage or loss of agricultural crops, animals and machinery/equipment as a result of droughts, dry hot winds (garmsel), mudflows, floods, shortage or lack of water, hail, cloudbursts, windstorms, hurricanes, frosts, heavy snowfalls, crop lodging as a result of continuous rainfalls, lightning and fire, landslides, groundwater table rise, etc.[83]

Based on agro-insurance experience of foreign countries, the JSC "Uzagrosugurta" has introduced a number of innovations in its practice. In particular, preferences are provided to private farmers for crops insurance against yields shortfall: on account of simplification of insurance policy provisions number of insured risks has been increased; insurance rates are differentiated by regions; system for consideration of insurance claims has been simplified; in absence of insurance events insurance rate is decreased. This has promoted growth of insurance market and increase in insurance compensation amount. If in the first half year of 2014, the total amount of insurance compensations paid to private farms was 2.8 billion Soum, then in the first half year of 2015, it was 5.8 billion Soum.[84]

In spite of fast development and high relevancy of agricultural insurance, its share in the insurance market of the country is yet not too large. Currently, the main incentive for crop yield insurance for farmers is commercial banks insurance requirements for granting of credits, and first of all lax credits for financing raw cotton and wheat production. The considerable number of potential insurants and their spatial scattering entail a number of problems for timely conclusion of insurance contracts both in crop husbandry and cattle breeding subsectors.

Share of agricultural production produced by the dekhan and private farms in Uzbekistan is around 98% from the gross agricultural production. In the zone of risky agriculture, where risks of droughts occurrence and crop yields shortfall cover vast territories, the agricultural insurance should be the efficient tool for protection of agricultural commodity producers, maintain stability of rural population incomes, and make development of agricultural sector more sustainable.

Further development of insurance system should take into consideration problem associated with increase in occurrence of dangerous phenomenon due to climate change. Therefore, it is necessary to resolve the following problems:

[82] UNDP. Profile of climate risks in Uzbekistan. – 2015. – 88pc. http://climatechange.uz/

[83] Official site of JSC "Uzagrosugurta". http://agros.uz/ru/page/statisticheskie-dannye

[84] A. Vakhobov. Agriculture and Insurance Market: Insider's View. Interview to Newspaper "Uzbekistan Today" of the Chief Manager of Department for Insurance of Agricultural and Financial Risks of JSC "Uzagrosugurta" (http://old.ut.uz/economy)

- On the basis of actual information it is necessary to develop clear criteria of dangerous phenomena taking into account features of various geographical regions of Uzbekistan;
- It is necessary to regulate rules for all main types of agro-insurance and adopt legislative act, which will increase requirements to quality of insurance coverage of agricultural producers, define clearly insurance types and objectives, insurance subjects and entities, and make it more attractive and transparent for the potential insurants;
- Introduction of mechanism for providing direct subsidies from governmental and donor funds for agro-insurance to cover damages in cases of large-scale natural disasters, associated inter alia with weather and climate;
- Improvement of staff training and retraining system for insurance agencies;
- Increase population awareness in insurance issues.

4.5 Climate Change Impact on Population Health

The global climate change is expressed in growing the average air temperatures, increasing number and intensity of the extreme weather phenomena (such as lengthy hot period, sharp changing atmospheric pressure, etc.), and has negative impact of people's health. With the expected further climate warming, degree and strength of this impact will be increasing. According to the IPCC[85] data, the key climate risk for the Central Asian region, including Uzbekistan, is most likely increased risk of mortality rate associated with hot weather (extreme hot weather, hot waves).

The efficient public health system, and its readiness to increase in number of certain diseases, as well as thorough monitoring and increased public awareness about probability of climate change impact and adaptation measures, may assist in solution of problems with negative climate change impact on population health.

Public Health Care System in Uzbekistan. Integration to the world community and expansion of the international relations and cooperation with the countries with developed public health care infrastructure has allowed Uzbekistan to identify strengths and weaknesses of its current population health care system and stipulated necessity for reformation of the national health care model.

In accordance with the State Program on Reforming of Health System in the Republic of Uzbekistan, the purpose of which is to create a system in the country, ensuring the preservation and improvement of public health, creating conditions for raising a healthy generation, there is a gradual improvement of the existing health care system, which is based on the principles of strict compliance conditions of social protection and universal access to guaranteed medical assistance.

The Program is being successfully implemented in Uzbekistan that is visually confirmed by the following indices: during the last 10 years level of overall mortality rate was decreased by 22%, child and maternal mortality rates were decreased by 68% and 38%respectively. Volume of the annual state budget allocations for public health care is increasing every year.[86]

One of the main directions of health care service reformation is creation of the rural health centers (RHC), equipped with the advanced medical facilities and qualified medical staff. During several past years procurement of medical equipment for RHCs was financed by both the state budget and World Bank credits. In the past rural dwellers had to go to the district's center to treat even any simple disease. Nowadays there are currently 3 thousand RHCs in the republic.

Reforms in the primary health care system have been supported by the World Bank through investment projects. As a result of implementation of the projects Health I and Health II, it was improved quality and economic efficiency of the primary health care services. The Project has carried out trainings for 3,770 general practitioners benefiting more than 18 million people in Uzbekistan, 2,389 rural health centers and 25 family polyclinics have been provided with medical equipment.[87]

The Project Health III was commenced in 2012, concentrating on improvement of secondary health care services on account of several arrangements: investments in diagnostic therapeutic equipment for hospitals at the district level; improvement of control over priority noninfectious diseases in polyclinics and hospitals financing. As of now more 1,000 general practitioners have participated in trainings under the Project Health III and another 3,000 doctors will pass trainings by the end of 2018.

Currently in the Republic of Uzbekistan 92 enterprises manufacture medical production. Control over pharmaceutical activities of these enterprises is carried out on the basis of the Law "On Drugs and Pharmaceutical Activities".[88] Currently more than 12 guidance documents are created in accordance with recommendations of the World Health Organization (WHO). They regulate quality and technologies for drugs production in the manufacturing enterprises. In the country the great attention is paid to introduction of quality management systems in the production sector enterprises in accordance with international standards. The main one is

[85] Fifth Assessment Report of the IPCC. Impact, Adaptation and Vulnerability, 2014, www.ipcc.ch

[86] www.moymir.uz/zdravoohranenie.html

[87] http://www.worldbank.org/ru/country/uzbekistan

[88] Law of the Republic of Uzbekistan "On Drugs and Pharmaceutical Activities" (edited in accordance with the Decree #399 dated 4.01.2016 "On changes and amendments to the Law of the Rebublic of Uzbekistan"

Service standard TSt 19-01:2003 "Good Manufacturing Practice" (GMP). The schedule of stage-by-stage introduction of international standard GMP at 15 pharmaceutical companies of the Republic of Uzbekistan for the period 2013-2017 has been developed.

A number of the governmental documents, aimed at development of private medical entrepreneurship, have been adopted in Uzbekistan. Currently the private clinics and medical centers provide population with the qualified medical care.

Connection of population morbidity with weather and climate factors. The main priorities aimed at mitigation of climate change negative impact on population health in the Republic of Uzbekistan have been identified in the developed National Strategy for adaptation of the public health care system to climate change. Climate change, which is shown in climate variability, increases both direct risks to human life safety and risks associated with increase in disease incidence due to unfavorable meteorological conditions, especially amongst vulnerable population groups: the chronic patients suffering from cardiovascular, bronchopulmonary and infectious diseases. [89]

According to recommendations of the WHO, the most favorable climate conditions for human activities are air temperatures in the range from 17 to 31°C, air humidity from 40 to 60%, wind speed up to 0.6 m/sec and atmospheric pressure of 760 mm hg.[90]

According to the results of TNC estimates, currently in Uzbekistan number of days with air temperature ≥ 40°C is mainly 5-10 days/year, that of in desert zone is 18-25 days (Tamdy, Buzaubay meteorological stations), and 34 day in the south of the country (Termez meteorological station) (Ref. Chapter 4.1.1). According to estimates, by the moderate GHGs emission scenario (Ref. Chapter 4.4) it is possible considerable increase in land area of the country with high frequency of air temperatures considered as dangerous phenomena. In summer period on the background of stable hot weather, "heat waves" are becoming dangerous for human health, frequency of which is especially high in southern parts of Uzbekistan with norms of maximum daily air temperatures in July close to 40°C.

So, the considerable part of Uzbekistan's territory by its temperature conditions in warm year period differs significantly from the temperature optimum specified in the WHO standards.

A number of studies have been conducted in Uzbekistan within the framework of the national and regional projects confirming presence of climate risks to population health and assessing meteorological parameters impact on human health, and its responses, including acclimatization. It was studied mechanisms of aggravation of ischemic heart disease, hypertensive disease and vascular brain disease in the arid zone with long exhausting summer accompanied by heat discomfort and external hyperthermic weather hypoxia. [91,92,93]

As has been shown in the SNC[94] and confirmed by the additional studies, the main indices, identifying climate risks to population health in Uzbekistan are:

- rise in air temperatures, especially night ones (by 2-3 degrees);
- increase in duration of hot year period (by 10-15 days);
- increase in recurrence of high air temperatures ("heat waves");
- decrease in number of days with frosts and snow cover (by 7-10 days);
- sharp weather change and air temperature decrease in winter against previous years (Ref. Chapter 4.4).

Specialists of the Scientific/Research Institute of Sanitary, Hygiene and Work-related Diseases under the Ministry of Health of the Republic of Uzbekistan have interviewed more than 4,000 people of 15-86 year old in Tashkent and Syrdarya provinces.[95] The study has revealed that more than 60% of population thinks that climate has been changed in the region. More than half of respondents think that climate change is associated with direct danger to their health and experience response to the climate factors, i.e. depend on meteorological conditions. This is especially relevant to the people with chronic diseases as heart-vascular system disease. Their ill-being they attributed to the following weather factors: sunny, very hot and dry weather; high pressure drops, overcast days without and with precipitations; frosty weather with the average daily air temperature below 10°C. In particular, during summer period more than 50% of population suffers from overheating or sunstrokes. Due to sharp change in relative air humidity more than 10% of people experience reduced ability to work. One third of population has been worsened prior several hours to sharp change in air temperature or atmospheric pressure and strong fitful wind. Almost 40% of respondents with disease of heart-vascular system have noted aggravation of their disease with change of weather. The hypertensic crisis, stroke and heart attack have been observed

[89] Climate Change Impact on Population Health: Convincing Facts. European Regional Bureau, Fact Bulletin, March 2010.

[90] 10 facts of Climate Change and Population Health, WHO Information Bulletin, October 2012.

[91] Madjidov Kh. M, Khalimova Z. Yu., Kilichev I.A. Cerebrovascular Diseases Incidence in Uzbekistan During Critical "Afghan Wind" Meteodays in Uzbekistan // Neurology and Psychiatry Magazine. - 1994. - № 2. – pages 28-30.

[92] Zunnunov Z. R. Meteo Pathogenic Mechanisms of Ischemic Heart Disease Aggravation in the Arid Zone // Issues of Balneology, Physiotherapy and Exercise therapy. - № 5. -2000. –pages 17-20.

[93] Yanabaeva Kh. I. Features of the Hot Climate Cardiology II (Clinic And Ecological Aspects). -Tashkent, 2003.

[94] Second National Communication of the Republic of Uzbekistan on Climate Change under the UN Framework Convention on Climate Change, - Tashkent, 2008.

[95] WHO/UNDP/Uzbekistan "Adaptation of Healthcare System to Climate Change", http://www.who.int/globalchange/projects/adaptation/ru/index1.html

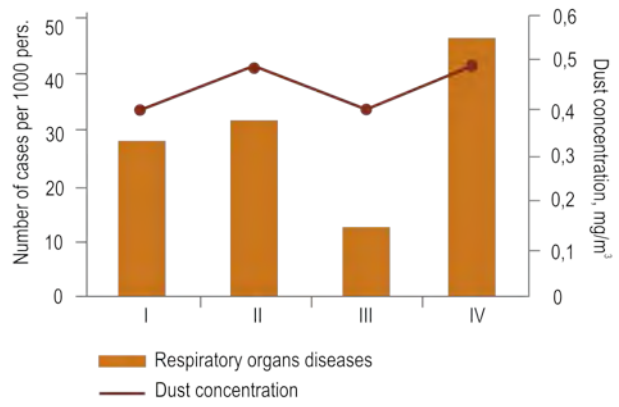


Figure 4.56 | *Respiratory Organs Disease Incidence and Air Dust Concentration in Nukus city in 2010*

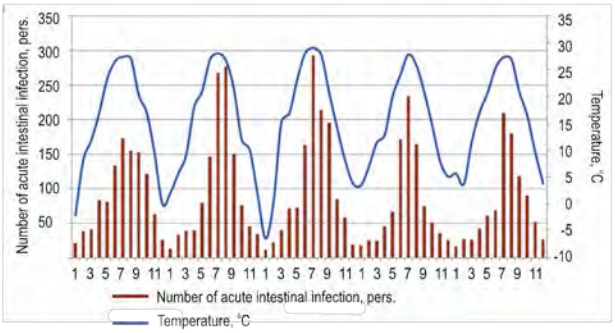


Figure 4.57 | *Comparative Graph of Number of Recorded Acute Intestinal Infection Incidence by Months and Average Monthly Air Temperatures for 2010-2014*

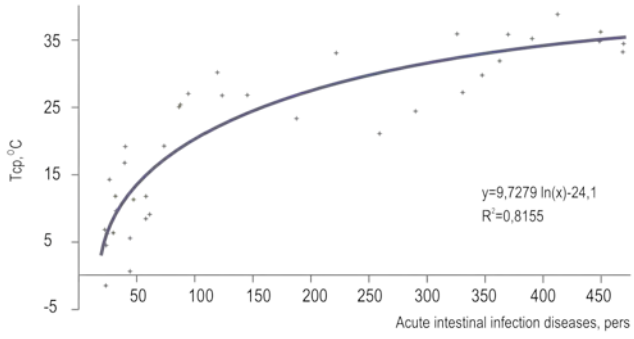


Figure 4.58 | *Acute Intestinal Infection Incidence in Tashkent Province and Air Temperatures*

very often. The majority of population, suffering from respiratory system disease, also respond to weather factors, increase in cases of acute respiratory and intestinal infections was marked.

The additional indirect risk factor to population health associated with climate change is deterioration of vital for human being environment conditions and quality of air, water and food staff. Besides that, due to climate warming it is expected water deficiency and its quality deterioration, increase in foodstuff infection.

Climate variability in Uzbekistan and increase in associated dust storms intensity, as well as increase in number of warm days in winter, entail growth of respiratory organ diseases, as air pollution is one of the main risks to human health, associated with environment. It should be noted that respiratory organ diseases occupy third place with 6.6% (32 incidences per 100,000 people) in the overall pattern of population mortality. That of amongst children below 14 years old is 35.2% or the first place. Children are more subjected to the respiratory organ diseases than adults, because as a rule, they spent more time on the open air both during warm and cold seasons of a year.[96] Figure 4.56 illustrates direct relation between respiratory organ disease incidences and air dust concentration in Nukus city, as an example.

Due to increase in air temperature and relative humidity Uzbekistan faces the risk of increasing microbial and protozoal causative agents, as well as rise in survival capacity of enteric viruses in ambience. Furthermore, reduction in the total precipitation amount entails decreasing river water levels and increasing concentration of pathogenic organisms in water.

In the hottest year period (June – August) enteric diseases incidence increases sharply versus the cold year period (Figure 4.57).[97]

Climate change will to some extent increase risk of acute intestinal infection incidence due to increase in air temperatures. Analysis of registered number of infectious disease incidence over the recent years indicates direct correlation between increase in air temperatures and growth of infectious diseases, which increases annually by 0.01%. According to expert estimates, rise in maximum air temperature by 1-2°C increases number of acute intestinal infections by 10-13% (Figure 4.58).

The Republic of Uzbekistan gains many-year successful experience in control of infectious diseases, based on preventive approach and the centralized system of epidemiological surveillance.

Currently vertical management structure is retained in the Republican Center of sanitary supervision and disease control, which allows promptly and effectively resolve the arising problems and prevent epidemic complications. With the aim of coordination preventive and anti-epidemic measures for acute intestinal infections, anti-epidemic units operate under the Ministry of Health and all Centers of sanitary supervision and disease control. On the basis of daily information they analyze situation with the acute intestinal infection incidence in the republic.

[96] Assessment of Climate Change Impact on Health, Vulnerability and Adaptation of Public Health Care System in Uzbekistan. UNDP/WHO/GEF-Tashkent 2011. -145 pages.
[97] Spectorman T.Yu, Petrova E.V. Use of Climatic Indices for Evaluation of Climate Change Impact on Population Health in Uzbekistan. Bulletin №7, Tashkent, NIGMI 2008, pages 37-46.

Apart from infectious diseases, in connection with climate changes, it is also predicted growth in incidence of cardiovascular and circulation organs diseases. Overheating of human being is first of all affects his central nervous system, changing his cardiovascular activities and increasing water-salt metabolism. Air temperature of 40-45°C causes depression of cardiovascular system performance, expressed in increasing pulse pressure on background of decreasing diastolic pressure and increasing systolic pressure. Thermal water thesaurismosis of extremities occurs. Performance impairment is already observed with air temperature of 25-30°C. In such conditions elderly people and people suffering from cardiovascular diseases (this is rather large percentage of population) are first of all subjected to thermal stress.

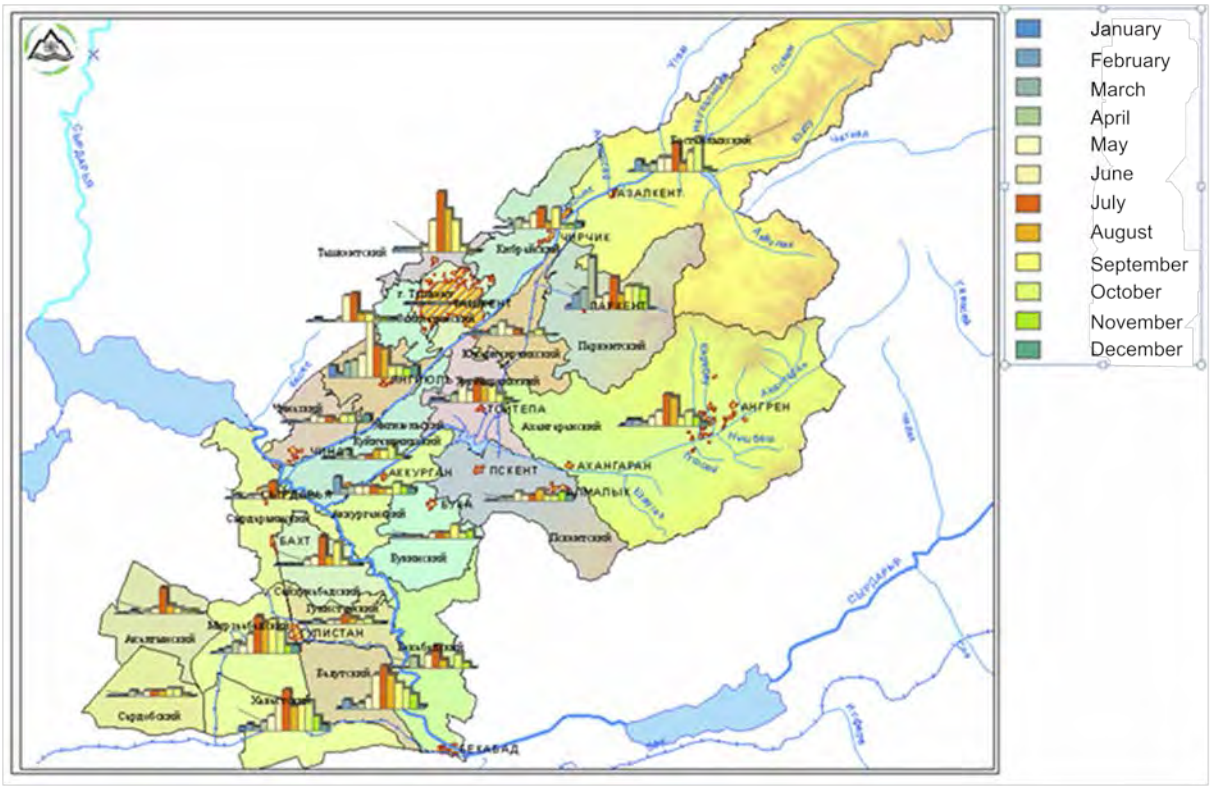


Figure 4.59 | *Propagation of Acute Intestinal Diseases in Tashkent Province by Months*

According to the Ministry of Health data, the main cause of mortality in Uzbekistan is cardiovascular diseases with the share of 60% from overall mortality, approximately half of which are associated with ischemic heart disease and around 25% with cerebrovascular diseases.

Comparison of hot waves duration with mortality rate from the cerebrovascular diseases has indicated that increase in mortality rate coincided with maximum duration of hot waves, which may be observed in any season of year and are accompanied by sharp change in atmospheric pressure. [98]

During hot months (June-August) and transitional months (April and November), with frequent sharp change in weather type, mortality rate from the cerebrovascular diseases is considerably higher.[99]

Transmissible diseases are also sensitive to the long-term climate change. One of the serious problems for people health is leishmaniasis and malaria. Zoonotic type of the dermal leishmaniasis is registered in Uzbekistan. The most frequently leishmaniasis is registered in the Bukhara, Kashkadarya and Surkhandarya provinces. Carrying agents of leishmaniasis and malaria are various species of mosquitoes. Climate change with increase in duration of warm year period will create favorable conditions for pullulation of both midges and malarial mosquitoes.

[98] Spectorman T.Yu, Petrova E.V. Use of Climatic Indices for Evaluation of Climate Change Impact on Population Health in Uzbekistan. Bulletin №7, Tashkent, NIGMI 2008, pages 37-46.

[99] Madjidov Kh. M, Khalimova Z. Yu., Kilichev I.A. Cerebrovascular Diseases Incidence in Uzbekistan during critical "Afghan wind" meteodays in Uzbekistan // Neurology and Psychiatry Journal. - 1994. - № 2. – pages 28-30.

Early Warning System about risks of diseases, sensitive to climate change (EWS). Development and implementation of the early warning system about risk of diseases in the conditions of global warming has been selected as one of the priority measures for adaptation of population to climate change. It was also carried out a number of reforms in this direction.

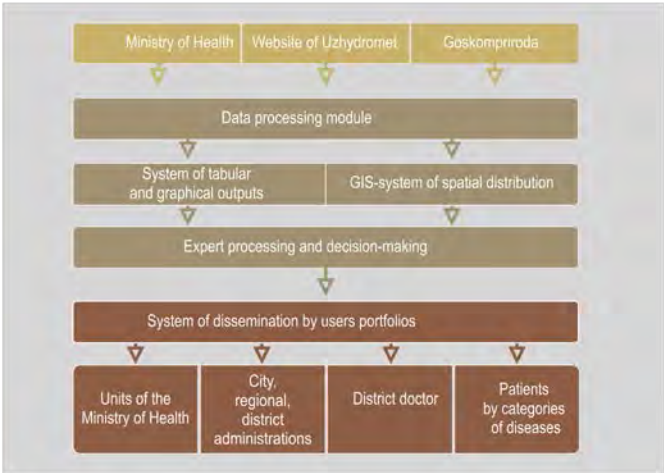


Figure 4.60 | *Scheme of Information Exchange, Processing and Dissemination*

Based on studies, carried out within the framework of the Project "Adaptation of public health care system to climate change", implemented in the pilot Tashkent and Syrdarya provinces, it was developed and implemented the Early Warning System (EWS) about risks of diseases, sensitive to climate change. Heads of the Ministry of Health, Uzhydromet and Goskompriroda have signed the Memorandum on population warning about predicted unfavorable weather conditions due to climate change through the respective informational services of these agencies.

Scheme of early warning system includes primary intersectoral information, module of information processing and forecasts calculation, analysis of information and preparation of recommendations and dissemination of analytical information amongst various groups of users (Figure 4.60).[100] Basis of the EWS is website www.meteomed.uz developed by the Project.

More than 500 general practitioners from 14 rural medical centers from Tashkent province have been trained to inform population about preventive measures in the conditions of unfavorable climate impact. More than 25 workshops have been conducted with support from the WHO, workshop training materials have been distributed amongst participants.

Adaptation Requirements and Measures. It is rather difficult to separate share of climatic factors from array of other factors affecting population health. As noted in the materials of Euro WHO (Copenhagen, 4 April 2008)[101], climate change affects population directly through anomalies and shifts of usual climate features, and indirectly due to change in air quality, quantity and quality of water resources and foodstuff, change in conditions of ecosystems and agricultural production, sources of income for population and infrastructure.

There is a need for improved qualitative assessment of climate change impact on population health, which require more reliable data on the main climatic risks, disease incidence and mortality index, as well as number of visits by various groups of population to various medical centers/facilities. The following measures and actions can be recommended to improve sustainability of the public health care sector to climate change:

- elaboration and introduction of territorial action plans in the health care area in case of extreme heat occurrence, as well as official instruction on actions of medical staff in unfavorable climate conditions;
- strengthening epidemic supervision and monitoring system for revealing changes and analysis of epidemiological trends related to water and foodstuff borne diseases, and ensuring safe drinking water supply from its source to end users;
- introduction and development of Early Warning System (EWS) about risk of diseases and prevention measures in the climate change conditions taking into account experience of other countries and recommendations of WHO;
- widening studies for climate risks assessment and their impact on population health in various climatic zones of Uzbekistan, establishment and maintenance of the state database on population health depending on meteorological indices, covering all regions of the republic;
- strengthening staff capacity of public health sector in respect to climate change impact on population health, introduction of relevant training programs in the system of medical education;
- improvement of public awareness regarding climate change impact on human health, strengthening sanitary educating for rural population, especially for the most vulnerable to disease risk groups of population (i.e. children, women, elderly age people).

[100] Myagkov S.V., Dergacheva I.V. Early Warning System for Prevention of Diseases Sensitive to Climate Change (Uzbekistan's experience). Bulletin №9, Tashkent, 2015, pages 76-83.

[101] Climate Change Impact on Population Health in Uzbekistan. Education program for general practitioners. Ministry of Health of RUz- Medical Education Development Center –Scientific/Research Institute of Sanitary. Hygiene and Occupational Diseases, Tashkent, 2013, 53 pages.

4.6 Biodiversity and Ecosystems

4.6.1 Conditions of Terrestrial Ecosystems Biodiversity

Living conditions on earth are formed and controlled by combined activities of natural ecosystems. So, biological diversity acts as index of ecological non-disturbance of biosphere.

Uzbekistan is a country with intensively developing economy and high population density located in the arid zone and vulnerable to climate change processes, and drought and desertification phenomena. Therefore loads on natural landscapes and ecosystems grow up. In the connection with that conservation and sustainable use of biodiversity is of vital importance.

Quality of biodiversity in Uzbekistan is estimated by experts[102,103] as follows:
- *high and very high* only for 6.8% of territory (comprising protected nature territories, natural forests and shrubs);
- moderate – *for* 50.5% of territory (non-irrigated hayfields and pastures);
- poor and very poor – for 16% of territory.

Only in the strictly protected natural reserves, non-disturbed habitat is being preserved. Limited land areas and scattering of natural reserves stipulate vulnerability of ecosystems and biodiversity in the long-term perspective.

National Planning in area of biological diversity conservation. Biological diversity conservation and ensuring its sustainable use in Uzbekistan are one of priority directions in governmental ecological policy, which is being implemented through various mechanisms, including:
- Development and implementation of the National Strategy and Action Plan for biodiversity Conservation;
- Maintenance of the national Red Book;
- Improvement of normative and legal basis for conservation of ecosystems and ensuring operation and development of Protected Nature Territories (PNT) system;
- Carrying out the state ecological expertise and environmental impact assessments for projects on economic development and other activities;
- Maintenance of fauna and flora cadastres;
- Introduction of economic incentive mechanisms, approaches and methods for evaluation of ecosystem services costs in planning system.

Programs and projects. The first National Strategy and Action Plan for biodiversity conservation and maintenance of ecosystem functions for period 1998–2007, was the most important document, which has played important role for subsequent long-term planning.

As a result of implementing measures and actions of this plan over the recent ten years:
- the Lower Amudarya biospheric reserve, and two nurseries for preservation of Bukhara deer and houbara bustard have been established in the country;
- inventory and description of 51 important ornithological territories have been accomplished;
- Aidar-Arnasay system of lakes has been included in the list of wetlands of Ramsar Convention;
- agreement with Kazakhstan on protection, reproduction and sustainable development of saigak antelope population has been signed.

Besides, a number of laws have been amended, including: " On Nature Protection", "On Protected Nature Territories", "On Conservation and Use of Flora", "On Conservation and Use of Fauna" and some others. Amendments have also been prepared to and considered for 12 laws with the aim of biodiversity conservation principles inclusion into these laws and more explicit reflection of principle "avoid– diminish –restore–compensate" in the extractive industries, taking into account experience gained in oil and gas sector along with exploration of oil and gas deposits in the Usturt Plateau.[102,104]

During the period from 2005 to 2014, a number of Projects on biodiversity conservation received financial support and technical assistance from various international agencies such as: GEF, WB, UNDP, UNEP, GIZ, World Wild Life Fund and others. Among these projects are:
- Central Asian Transboundary Project on Biodiversity Conservation in Western Tien Shan (2006);
- UNDP/GEF Project "Conservation of Tugai Forests and Strengthening System of Protected Territories in the Amudarya River Delta in Karakalpakstan" (2005-2012);

[102] National Report on Environment Conditions and Natural Resources Use in the Republic of Uzbekistan (2008-2011). / Under Editorship of N.M. Umarov; The State Committee for Nature Protection of the Republic of Uzbekistan. -Tashkent: Chinor ENK, 2013. - 260 pages
[103] Biodiversity Conservation. National Strategy and Action Plan. Uzbekistan. – Tashkent, 1998. – 135 pages.
[104] UNDP/GEF/Goskompripoda RUz. Fifth National Report of the Republic of Uzbekistan on Biodiversity Conservation. – Tashkent, 2015. – 58 p.

- UNDP/GEF Project "Strengthening Sustainability of National System of Protected Nature Territories through Focusing on Natural Reserves" (2008-2014);
- International Program "Important Bird Area" (2005-2007);
- UNDP/GEF Project "Integration of Biodiversity Conservation Principles into Oil and Gas Sector of Uzbekistan" (2010-2015);
- UNEP/GEF Project "Preservation and Sustainable Use of Agro-Biodiversity for Improving Support to and Regulation of Ecosystem Services in Agricultural Production Systems of Uzbekistan" (2014-2015);
- European Union Project "Forests and Biodiversity Management, Including Environmental Monitoring (FLERMONECA)" (2014-2015).

The new second National Strategy and Action Plan for biodiversity conservation (NSAPB) for period up to 2025 has been prepared and is under consideration now. It is developed in compliance with the Strategic Plan of Convention on Biological Diversity for 2011-2020 (Aichi Targets), and aimed at achievement of steady balance between economic development of country and continuous development of ecosystems.

Measures and actions aimed at biodiversity conservation have been included in a number of national and sectoral programs and plans, in particular: Program of actions on environment conservation for 2007-2012 and 2013-2017, Strategy for improvement of population welfare of Republic of Uzbekistan for 2013-2015, Program on irrigated lands improvement for 2008-2012 and 2013-2017, Program of measures on development of fishery in the Republic of Uzbekistan for 2009-2011, etc.

In a number of industry sectors of Uzbekistan the Action Plans for biodiversity conservation have been developed and being implemented. In particular, LLC "Lukoil Operating Company" implements the operational sectoral Action Plan for biodiversity conservation for the period 2014-2016, which comprises monitoring, reporting. This plan envisages land rehabilitating, restoring indigenous dominating vegetation, informing local population about activities aimed at biodiversity conservation.

The sectoral Action Plan for biodiversity conservation is being implemented by the JV LLC "Uz-Kor Gas Chemical" within the framework of Surgil project on construction of polyethylene and polypropylene manufacturing plant on the basis of Surgil gas field in Karakalpakstan. The Plan comprises measures on risks mitigation, compensation, as well as monitoring system and programs for evaluation of biodiversity conservation, in compliance with the best international ecological requirements and advanced practice.

Measures for biodiversity maintenance, implemented by departments of MAWR, comprise: afforestation, water management infrastructure improvement, agricultural production pattern diversification, etc.

Enterprises of mining industry and metallurgic sector carry out rehabilitation of disturb lands, as well as cutting, storing and retaining fertile topsoil.

System of Protected Nature Territories (PNTs). Significant importance is paid in Uzbekistan to development of PNTs system. Currently, the national PNTs system includes 8 reserves, 3 natural and 1 national parks, 1 biospheric reserve, 7 natural landmarks, 3 natural nurseries, 12 wildlife reserves, more than 25 water protection zones, coastal strips and aquifer formation zones, 73 forestry enterprises and 5 state forest hunting ranges. However, the total land area of PNTs, ensuring sustainable biodiversity conservation (I-IV categories by definition of International Union for Conservation of Nature – IUCN) is not large and equals to approximately 5% from the country's territory. [105]

Out of 51 the most important ornithological sites of Uzbekistan only 17 sites (or 35.4%) completely or partly coincide with the existing PNTs. The state wildlife reserves are represented by temporary, sometimes seasonal zones with weakened protection regime. The wildlife reserve territories partly belong to other land users, which predetermine their increased vulnerability to anthropogenic factors. [106]

Currently, the draft Program for development of existing PNTs system of the Republic of Uzbekistan up to 2024, has been prepared and considered by the Government. The Program envisages expansion of PNTs land area up to 8,114,140ha, which will improve significantly its representativeness and ensure conservation of the entire range of landscape and biological diversity**.**

Biodiversity monitoring in Uzbekistan is included in the State Program for Environmental Monitoring and implemented through staged enumeration of animal and plant species by biomes. The Program also includes regular hydro-biological observations of species composition of indicating biocenosis, carried out by Uzhydromet predominantly in main water courses of Tashkent province.

Nevertheless, the system of biological monitoring in the country has a number of shortcomings. Biodiversity monitoring in the republic is carried out mainly by some separate directions, with insufficient introduction of integrated monitoring programs. There is a lack of methodological materials, and logistical and technical support.[107] Up till now no standard monitoring programs for each

[105] Review of previous planning processes in area of biodiversity in the Republic of Uzbekistan. Analytical review. UNDP/GEF/Government of Uzbekistan, - Tashkent, 2013

[106] Fifth National Report of the Republic of Uzbekistan on Biodiversity Conservation, UNDP/GEF/Goskompriroda. – Tashkent, 2015 – 58 pages.

[107] National Report on Environment Conditions And Natural Resources Use in the Republic of Uzbekistan (2008-2011). / Under Editorship of N.M. Umarov; The State Committee for Nature Protection of the Republic of Uzbekistan. -Tashkent: Chinor ENK, 2013. - 260 pages

PNTs category have been developed. There are practically no researches on general assessment of ecosystem conditions by use of indicator species. The Government assistance, and logistical and technical support for carrying out researches and establishment of systematic biodiversity monitoring are needed.

Biodiversity vulnerability of terrestrial ecosystems and adaptation measures to climate change. The distinctive feature of majority of ecosystems in Uzbekistan is their increased vulnerability, associated with climate aridity. Apart from the fact that ecosystems experience serious anthropogenic pressure, they are also subjected to strong impact from changing hydrological and climatic conditions.

According to the findings of National Reports on environmental conservation and scientific reports of experts, the process of biodiversity reduction, mainly due to destruction of habitats and excessive use of biological resources is ongoing in the republic. Degradation of habitats and direct extirpation have touched first of all large predators and hoofed mammals. As a result, 87 animal species of aquatic and near-aquatic ecosystems, 47 animal species of desert ecosystems, and 43 animal species of mountain ecosystems are to various extent subjected to danger of extinction.[108] In a number of cases risk of extinction of some species was possible to diminish only due to special measures, such as establishment of protected nature territories, entry of endangered species in the National Red Book, development and implementation of Action Plans on conservation and regeneration of species and their habitats, etc.[96, 97]

The main factors of natural ecosystems destruction in the country are virgin lands development for agriculture and redistribution of surface water runoff, distant-pasture cattle rearing, development of energy sector and mining industry, as well as expansion of economy infrastructure and settlements in mountainous area (See Table 4.22).[96, 109]

Table 4.22 | *Main Risks of Ecosystems Degradation and Biodiversity Loss in Uzbekistan*

Global (external) Risks	Local (direct) Risks, Threats
– Limitation of national water resources – substantial part (more than 85%) of consumed water recourses is formed beyond the boundaries of Uzbekistan; – Climate warming and aridization, aggravating processes of fragmentation and reduction of biodiversity in all ecosystems; – Shrinking of Aral Sea – dried up bottom of Aral Sea turned into zone of ecological disaster and source of sand and salt storms; – Loss of biodiversity components on territories of CAR countries, leading to fragmentation of species habitats	– Increasing economic and demographic pressures on ecosystems; – Lands desertification/degradation, resulting in especially intensive loss of biodiversity in the Aral Sea littoral zone, Usturt Plateau, Kyzylkum desert and piedmont areas; – High anthropogenic pressure on forest ecosystems (unregulated cattle grazing, illegal timber cuttings, fires); – Replacement of natural ecosystems (especially in arable farming) by anthropogenic landscapes; – Cardinal change in hydrological regime of water bodies, water mineralization in river lower reaches and associated degradation of near aquatic ecosystems, – Poaching, uncontrolled harvesting of wild-growing fruits, medicinal plants, etc.

Climate change aggravates land degradation and desertification processes and therefore, affects biodiversity conditions. Presumably, climatic changes are the reasons for habitat changes for some species and faunal complexes of vertebrate animals in plain and low mountain zones[110]. Increase in frequency of droughts occurrence will enhance risks of degradation for aquatic and coastal ecosystems, contribute to water quality deterioration and biodiversity loss, and decrease in ecosystems productivity.

Consistent assessment of the on-going natural processes appears to be very complicated task, since the main natural ecosystem groups of Uzbekistan have been explored non-uniformly throughout the territory in terms of long-term biodiversity dynamics.

In connection with this, analysis of probable responses of ecosystems and their components on climate change relies on expert evaluations, which in turn are based on the fact that majority of climatic scenarios for Uzbekistan assume increase in air temperatures and climate aridity, and shifting of climatic seasons (see Box 4.4).

[108] Red Book of the Republic of Uzbekistan: Rare and Endangered Species of Plants and Animals. In 2 v. – 3rd ed.-Tashkent: Chinor ENK, 2009.

[109] Review of Previous Planning Processes in Area of Biodiversity in the Republic of Uzbekistan. Analytical Review. The UNDP/GEF/Government of Uzbekistan Project "National Planning Biodiversity Conservation in support of implementing in Uzbekistan the Strategic Action Plan for Convention on Biological Diversity for 2011-2020", Tashkent, 2013

[110] Talskikh V.N., Mitropolsky O.V. Biological Diversity Response to Climate Change and Adaptation Measures // Climate Change Impacts, and Adaptation Measures.- Bulletin № 7. Tashkent: NIGMI, 2008. – pages 62-67.

Box 4.4

Expert predictions of ecosystems and their components response to climate change. In perspective increase in air temperatures will entail upward shift of zonal belts in mountains. If for ecosystems of lower and middle mountain belts there will not be any significant problems, then negative impacts are possible for species inhabit alpine and sub-alpine belts. The most vulnerable are small species, such as stenophagous insects and plant species with vegetative reproduction prevailing over seed reproduction, as well as species with narrow ecological niches. Hence, it is arisen necessity for increased attention to monitoring flora and fauna in high mountain belts and elaboration of issues associated with their probable cultivation in ex-situ conditions.

Substantial negative impact on majority of bird and large mammal species will be associated with competitions with domestic animals, because their number will unavoidably be increasing in mountain pastures and on watering sites. Pasture management in low maintain and piedmont areas could mitigate this problem, which would require study and dissemination of experience from other regions.

Shifting in intra- year seasons, and in particular, late fall of majority precipitation amount may adversely impact survival of ephemerous and ephemeroid plants, as well as other early flowering plants due to mismatch of actual temperature and humidity regimes with favorable ones for their development. Insect species related to such vegetation may suffer accordingly.

Increase in share of liquid precipitations will entail growth of mudflow activities in mountain and piedmonts areas, and as a consequence, soil erosion and habitat deterioration.

Climate change will also cause various impacts on spatial distribution of tree and shrubbery vegetation biocenosis. It is unlikely that tree vegetation in plain deserts will be changed significantly because soil salinity conditions with shallow groundwater table in solonchaks will remain practically unchanged. Sand vegetation most probably will remain in the same growth conditions as now. Its tolerance for high air temperatures in summer has already been formed during evolution process. However, more arid and hot conditions may lead to decrease in productivity of saxaul (Haloxylon) and other associated plant species.

Tugai forests growing in flood plains and riparian belts, requiring intermittent flooding, will not suffer too much with retained floods. However, with change in flooding regime and decrease in river water flow it is possible narrowing of tugai forest belts and their further fragmentation.

Xerophytic tree species in piedmont and low mountain areas during evolution process have developed sufficient tolerance to survive with minimum precipitations and high air temperatures in summer. Besides, xerophytic tree species habitat is quite wide and covers territories with various eco-geographical conditions, which they are well adapted to.

Almond (Amigdalus) and pistachio (Pistacia vera) are xerophytic plant species with wide ecological amplitude and therefore, increase in air temperatures should not impact them very.

Vegetation belts of coniferous archa (Juniperus) forests may suffer with increase in air temperatures, due to rise in orographical elevations of their habitat boundaries and narrowing altitudinal belt of their dispersal. Favorable combination of climatic factors will be shifting up in respect to orographical elevations of current habitat belt of particular archa species. This means that in the current archa habitat belts conditions for its growth and reproduction will be changed significantly, especially at lower elevations of its current growing. The most vulnerable to climate change is dendritic form of archa (Juniperus turcomanica), which may extinct in accordance with scenario for the long-term perspective.

Tree vegetation in leafed forest belts of medium-altitude mountains, comprising such mesophytic tree species as walnut (Juglans), poplar (Populus), apple (Malus), etc., accompanied by mesophytic shrubs, may turn out to be in most difficult conditions. They are already now in very tense situation for survival. With deterioration of soil water regime this mesophytic vegetation may be pushed out by more aggressive siccocolous low tree and shrub vegetation. Increase in air temperatures, especially in summer with simultaneous decrease in soil moisture content may lead to considerable narrowing habitat of mesophytic plant species.

Possible decrease in nectar yields of nectariferous flowering plant may lead to death of some insect species, especially nectarivorous monophages (some species of butterflies, pollinating insects), etc.

Trends towards transformation and fragmentation of desert, river flood plains, piedmont and low mountain ecosystems will be retained or strengthened.

4.6.2 Aquatic Ecosystems, Their Diversity and Vulnerability to Climate Change

In Uzbekistan integrated and systematic hydro-biological observations over surface water quality were actually commenced from 1978 and include observations over species composition and pattern of indicating biocenosis (periphyton, zoobenthos, macrophytes) in the Akhangaran and Chirchik river basins (Tashkent oasis), water courses of Fergana valley, water courses of the Surkhandarya and Kashkadarya river basins. Aquatic biocenosis of lake ecosystems in the middle and lower reaches of Amudarya river have been studied in various years under international projects sponsored by UNESCO, IWACO, GEF/WB.

The on-going climate change in combination with the anthropogenic stress may entail certain negative changes in water quality of aquatic ecosystems, lead to disturbance of their fully formed ecological equilibrium, decrease in or loss of their biospheric and social functions, i.e. enhance their vulnerability on a background of general ecological regress, which is already now come out acutely in years with water shortage and extremely dry years, which may be considered as analogues of predicted climate warming and aridization. This methodological approach seems so far as the only one possible option for assessment of vulnerability and expert forecasts due to insufficiency of monitoring data for river and lake type aquatic ecosystems.[111,112]

Change in volume of water resources as a result of anthropogenic activities had negative impact on sustainable functioning of rivers and connected with them lake ecosystems in the river lower reaches, causing water deficiency during vegetation period. In Uzbekistan collector and drainage waters have the highest negative impact on water quality in the Amudarya river delta and in lower reaches of its main tributaries. Industrial and municipal effluents impact most of all on aquatic ecosystems in the districts with rural and industrial agglomerations.

In the river upper watersheds (UWS) without noticeable anthropogenic impact, changes in hydrological and biological river features are of natural kind, depending mainly on dynamics of climatic factors, which in turn depends on prevailing watershed elevation and river feeding type. The general impression on pattern of the upper watershed rives' temperature regime (as the important abiotic factor for aquatic biota) gives classification in Table 4.23[103], which is based on combination of river location elevation and landscape.

Table 4.23 | *Distinctive Ecological River Features in Upper Watersheds in Relation to Prevailing Type of Their Feeding*

Prevailing Feeding Type	Distinctive Features
1. Glacier-snow	Full- and cold water rivers: with extended flooding and its peak in summer-autumn period; characterized by poor development of aquatic biota and relatively high "passivity" in regard to climatic factors.
2. Snow-glacier	
3. Snow	Intermediate type of rivers with spring-summer shorter flooding and lesser "passivity" in regard to climatic factors.
4. Snow-rainfall	Water-short rivers: with short spring flooding, intensive water warming-up in summer, high or even ample development of aquatic biota; very sensitive to change in climatic factors, and therefore have pronounced seasonal nature of hydrological and biological stages over annual cycle.
5. Groundwater-rainfall	Water-short rivers and streams: with very short spring flooding, ample development of aquatic biota and predominance of heterotrophic component in trophic structure of aquatic biocenosis; extremely vulnerable to change in climatic factors and conditions of adjacent landscapes.

In general, river water quality in upper watersheds, calculated by integrated biological indices, remains high: within Class I and II (very clean and clean waters); with mineralization from 89 to 309 mg/dm^3 in rivers with types of feeding 1-4, and up to 420 mg/dm^3 – in rivers with type of feeding 5 at their lower boundary. In water shortage and dry years water quality in the upper watersheds deteriorates and may correspond to Class II and III (clean and moderately polluted waters).

Content of specific pollutants, such as heave metals, phenols, petrochemicals (natural hydrocarbons), pesticides and others does mainly not exceed MAC. Their content depends mainly on natural geochemical background, progress level of background biological processes in river ecosystems and regional transfer of pollutants. In general, water quality is suitable for use it without limitations in all types water consumption.

At the same time, as a result of anthropogenic activities, land degradation processes (deforestation, erosion, pollution by wastes and pastures shrinkage) are being enhanced in piedmont and mountain areas. The zone of intensive runoff consumption also shifts

[111]Rubinova F.I. Ameliorative Water Use Impact on Runoff and Hydro-Chemical Regime of the Aral Sea Basin's Rivers // SANIGMI, 1987, Edition 124(205), 159 pages.

[112] Talskikh V.N., Beglov E.O. Climatic Factors Impact on Aquatic Ecosystems and Adaptation Measures // Climate Change Impacts, and Adaptation Measures - Bulletin № 7. Tashkent: NIGMI, 2008. – pages 53-61.

towards higher elevations due to expansion of urbanized and recreational zones with associated river flow diversion by local intakes. The latter entails hydrological eutrophication of small rivers and their water quality deterioration within lower mountains, especially pronounced in dry years. [113]

These negative processes aggravate vulnerability of river types 4 and 5 to climate change, which in the conditions of increased dry year recurrence may be accompanied by growth of background concentration of some pollutants. [114] In such situation it is important on the one hand to prevent further increase in organic pressure on biocenosis of these water courses, and on the other hand to retain natural grass cover on mountain slopes, regulating intensity and uniformity of underground and spring water inflow to these water courses.

As a result of climate warming and air temperatures increase, in some rivers of upper watersheds with types of feeding 1-2,[115] it is observed stable negative trends towards increase in water temperatures and mineralization, associated with growth in snowmelt runoff contribution in their respective basins (Figure 4.61).

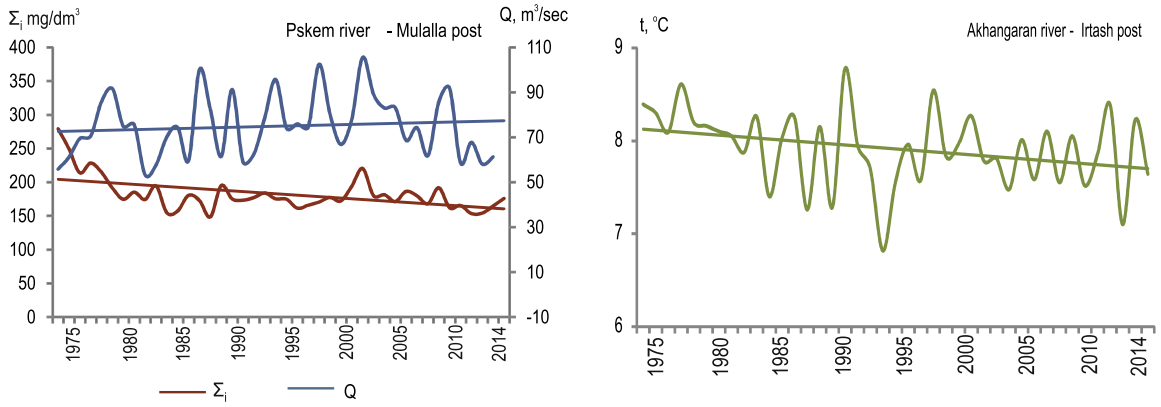


Figure 4.61 | *Variations in Long-terms Values of Temperatures (T, °C), Mineralization (Σi) and Water Discharges (Q) in Some Rivers of Upper Watersheds (UWS)*

Rivers in zone of intensive runoff consumption (ZIRC). Current situation in the zone of intensive runoff consumption is characterized by high degree of river flow regulation, mineralization and pollution of waters and landscapes. In the long-term perspective, variations in quantity of chemical ingredients in river water of this zone have both positive and negative trends.[116] During the recent 15-20 years, there is practically no increase in new land area developed for irrigation and no any growth in drainage waters runoff. Therefore there is no countrywide increase in river water mineralization. However its increased level remains in the main rivers lower reaches. Variations in water mineralization values over the recent years are mainly associated with climatic factors, namely, with long-term variations in water runoff.

In lower reaches of all rivers the inverse proportion between water mineralization and water discharges is well pronounced. Their average annual correlation coefficients vary in the range from 0.68 to 0.83. Meanwhile, in dry years (1986, 1989, 1997, 2000, 2001, 2011) in ZIRC the average annual values of water mineralization within rivers low reaches may rise by 1.1 – 1.6 times against long-term average ones, and in some month – by 2 – 5 times. This indicates that climate warming may lead to deterioration of river water quality. In the conditions of on-going climate aridization and retention of unchanged situation in surface water management, increase in river water mineralization in the zone of runoff consumption should likely be expected. [117]

Between river upper and middle reaches water quality changes from Class II to III (moderately polluted waters). This water category is the most distinctive for ZIRC rivers, where down the water course length, cannel siltation, sediments pollution and macrophytes and filamentary green algae weediness increase along with water mass warming-up. In estuary of these rivers with brackish water, aquatic flora and fauna species are being developed. The latter comes out in summer-autumn season, but especially in dry years, when water quality by hydro-biological indices in estuaries may drop down to Class IV (polluted waters). Most likely, these trends will be retaining or even enhancing, with increase in duration of dry and warm periods in conditions of on-going climate aridization.[108]

[113] Talskikh V.N., Problems of River Ecosystems Eutrophication in Central Asian Region // Problems of Conservation And Rational Use of Biological Resources of Uzbekistan's Water Bodies: Materials for Republican Scientific and Practical Conference. Tashkent, 2001, pages 92-96

[114] . Talskikh V.N., Beglov E.O. Climatic Factors Impact on Aquatic Ecosystems And Adaptation Measures // Climate Change Impacts, and Adaptation Measures - Bulletin № 7. Tashkent: NIGMI, 2008. – pages 53-61

[115] Spectorman V.Yu.Climate Change Scenarios for the Territory of Uzbekistan and Zones of Flow Formation of Amudarya and Syrdarya Rivers. – Bulletin No 9. – Tashkent, 2015. – pages 29-39.

[116] Rubinova F.I. Drainage Water Impact on Runoff and Hydro-Chemical Regime of the Aral Sea Basin's Rivers // SANIGMI, 1987, Edition 124(205), 159 pages.

[117] Nikitin A.M. Lakes of Central Asia. – Leningrad., Hydrometeoizdat, 1987, - 106 pages

Lake ecosystems in Uzbekistan are of various origins. Mountain lakes are usually of rock-dammed or glacier origin. Number of lakes in Uzbekistan is relatively small with water surface area less than 1 km^2. In plains the predominant type of lakes has become irrigation/drainage water disposal lakes, formed during recent decades in landscape depressions as a result of discharge flood or drainage waters. They are mainly located beyond boundaries of irrigated land massifs in the middle and lower reaches of the Amudarya and Syrdarya rivers and their deltas.

Practically all plain lakes are "very open" ecosystems that in combination with high evaporation rate (up to 2000 mm and more) stipulates their high dependence on climatic factors. Such large lakes by water surface area as the Dengizkul, Tuzkan, Aidar, Togiz-Tore have very high values of openness indices – from 41 to 300. Dependence on climatic factors is especially pronounced for drainless lakes, which are characterized by higher salts content. At reaching and passing over certain mineralization threshold these lakes are also characterized by progressing swamp formation[108], which restricts scope of ecosystem services being provided. [118]

During water shortage "crisis" years mineralization of lakes water increases considerably as compared with its value during usual or average by water availability years. In such periods water mineralization in upstream lakes, filled with river water, increases by 2.5 times, and at the lower end of lake chain – by 6 – 9 times. This is typical for Amudarya delta lakes. In running-water lakes, fed by drainage waters, water mineralization in upstream lakes is practically repeats the hydrological and hydrochemical regimes of inflow water and may be increased by 1.5 – 3 times. In drainless lakes located in the lower river reaches water mineralization increases by 1.5 – 4.1 times.

The main threats to development of wetlands in the Amudarya river delta are unstable hydrological regime and their ecosystems unsustainability, entailing in dry years degradation of aquatic and near-aquatic ecosystems, disturbance of ecological equilibrium, risk of running-water lakes weediness and loss of social and ecological functions. For drainless lakes the main threat is lack of flowage and as a consequence progressing mineralization, weediness and swamp formation, which is especially pronounced in dry years.

Increasing climate warming with retention of unchanged situation in river delta water management, will more and more aggravates vulnerability of lake ecosystems. Majority of irrigation/drainage water disposal lakes are important for maintenance of local biodiversity and have high fishery capacity. Preservation or loss of their social and biospheric value depends to large extent on hydro-technical, ameliorative and managerial measures. Implementation of these measures or failure to do so may predetermine ecological progress or regress for these ecosystems, and correspondingly, retention or loss of their socially beneficial functions.[119]

Aral Sea and Priaralie (Aral Sea Littoral Zone). Growth of water withdrawals in 1970-80s for irrigation of increased large irrigated land areas for increase in cotton production, accompanied by shrinkage of the Aral Sea, has lead to ecosystems degradation in the Priaralie. Major part of this zone, more than one million ha, is Amudarya river delta. Not long ago the Sea and Amudarya river delta have provided local population with fish, hunting game, reeds/cane and other numerous ecosystem services, and acting as the natural climatic regulator for adjacent territories.

The country applies great efforts for solution of practical tasks aimed at overcoming this ecological disaster. Starting from 1990s, a number of programs and projects have been implemented in Uzbekistan. In particular, it was approved Plan for 2013, on financing projects and measures in the Priaralie for the total amount equivalent to USD1.3 billion. The Plan comprised creation of small local ponds in the Amudarya river delta, construction of water intake structures with de-salination plants, creation of protective forest plantations and ornithological monitoring of water bodies in the Southern Priaralie. Currently protective forests have been planted in the Aral Sea dried bottom on the total area of 350.7 thousand ha. [120] Creation of protective forest plantations from desert plant varieties is one of the efficient means to control transfer of harmful dust and salt particles. Transfer of harmful particles from land surface sharply decreases in the zone of protective forest plantations, root system of saxaul and other shrubs fixes sand barchans, facilitating emergence of grass cover and therefore, restoration of ecosystems, and creates conditions for development of pastures, which in future can be used for establishment of cattle breeding farms.

Taking into account increasing aggravation of ecological, socio-economic and humanitarian consequences of the Aral Sea drying-up and degradation of human living environment in Priaralie, the First President of the Republic of Uzbekistan took the initiative on 68th session of United Nations General Assembly (September 2013) to distribute as the official document the "Program of Measures on Elimination of Aral Sea Drying-up Consequences and Prevention of Ecosystems Disaster in Priaralie".

The Program envisages implementation of the following most important measures to combat the Aral Sea crisis consequences:

- Creation of conditions for living, reproduction and preservation of genofond in Priaralie;
- Improvement of system for management and rational use of water resources.

[118] Talskikh V.N. Study of Periphyton and Zoobenthos in Lakes of Sudochie Wetland: Main Results And Lessons Learned // Ecological Sustainability and Advanced Approaches to Water Resources Management in the Aral Sea Basin: Materials of International Central Asian Scientific and Practical Conference, Almaty, 5-8 May 2003. - Almaty-Tashkent, 2003. - pages 369-375

[119] The Economic Potential of Fish of Delta Zone of the Amudarya River and Problems of its Sustainable Development / Joldasova I., Pavlovskaya L., Lyubimova S., Urasinbetova B., Temirbekov R. – Towards Rational Water and Land use Management in the Northern Amudarya Delta Region. Intas Project Meeting, Nukus – 2002. – p. 17-19.

[120] National Report on Environment Conditions and Natural Resources use in the Republic of Uzbekistan. The State Committee for Nature Protection. -Tashkent: Chinor ENK, 2013. - 256 pages

- Maintenance of natural water bodies system in the Aral Sea aquatory;
- Implementation of large scale measures on forests planting in the dried-up Aral Sea bottom, and prevention of region's desertification;
- Biodiversity conservation, regeneration of biological resources, protection of fauna and flora;
- Further improvement of institutional basis and strengthening cooperation between region's countries within the IFAS framework, as well as activization of efforts aimed at attraction of the world community attention to solution of problems, associated with the Aral Sea disaster.

Currently, the governmental "Integrated Program on Mitigation of the Aral Sea Disaster Impact, Rehabilitation and Socio-Economic Development of Priaralie for 2015-2018" was developed for mobilization of technical and financial resources in the country.[121]

In the conditions of current and expected climate change it is possible exacerbation of complicated ecological situation in Priaralie and degradation of delta ecosystem. For example, in Mejdurechye reservoir during dry years biomass of phytoplankton may be increased in various seasons by 20 – 400 times, and in more eutrophic Muinak bay – by 2.3 – 15 times as compared with the average year by water availability. So, in 2000-2002, crisis situation was registered in all lake ecosystems of delta, stipulated by extreme water shortage. During the last two years lake systems of Amudarya river delta practically completely degraded and for indefinite time lost all their ecosystem (biodiversity) and socially beneficial functions and services.[122,123]

Although the delta water bodies have experienced the whole set of negative changes, such as decrease in water volume, water mineralization increase, biodiversity and biological productivity decrease, they nevertheless considered as the most important elements of stability and vital means of living source for local communities in the region. According to opinion of majority of local experts their rehabilitation is precondition for mitigation of the Aral Sea crisis. Among other things, the region's sustainable wetlands may be the efficient greenhouse gases sink.

Stabilization of ecological and socio-economical situation in Priaralie, including through creation of landscape ecosystems in the Amudarya river delta and improvement of its natural productivity of biological resources is one of the most important priority tasks for Uzbekistan. Stabilization of social and ecological situation in Priaralie, creation of relevant infrastructure will obviously improve sustainability of Priaralie ecosystem in the conditions of current climate variability and allows adaptation capacity building to climate change in future.

Aidar–Arnasay lake system, comprising Aidarkul, Tuzkan and Upper Arnasay lakes was formed in abnormally wet year of 1969, as a result of 21km^3 water volume release from the Chardara reservoir on Syrdarya river into natural depression. The emerged lake system that combined Aidar, Tuzkan and Arnasay depressions, at that time reached the area of 2,000 km^2 with water mineralization ranging from 2 to 4 g/dm^3. The emerged water body has been characterized by high biological productivity. These lakes have become a base for fishery development. Starting from 2006, volume of water releases from the Chardara reservoir was decreased, and in some years there was no water releases at all. Water inflow reduction has led to beginning of new regressive phase, accompanied by water level recession and its mineralization increase, which reached 10g/dm^3 in the Aidarkul lake.

Currently, the Aidar-Arnasay lake system in addition to its fishery capacity, gains the important ornithological value both for Uzbekistan and Central Asia as a whole. It has become place for nesting, migrating stops or wintering for substantial number of waterfowl and near water birds (up to 120,000 bird species), including bird species listed in the International and Uzbekistan's Red Book. In 2008, the Aidar-Arnasay lake system was included in the list of Ramsar Convention on wetlands of international importance. Therefore, responsibility for conservation of this lake system, maintaining high biological diversity of regional importance, increases correspondingly.

Study of conditions and perspectives for development of the Aidar-Arnasay lake system by departments of Uzhydromet (NIGMI), Goskompriroda of RUz, Academy of Science of RUz (Institute of flora and fauna genofond) have indicated that water level recession in lakes started from 2006, and pattern of their use, are accompanied by deterioration of their ecological conditions and adjacent territories, expressed in gradual water mineralization increase and formation of degraded parts of dried bottom and coastal belts salinization[124].

The on-going climate change will aggravate the above mentioned negative trends and vulnerability of the Aidar-Arnasay lake system. For ensuring stabilization of ecological situation in the long-term perspective, adaptation measures will be required, including:

[121] Decree of the Cabinet of Ministers dated 24.12.2014, #PKM-363 «On measures to Implement the Agreements Reached at the International Conference" Development of Cooperation in the Aral Sea Basin Region to Mitigate Environmental Catastrophe"// Law Book of RUz, 2014, #52, Article 626.

[122] Talskikh V.N., Beglov E.O. Climatic Factors Impact on Aquatic Ecosystems and Adaptation Measures // Climate Change Impacts, and Adaptation Measures - Bulletin № 7. Tashkent: NIGMI, 2008. – pages 53-61.

[123] Tuchin A.I., Gromyko K.V., Ruziev I.B. Ecological Problems of Southern and Northern Priaralie and Proposals for their Functions Rehabilitation and Stabilization // Ecological Sustainability and Advanced Approaches to Water Resources Management in the Aral Sea basin: Materials of International Central Asian scientific and practical conference, Almaty, 5-8 May 2003. - Almaty-Tashkent, 2003. - pages 341-351.

[124] National Report on Environment Conditions and Natural Resources Use in the Republic of Uzbekistan (2008-20110). The State Committee for Nature Protection. - Tashkent: Chinor ENK, 2013. - 256 pages

a) improvement of stationary monitoring system;
b) ensuring annual guaranteed sanitary water releases in order to stabilize water level within the framework of integrated water resources management introduction in the middle reaches of Syrdarya river;
c) ensuring water flowage in water bodies that will allow certain desalinization of water volume and efficient use of lake system water resources in the long-term perspective.

Therefore, climatic factors have impact on aquatic ecosystems functioning through change in volume of surface water runoff, which is subjected to considerable fluctuations. During dry years (with 95% probability) water runoff in the main river basins of Amudarya and Syrdarya may be decreased by 1.7 times against the long-term average volumes, accompanied by deterioration of water quality and ecological conditions of rivers and aquatic ecosystems, decrease or loss of their ecological and socially beneficial functions. This is especially pronounced in the "crisis" dry years in the low reaches/closing systems, which are Amudarya river delta and its lakes system, as well as the Aral Sea.

In general, knowledge level and information about transformation of aquatic and adjacent ecosystems are insufficient. Therefore, the regional integrated monitoring of ecosystems is extremely important, since ecological situation in the Aral Sea basin is very dynamic and unstable.

Adaptation measures for aquatic ecosystems. In the conditions of current water deficiency aquatic ecosystems have turned out to be very vulnerable to progressing climate aridization. For retention and maintenance of ecosystems' ecological and socially beneficial functions it is required the certain strategy for their management and the following adaptation measures:

- *Development and improvement of integrated ecological monitoring of aquatic and adjacent coastal ecosystems,* including inventory of various aquatic ecosystem types, development of background monitoring in the rivers upper watersheds, governmental support to scientific researches, dissemination of information about climate impact on conditions of aquatic ecosystems;
- *Development and introduction of methods and approaches to integrated management of aquatic ecosystems,* including development and implementation of territorial programs for management of especially valuable aquatic ecosystems (delta lakes); elaboration of norms and rules of aquatic ecosystems operation in order to reflect essential ecological provisions in water law; expansion of integrated river basins management, including land resources, and upper watersheds with vegetation cover;
- Creation of favorable hydrological conditions, ensuring satisfactory ecological conditions in deltoid and irrigation/drainage water disposal lakes: to identify and maintain minimum water levels, preventing water bodies drying-up; ensure control and provide technical means (infrastructure) for maintenance of minimum and maximum water levels for ensuring natural biological cycles, reproduction of commercial potential and the main components of biodiversity in aquatic ecosystems.[125, 126]

4.6.3 Forests and Forestry, Threats, Mitigation and Adaptation Measures to Climate Change

Forests impact significantly on climatic conditions, ensuring supply of oxygen for human beings, and being the only long-term natural sink of carbon dioxide. Forest plantations help to preserve all nature diversification by performing ecological and environment forming functions.

Forests in Uzbekistan differ substantially by their composition and can be subdivided into desert, mountain, tugai (flood-plain forests) and artificial forest plantations in oasis. Taking into account forests importance, consistent works for their conservation are carried out in the republic. In accordance with the Law "On Forest" (1999), the Main Administration for Forestry under Ministry of Agriculture and Water Resources is responsible for coordination of all forestry activities. The Main Administration for Forestry regulates use, conservation, protection, reproduction and productivity improvement, development and implementation of normative and legislative basis, conservation of biological and landscape diversity.

Unauthorized tree cuttings and unregulated cattle grazing cause tangible damage to forest fund. Among factors that have negative impact on forest fund conditions are poor quality of seeds and low survival rate of forest crop seedlings, insufficient introduction of advanced methods in seedlings production and availability of gaps in the system of forest resources monitoring. [127]

Capacity of measures for mitigation of climate change impact in forestry. Mitigation measures of climate change impact in forestry allow getting higher increase in forest productivity. Such effect may be obtained by various ways or combined actions aimed at qualitative and quantitative increase/improvement of forestry activities, including:
a) measures on afforestation – planting of new forest on land where it was no forest in the observable past;

[125] Kreitzberg-Mukhina E.A., Mirabdullaev I.M., Talskikh V.N., Main Results of Ecological Monitoring on Sydochie Wetland // Ecological Sustainability and Advanced Approaches to Water Resources Management in the Aral Sea Basin: Materials of International Central Asian Scientific and Practical Conference, Almaty, 5-8 May 2003. - Almaty-Tashkent, 2003. - pages 355-363

[126] Talskikh V.N., Problems of River Ecosystems Eutrophication in Central Asian Region // Problems of Conservation and Rational Use of Biological Resources of Uzbekistan's Water Bodies: Materials for Republican Scientific and Practical Conference. Tashkent, 2001, pages 92-96.

[127] National Report on Environment Conditions and Natural Resources Use in the Republic of Uzbekistan (2008-2011). The State Committee for Nature Protection. - Tashkent: Chinor ENK, 2013. - 256 pages.

b) measures on forest restoration, i.e. planting of forest where it was forest in the observable past, but for some reasons it disappeared now;
c) measures allowing to increase GHGs sink in the already existing forest plantations by:
- their densification (partial or up to the standard number of plants per unit area on account of artificial seeding/planting of trees/shrubs;
- facilitating natural forests reproduction;
- implementation of measures creating better conditions for plants growth.

Expert estimates, carried out within framework of preparation of the TNC, indicate that the territory of Uzbekistan has considerable potential for increasing greenhouse gases sink in the State Forest Fund and in other land categories, which in total may be equal to 14 Mt CO_2 per year (Chapter 3).

Strategy for forestry adaptation is associated with elimination of vulnerability threats and factors. It includes:
- development of monitoring system for conditions of forest plantations, implementation of development plans and formation of database for all forest plantations in the country;
- strengthening of material, technical and methodological basis for obligatory forest regulation by all forest fund owners and provision of the organizations concerned with reliable and updated statistical data on relevant forest areas by plant species composition, age pattern, timber supply, which in turn will allow to prepare feasible plans for forestry development, i.e. to take correct managerial decisions;
- improvement of efficiency in implementing measures on afforestation and forests recreation, including development and approval of the state program for science-based creation of field-protective forest belts on irrigated arable and rainfed lands;
- measures on prevention of unregulated cattle grazing in forest lands, unauthorized tree cuttings, fire, and measure on pest and diseases management;
- preparation of perspective plans for development of forestry enterprises on the basis of forest typology taking into account vulnerability of forest ecosystems to climate change;
- strengthening of forestry human and scientific capacity, including necessity of special forestry education for administrative staff, provision of system for continuous advanced trainings and development of applied scientific researches.

4.7 Climate Change Impact on Energy Resources Consumption in Economy Sectors

According to the International Standards,[128] cumulative differences between indoor and outdoor daily air temperatures - HDD (Heating degree days) and CDD (Cooling degree days) are proportional to energy consumed for buildings heating and cooling. The HDD and CDD are used in many countries. Criteria for their calculation are determined by climatic conditions, type of buildings and desirable indoor temperature.[129]

The HDD index is not used in Uzbekistan so far. Therefore it was necessary to indentify its conformity to DDHS (degree-days of heating season) index, currently used in Uzbekistan.

For assessment of indices conformity, values of HDD index for criteria 16 and 18°C (HDD16 and HDD18[130]) have been used:
- HDD18 index, calculated for October – April is practically identical to DDHS index, computed for criteria with outdoor and indoor air temperatures of 10°C and 20°C respectively at the beginning/end of heating season;
- HDD16 index has turned out to be close to DDHS one, computed for criteria with outdoor and indoor air temperatures of 8°C and 18°C respectively (See Figure 4.62).

The DDHS index is computed at the end of heating season, describing by one number the whole period of year interchange, which does not allow comparing its value with statistical data, collected for the whole

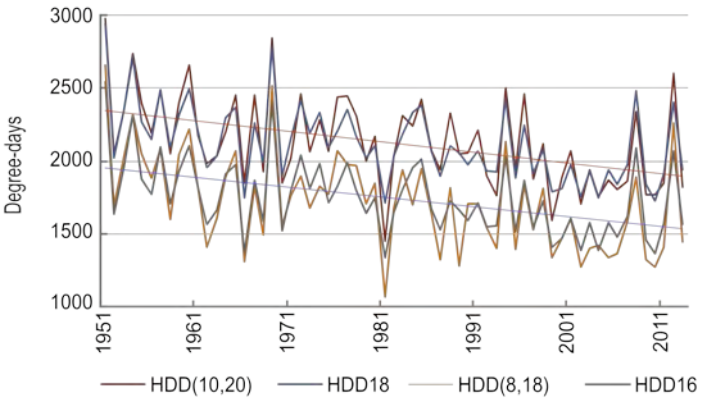


Figure 4.62 | *Correlation between HDD and DDHS Indices, Computed for Tashkent for Period 1951-2013*

[128] ISO 15927 – 6. 2009. Hygrothermal Performance of Buildings — Calculation and Presentation of Climatic Data —Accumulated Temperature Differences (degree days).
[129] A practical Introduction «Degree days for energy management». Carbon Trust, 2012. Degree days for energy management a practical introduction, Carbon Trust 2007.
[130] Spectorman T.Yu. Change in Applied Climate Characteristics Needed for Vulnerability Analysis of Energy and Other Economy Sectors // Climate change, reasons, impacts and response measures, Bulletin No. 10. – Tashkent, 2016. – p. 17-28.

calendar year. Therefore, the DDHS index, currently used in normative documents[131], cannot describe the value of annual energy consumption for heating of buildings.

The HDD18 index, computed from daily data for calendar year, allows to do so (See Figure 4.63). Data on energy consumption for heating in Uzbekistan are taken the reference.[132]

Climate change impact on energy consumption for cooling is identified by values of the CDD index, computed for hot period of year by criteria 20 and 25°C (CDD20 and CDD25). Evaluation of the HDD and CDD indices for perspective has been computed using histograms of annual air temperature variations based on monthly data for various GHGs emission scenarios[133] (WRE450 (soft), WRE750 (moderate), A1FI (extreme)).

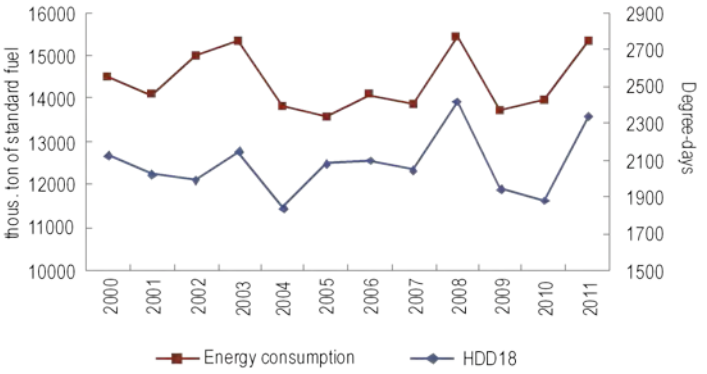


Figure 4.63 | *Correlation between HDD18 index, Averaged by Center Towns of Uzbekistan's Provinces, and Energy Consumption for Heating for Period 2000–2011*

Energy consumption for buildings heating. Half of the total energy consumption in Uzbekistan (around 17 mln. t.o.e. per year) is used for buildings heating.[134] Due to deterioration of engineering pipeline infrastructure and insufficient isolation, energy consumption in buildings is by 2-2.5 times higher than in other countries. The considerable energy losses and substantial potential available for energy saving identify necessity for improvement of energy efficiency in buildings.

Calculations have indicated that as result of air temperature increase by entire territory of Uzbekistan there is a trend towards decrease in value of the HDD18 index, which describe physical energy requirements for heating on background of its high inter-annual variability (See Table 4.24).

Table 4.24| *Variations in Average 20-year Values of HDD18 Index by Some Cities of Uzbekistan*

Parameters	Nukus	Samarkand	Tashkent	Termez	Bukhara	Fergana
Average for 1950-1969	3230	2353	2326	1674	2273	2453
Average for 1994-2013	2857	2011	1989	1487	1999	2123
Decrease in %	13	17	17	13	14	16

As indicated in the Table 4.24, energy resources requirements for heating by Uzbekistan's cities in the current period are by 10-15% less than in the previous years (1950-1969). This decrease has to some extent compensated the considerable heat losses. Demand in energy resources for heating during extremely cold and warm years may differ by more than 50%. Therefore, it is necessary to regulate strictly heat generation in compliance with outdoor air temperatures. Due to predicted increase in air temperatures in accordance with GHGs emission scenarios, energy resources requirements for buildings heating will continue reducing (Table 4.25). Evaluation of changes by 2040 may be considered as forecast.

Table 4.25 | *Average Values of HDD18 Index for Baseline Period (1980-1999) and Current Period (1994-2013), and Their Estimates in Accordance with GHGs Emission Scenarios by Uzbekistan's Cities*

Parameters	1980-1999	1994-2013	2021-2040	2041-2060			2071-2090		
			Predictive Estimates	WRE450	WRE750	A1FI	WRE450	WRE750	A1FI
Norms, °C	2231	2117	2026 - 2010	1974	1922	1782	1906	1608	1328
Variations in %	0	-5	From -9 to -10	-12	-14	-20	-15	-28	-40

[131] KMK 2.04.05.-97*. Heating, Ventilating an Air Conditioning. Approved by Gosarchirektstroy. 12 July 2011: Directory of Normative Document in Force in Construction Sector (as of 1 July 2013); Prepared by the Information Center of AQATM Gosarchirektstroy RUz – Tashkent, 2013.

[132] UNDP/Ministry of Economy. Energy Efficiency in Buildings: Hidden Resource for Sustainable Development of Uzbekistan. – Tashkent, 2014.

[133] T.Yu Spectorman. Climate Change Scenarios for Territory of Uzbekistan and Upper Watersheds of Syrdarya and Amudarya Rivers. Climate Change, Reasons, Impacts and Response Measures, Bulletin № 9, Tashkent 2015, pp. 29-39

[134] UNDP/Center for Economic Studies. Analytical Report 2011/09. "Green" Buildings in Uzbekistan: Technologies, Norms and Incentives. – Tashkent, 2011.

On average by Uzbekistan for the soft scenario of GHGs emission WRE450, variations in HDD index will retain the already observed trends towards reducing on the background of its high variability. For the moderate scenario WRE750, the probable reduction in energy resources requirements for heating is estimated in 28%, that of for extreme scenario A1FI is around 40%.

Possible benefits for energy sector from climate warming will be expressed in reduction of duration (Figure 4.64) and intensity of heating season throughout the territory of Uzbekistan on account of decrease in number of days with cold air temperatures.

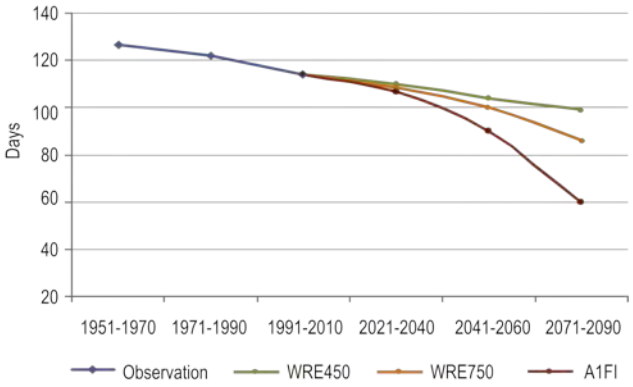


Figure 4.64 | *Variations in Average 20-year Values of Heating Season Duration (criterion is stable transition over +8°C) in Uzbekistan in Accordance with GHGs Emission Scenarios*

High natural climatic variability will not allow refusing from the existing heating systems in future. However, efficient energy resources management for heating, taking into account climatic variability, may give their considerable saving.

For promotion of energy saving in buildings it is expedient to set up more energy saving criteria. For example, for majority of building it is possible to use the HDD16 index, and HDD18 - for social sector buildings, value of which is on average higher by 17.7% than HDD16 index.

With the overall climate warming, the probability of intensive cold waves and rather cold temperatures occurrence in future is remained.

For example, rates of minimum monthly air temperatures, computed for various scenarios (even for extreme warming scenario), by 2050 will remain below -10°C, and once in 10 years air temperature may be dropped down below -18°C. Hence, in spite of overall climate warming in Uzbekistan, demand for efficient heating systems is remained.

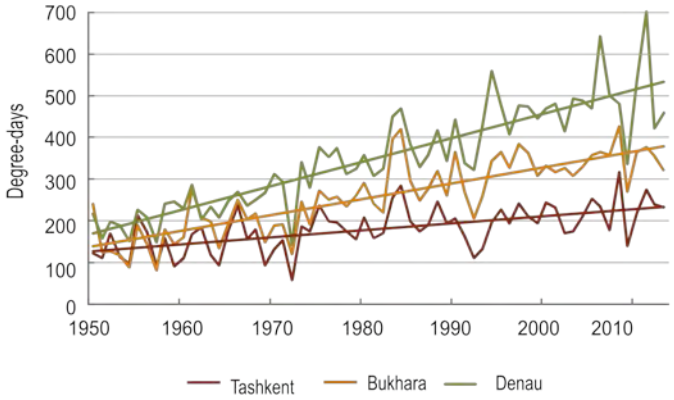


Figure 4.65 | *Variations in CDD25 Index by Cities Characterizing Central (Tashkent), Desert (Bukhara) and Southern (Denau) Territories of Uzbekistan*

Energy Resources Consumption for Cooling is characterized by values of CDD index, computed for hot periods of year (Figure 4.65). In Uzbekistan demand for energy resources for cooling in summer grows up not only due to rise in air temperatures and increase in duration of hot period, but also owing to population growth and improvement of living standards. Increase in energy demands for cooling in the conditions of predicted growth of air temperatures in accordance with GHGs emission scenarios is presented in Table 4.26. For the soft scenario increase in CDD25 index already by 2030 will be 56%, and by 2080, the current average values may be doubled. To great extent, such sharp increase is explained by small baseline rates.

Table 4.26 | *Average Values of CDD Indices for Baseline Period (1980-1999), Current Period (1994-2013) and Their Evaluations in Accordance with GHGs emission Scenarios on Average by Uzbekistan*

Parameters	1980-1999	1994-2013	2021-2040	2041-2060			2071-2090		
			Predictive estimates	WRE450	WRE750	A1FI	WRE450	WRE750	A1FI
Norms CDD25, °C	241	270	377 - 409	441	496	580	503	640	933
Variations in %	0	12	56 - 70	83	106	141	109	166	287
Norms CDD20, °C	737	782	832-872	897	946	1030	962	1071	1330
Variations in %	0	6	13 - 18	22	28	40	31	45	81

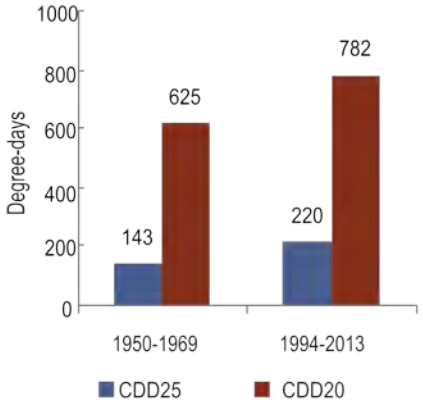


Figure 4.66 | *Values of CDD25 and CDD20 Indices for Tashkent*

Total energy consumption for heating and cooling of buildings. Such indices as heating degree days and cooling degree days may be summed up and compared for various time periods. Annual variations in number of the total monthly degree days for heating and cooling of various purpose buildings indicate differences in energy requirements for maintenance of comfortable conditions in premises (Figure 4.67).

For example, for the social purpose buildings maintenance of higher indoor temperature is needed for both cold and warm periods of a year. Criteria HDD18 and CDD25 may comply with these conditions. For residential and administrative buildings requirements may be different, e.g. HDD16, CDD20. For each type of buildings their specific criteria should be established, which must be specified in normative documents.

In majority of administrative and working buildings requirements in air conditioning may arise in conditions of more low daily temperatures on account of higher level of solar radiation and extended warming-up of building in conditions of stable hot weather typical for Uzbekistan. So, values of CDD for criterion of 20°C have been computed (Figure 4.66). Assessments of variations in cooling degree days for criterion of 20°C also indicate their considerable increase in accordance with GHGs emission scenarios. For the soft scenario WRE450 increase in the CDD20 index by 2050 will be 22%, and for extreme scenario A1FI increase by 40% against baseline value is possible. Increase in energy demand for cooling administrative and working buildings will correspond to computed values of CDD20 index.

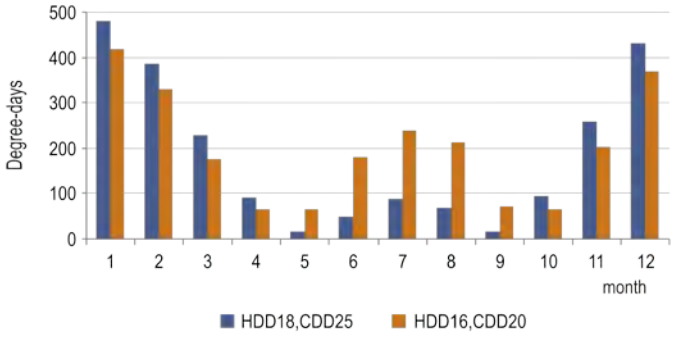


Figure 4.67 | *Annual Variations in Energy Requirements Index for Heating and Cooling Buildings Depending on Selected Criteria for Tashkent for Period 1994-2013*

Analysis indicates that increase in energy resources requirements for cooling of buildings in hot period of year are so far completely compensated by decrease in energy requirements for heating during cold period of year irrespectively of GHGs emission scenario (if not to take into consideration non-climatic factors impact).

For assessment of energy requirements for cooling various types of buildings depending on outdoor air temperature and indoor comfortable temperature it is necessary to identify numeric relations between values of HDD and CDD, and volume of energy consumed in unit time. The relations obtained allow developing electric energy consumption norms and using them for efficient planning and managing.

Increase in electric energy demand in agricultural sector. In 2013, share of agriculture in electric energy consumption pattern by sectors of Uzbekistan's economy was 21.9%. Out of this percentage around 70% of electric energy is used by irrigation pumping stations. Increase in irrigated land area in Uzbekistan is limited, therefore growth of electric energy demand in the sector, stipulated by climate change, will be in proportion to increasing demand for irrigation water due to increasing crops evapotranspiration in new climatic conditions. Percentage of increase in crop irrigation norms, calculated from climate scenarios data, will describe variations in water demand for irrigated agriculture and indicate growth of demand for electric energy.

The highest increment in evaporation from irrigated fields is expected in desert and steppe zones: by 2030 – 5.3-7.1%, by 2050 – 8.4-15.2%, by 2080 – 12.7-27.1% (minimum values are attributed to soft GHGs emission scenario, the maximum ones – to extreme scenario).

Seasonal variations in demand for energy resources in motor transport sector. Temperature indices identify values of summer and winter supplements to fuel consumption rates in the motor transport sector. Value of supplement to norms of fuel consumption reaches 10% in winter. That of in warm period is 5%.[135] Supplements are applied in accordance with climatic zoning of territory.[136]

[135] RH 88.20-01: 2003. Reference/Normative Document: Norms of Fuel and Lubricants Consumption by Vehicles and Road Construction Machines. – Tashkent, 2003.
[136] KMK 2.01.01-94. Climatic and Physical/Geological Data for Designing – Tashkent, 1996.

Due to climate warming, it is expected decrease in winter supplements to fuel consumption norms and its increase in summer period. Obviously, that owing to intensive climate warming the climatic zoning of territory should be revised.

Increase in normal wastage of natural gas and oil products. Losses of natural gas and oil products associated with their storage, transportation and marketing are understood under normal wastage. This wastage is a consequence of gas and oil physical and chemical properties, climate factors impact and equipment shortcomings. One of reasons for increasing normal wastage of natural gas and oil products is intensive growth of ambient temperature. For example, losses of liquefied gas are technologically unavoidable in operation of motor-vehicle gas refueling stations. Norms of oil products normal wastage in motor-vehicle refueling stations depend on season of year, air temperature and particular climatic zone.[137] Losses of hydrocarbons are unavoidable with air-steam mixtures emitted by technological equipment of oil processing plants. Values of normal wastage depend inter alia on oil product temperature, which directly related to ambient temperature of particular climatic zone.

It is obvious that increase in air temperatures and duration of hot period will lead to increase in normal wastage of natural gas and oil. Calculations indicate that use of incorrect climatic information may lead to errors (up to 8%) in evaluation of normal oil products wastage.[138]

Climate change impact and adaptation measures in certain economy sectors. Climate change affects significantly demand for fuel and energy resources (FER) in all seasons of year, as well as by many sectors of economy. The main negative impacts of climate change, listed below in their importance order, include:

- increase in energy consumption for cooling and ventilating all types of buildings and industrial complexes due to intensive climate warming throughout territory of Uzbekistan;
- increase in electric energy demand for irrigation during vegetation period due to necessity to compensate additional crop evapotranspiration and water losses in irrigation systems;
- increase in load on electric grids in hot period of year, reduction in reliability of electricity supply, need for additional resources for O&M of cooling systems equipment;
- increase in normal wastage of natural gas and oil products due to higher air temperatures, decrease in operation efficiency of equipment, used for extraction of oil and gas, probable increase in frequency and duration of fire;[132]
- decrease in productivity of small and large hydropower stations due to probable reduction in rivers runoff, mainly in summer and autumn periods;
- decrease in productivity of thermal power stations since increase in air temperatures will affect efficiency of gas turbines operation in hot period of year and due to deficiency of water for cooling.[139]

The main risks, associated with climate change, will be: increasing requirements of FER and considerable increase in demand for electric energy in warm period of year.

One of the positive climate change impacts on energy sector is gradual decrease in duration of heating season and its intensity, which assume decrease in load on heating systems.

The main strategy for adaptation to climate change in various sectors of economy, being at the same time the mitigation strategy, is more rational use of energy resources in the climate change conditions. It is presented in Chapter 3. The main adaptation measures include:

- thermal insulation of buildings;
- efficiency improvement of heating, ventilation and hot water supply systems;
- calculation of heating and hot water supply costs on the basis of individual consumption;
- improvement of approaches to buildings designing;
- use of advanced construction technologies and materials.

Relevant sectoral normative documents, construction norms and rules, comprising climatic information, should be updated regularly with use of advanced methodological approaches and international standards.

[137] Instruction for inventory of pollution sources and regulation of pollutants emission in atmosphere for enterprises of the Republic of Uzbekistan. http://Lex.uz

[138] L.E. Skripnikova Climate change impact on various economy sectors of Uzbekistan // Climate change impacts and adaptation measures. – Bulletin No 7. – Tashkent, 2008. – p.32-36.

[139] World Bank.Summary Report. Assessment of climatic vulnerability, risks and adaptation measures to climate change. Assistance to countries in creation of efficient energy sector. Focus on Uzbekistan. – June 2012.

4.8 Development Priorities and Capacity Building for Adaptation in Main Economy Sectors

According to data[140], published by the Intergovernmental panel on climate change, number of hot days will be increased by 4 times in the nearest 30-40 days, and by 10 times towards the end of the century. Maximum temperatures of the "heat days" will grow up by 5°C by 2050, and by 9°C after another 50 years. Authors of the Report estimate probability of such changes as more than 90%.

Uzbekistan is located on territory with high rates of climate change. The on-going climate change already considerably impacts social and economic development of the country in general.

The abovementioned assessments of climate change impact on agriculture, water resources and other economy sectors of Uzbekistan have confirmed presence of dangerous changes in the regional climatic system and serious negative impacts, such as:

- enhancement of general aridity of climate due to intensive increase in air temperatures and growth in duration of dry hot period that has adverse impact on all natural ecosystems, increases evaporation rate, deteriorates quality of surface water and increases water losses from irrigated lands;
- growth in electric energy demand for irrigation in vegetation period due to necessity to compensate additional crops evapotranspiration on account of increase in evaporation rate;
- reduction in volume of snow/glacial resources in the upper watersheds of Amudarya and Syrdarya rivers, which assume decrease in surface runoff for perspective, especially during vegetation period, earlier peaks of spring high water and later beginning of moist season in autumn;
- increase in variation of precipitation amount that entails growth in runoff variations and as a consequence, increase in frequency of dangerous phenomena occurrence (mudflows, floods, breakthrough of high mountain lakes), as well as extreme shortages of water causing droughts in the region;
- enhancement of water stress on crops, increase in water demands, land salinity increase and decrease in irrigated lands productivity;
- increase in frequency and severity of droughts, enhancement of land degradation processes that additionally aggravating by practically complete vanishing of the Aral Sea, degradation and danger of extinction of coastal and aquatic ecosystems in delta and low reaches of the Amudarya river;
- additional losses of crop yields due to increase in water deficiency, frequency of high air temperatures, atmospheric droughts, dry hot winds, heavy rains;
- decrease in productivity of cattle breeding due to increase in heat stress on animals and deterioration of fodder base (more pronged and hot summer will require additional forage supply, decrease productivity of desert and mountainous pastures and forests);
- growth in frequency of high air temperatures and "heat/heat waves", which in turn increase risk of cardiovascular, transmissible and infectious diseases;
- growth in duration and tension of hot year period, which lead to increase in energy consumption for ventilation and air conditioning, and load on electric grids.

Climate change negative impacts are possible to minimize by implementation of adaptation measures, which may be aimed at both climatic risks decrease and getting potential benefits from climate change.

It should be noted that climate warming has positive effect for the country's economy in terms of thermal energy saving on account of decrease in duration of heating season and heat losses from buildings, increase in duration of crops vegetation period and improvement of conditions for cattle overwintering, increase in heat availability for crops with sufficient moisture supply leading to agriculture productivity.

Examples of adaptation measures are introduction and use water saving irrigation methods, breeding of drought resistant crop varieties, selection, maintenance and regeneration of forest and desert pastures vegetation, improvement of forestry management methods, etc. Timely actions will allow minimizing climate change impacts on ecosystems, population health, economic development and infrastructure, and giving tangible economic benefits.

Integrated approach to development of adaptation measures combining science, technologies and response actions system will facilitate decrease in society and economy vulnerability to climate change. Directions of adaptation actions to climate change are presented in Table 4.27 below.

[140] IPCC. Special Report on Risks Management of Extreme Phenomena and Disasters for Assistance to Adaptation to Climate Change – 2012. https://www.ipcc.ch/pdf/special-reports/srex/IPCC_SREX_RU_web.pdf

Table 4.27 | *Current and Recommended Adaptation Actions to Climate Change*

Agriculture and Water Resources Sector	
Studies and research works for optimization of water and land resources use	– Optimization of cropping pattern taking into account climate change and increasing water deficiency (decrease in share of water consumptive crops), planting dates correction; – Correction of irrigation schedules and norms based on scientific data; – Improvement of agro-meteorological services (information and forecasts); – Introduction of advanced technologies for minimal and zero land tillage; – Maintenance of land leveling, introduction of water saving irrigation methods.
Improvement of knowledge and awareness raising	– Improvement of access for farmers to information on climate resistant technologies; – Pilot projects on water saving and use of advanced irrigation practices.
Improvement of insurance system in agriculture	– Development of normative and regulatory framework for agricultural insurance; – Development of well-defined criteria for insurance events with use of climatic data; – Establishment of funds for support of agricultural commodity produces in drought years.
Infrastructure and technologies	– Improvement of lands amelioration conditions and quality; – Rehabilitation and maintenance in operational conditions irrigation and drainage systems, construction of reservoirs; – Introduction of water saving irrigation technologies (drip, subsoil, surge irrigation methods, etc.); – Development of technologies for fertilizers application and plant protection; – Development of agroforestry, planting of field-protective forest belts.
Improvement of crop husbandry productivity	– Selective/genetic activities for breeding crop varieties resistant to extreme weather conditions; – Introduction of highly productive salt and drought resistant crop varieties; – Programs of support to farmers on low productive lands, to producers of fruits and grapes, and to enterprises for horticulture products processing.
Improvement of cattle breeding productivity	– Development of fodder base for cattle breeding, increase in share of forage crops in cropping pattern; – Regulation of grazing load on pastures, regeneration of degraded pastures (phytomelioration, establishment of planted pastures, improvement of pastures watering); – Decrease in thermal and water stress to animals with livestock breeding on pastures; – Improvement of cattle breeds.
Agriculture and Water Resources Sector	
Improvement of water resources monitoring system	– Improvement of hydro-meteorological observations network, renewal of instrumentation pool; – Development of transboundary water recourses monitoring; – Development and introduction of early warning systems regarding water shortages by river basins; – Development and dissemination of output hydro-meteorological information (special reviews and hydro-meteorological forecasts by river basins/provinces, adapted for farmers, comprising assessment of water availability, meteorological conditions and recommendations for crops irrigation regime); – Capacity building (organization of trainings) for water resources users at various levels, including local authorities and farmers.
Improvement of efficiency in water resources use	– Set-up of water consumption metering in farms; – Incentive pricing policy for water use in all economy sectors, introduction of advanced water saving technologies in industry and public utilities sector; – Introduction of integrated water resources management at all levels of water use.
Population Health	
Precaution and prevention of health risks	– Improvement of clean drinking water supply to population; – Creation of local water supply sources for rural population; – Improvement of water purification technologies; – Introduction of medical warning system regarding unfavorable meteorological conditions; – Studies of climate change risks (“heat/heat waves”) for health of various population groups; – Improvement of sanitary and epidemiological control system.
Dangerous Hydro-meteorological Phenomena	
Improvement of hydro-meteorological monitoring, forecasting and early warning systems	– Expansion of on-ground network of hydro-meteorological observation stations, including mountainous zone, development and use of remote monitoring methods of dangerous hydro-meteorological phenomena; – Improvement of dangerous hydro-meteorological phenomena forecasting methods; – Creation and storage of retrospective hydro-meteorological databases on dangerous hydro-meteorological phenomena (conversion of data in electronic format); – Development and implementation of response action plans to expected decrease in water availability depending on drought severity for each province of the republic.

Table 4.27 Continued

Capacity building of prompt response and protection system	– Improvement of warning systems. Identification and mapping zones of increased risk. Based on actual information to develop well-defined criteria for dangerous phenomena taking into account features of various regions and economy sectors; – Development of protective infrastructure (such as mudflow and flood protection structures, barrages, dams).
Increase in efficiency of current measures	– Improvement of legislation aimed at development of system of protected nature territories, conservation of natural ecosystems; – Development and implementation of actions plan for biodiversity conservation; – Development and maintenance of natural reproduction of fish resources in the most vulnerable fishing zones; – Stabilization of sands, forests planting on the dried Aral Sea bottom; – Rehabilitation of ecosystems in Priaralie taking into account demands of local communities.
Development of environmental monitoring	– Inventory of natural and anthropogenic ecosystems and arrangements of integrated and regular system for biodiversity monitoring; – Development of monitoring network over migration routes of the main components of terrestrial and aquatic ecosystems; – Monitoring of climate change indicators.
Scientific studies and education	– Approaches and methods for selection and assessment of biological species – climate change indicators. Assessments of climate change risks for biodiversity of terrestrial and aquatic ecosystems; – Development and introduction of advanced fishery technologies; – Capacity building and awareness raising of public in climate change impacts and risks for biodiversity.
Forest and Forestry	
Improvement of system for forest resources management	– Development and adoption of the program for field-protective forestation; – Development of system for forests inventory and forestry management; – Improvement of water allocation (quota) for forestry; – Establishment of tool for interaction between forestry enterprises and local population and involvement of local population in forest management activities.
Applied studies	– Selection of heat and drought resistant forest plant species, tolerant to pests and deceases; – Assessment of climate change risks for forestry; – Evaluation of GHGs sink capacity by various types of tree plantations; – Methods and approaches to afforestation and sand stabilization on the dried Aral Sea bottom.
Improvement of efficiency in forestry management and capacity building of forestry staff	– Improvement and development of system for monitoring current conditions of forest plantations; – Formation of the national database for all forest plantations; – Planning of new forests planting with taking into account climatic conditions including establishment of pistachio and almond plantations on lands of the State forest fund and agricultural lands in piedmont rainfed land belt; – Forest amelioration of small river watersheds as stage in watersheds management; – Organization of advanced training for forestry staff.

There is currently no special Program for Adaptation to Climate Change in Uzbekistan. Its development is only at planning stage. However measures and actions associated one way or another with adaptation to climate change are included in the sectoral and national development plans and programs.

A number of adaptation measures and actions have been implemented with broad support and in cooperation with the international financial institutions (See Annex 4).

The World Bank has adopted and implemented the Partnership Strategy for 2012-2015, aimed at support of measures for improvement of infrastructure efficiency, economical competitiveness, diversification and social integration as part of the state strategy for development of Uzbekistan. Financing for implementation of 15 projects under this Strategy was equal to USD1.35 billion. The Strategy has specified that agriculture in Uzbekistan possesses great capacity and therefore it is challenging to support projects on productivity improvement of crop husbandry and cattle breeding. Amongst these Projects were: the Rural Enterprises Support Project, Phase-II, Water Resources Management Project in Fergana Valley, Phase-I, Improvement of Water Resources Management in the Southern Karakalpakstan, Rehabilitation of Irrigation and Drainage Infrastructure and Wetlands Restoration, etc.

The Global Environment Facility (GEF) has allocated to Uzbekistan grant in the amount of USD12.7 million to support implementation of the Project on sustainable development of agriculture and mitigation of climate change impact. The project objectives are to provide assistance to improvement of energy efficiency (biogas), rehabilitation of degraded irrigated lands and improvement of water resources use efficiency on project's areas in 7 provinces of Uzbekistan.

The Asian Development Bank (ADB) provides significant part of its financing to development of agricultural production in Uzbekistan. With support from the ADB the following projects have been implemented: Project for rehabilitation of the Amu-Zang Irrigation System; Projects for Improvement of Water Supply and Sanitation in the Kashkadarya, Navoi and Surkhandarya provinces, Land improvement project in the Bukhara, Navoi and Kashkadarya provinces. The Project "Rehabilitation of Amu-Bukhara irrigation system" is in implementation stage.

The United Nations Development Program (UNDP) implements the Project of Adaptation Fund, aimed at adaptation of dekhkan farms to climate change impacts (more than USD5 million).

The European Union (EU) supports the Project for improvement of economic independence and living conditions of women (dekhkans and farmers) through establishment of the social enterprises of women farmers.

The United Nations Food and Agricultural Organization (FAO) implements a number of the technical assistance programs in area of sustainable agriculture development, including efficient irrigation systems, development markets for agricultural production and others. Currently with support from FAO within framework of implementation of the National Action Program to Combating Land Desertification and Droughts Control (UNCCD), the project for mitigation of drought impacts (Uzhydromet) and project for control of land salinization and improvement of forest resources management in the conditions of climate change (MAWR) have been prepared.

The German Society for International Cooperation (GIZ) supports the project on transboundary water resources management for optimization of cooperation in water sector of the Central Asia and improvement population living standards in the region, including Uzbekistan. The GIZ has also implemented the Project "Sustainable Pastures Management with Participation of Local Communities".

Small Grants Program of Global Environmental Facility (GEF SGP) implements a number of demonstration projects in aid of promotion and further replication of approbated technologies amongst local communities. Starting from 2008, the Program provided support to 78 projects for total amount of around USD1.7 million from GEF fund with attraction of additional financing in the amount of more than USD4.0 million from various sources. The Program includes: 39 projects on climate change, 20 – to combat land desertification, 6 – for capacity building, 13 – for biodiversity conservation. The following benefits have been obtained as a result of the above projects implementation:

- GHGs emission decreased by 39,5 thousand ton CO_2-eq;
- land use practice improved on the area of 2400ha of agricultural lands;
- more than 157 thousand trees planted;
- more than 43 million m^3 of irrigation water saved;
- more than 4,5 billion kWh electric energy saved an account of introduction of clean technologies in energy generation.[141]

Hence, Uzbekistan, in cooperation with international partners, implements a number of projects, which are virtually measures of adaptation to climate change and mitigation of its impacts on various economy sectors. However requirements for implementation of essential adaptation measures, especially in agriculture and water management sectors, are considerably higher. The main limiting factors are: shortage of financial resources and lack of the ***National Action Plane on adaptation.*** Therefore, there is a need for additional portfolio of climatic projects with estimation of investment requirements for attraction of resources from adaptation funds under the UNFCCC. Vulnerability to climate change will be increasing with inefficient land and water resources use, deteriorated infrastructure, environment pollution, incomplete implementation of development strategies and programs.

[141] "Simple technologies– great benefits", Selection of info-graphic, Edition of GEF SGP and UNDP, Tashkent–2015

DEVELOPMENT AND TRANSFER OF ECOLOGICALLY CLEAN TECHNOLOGIES

5 DEVELOPMENT AND TRANSFER OF ECOLOGICALLY CLEAN TECHNOLOGIES

Development and transfer of environmentally sound technologies (EST)[1] between and inside the countries is an important part of the UN FCCC activities on control and adaptation to climate change.

The term "technology transfer" covers the wide range of processes and activities for creation of favorable conditions, capacity building, exchange of technological information and development of tools for transfer of technologies.

During the recent years economy of Uzbekistan is rapidly developing, ensuring the stable GDP growth at the level of over 8%. Reforms are carried out in all economy sectors and social sphere. The reformation strategy, aimed at production of competitive exportable and import-substituting products with high added value, includes sustainable development of industry, diversification of its main sectors on the basis of technological modernization and renovation of productive capacities, production localization, and improvement in efficiency of fuel and energy resources use. Special attention is given to replacement of outdated technologies by energy saving ones and their exclusive use in implementation of new projects, introduction of electricity and gas-saving equipment into production, promotion of projects on secondary raw materials processing, expansion of alternative energy sources use.

Legal framework, which ensures ecological safety in renewal of productive capacities, is determined by the following laws of the Republic of Uzbekistan: "On Nature Protection", "On Ecological Expertise", "On Ecological Control" and other legislative acts. The law "On Nature Protection" (Article 46) imposes a ban on use of raw and other materials, introduction of technologies and manufacturing products without ecological certificate, as well as incompliance with the established parameters. According to the law "On Ecological Expertise" the following documents are subject to the state expertise:

- draft state programs, concepts, industrial capacities distribution and development schemes;
- city/town planning documentation;
- documentation on creation of new type of equipment, technologies, materials, substance, products;
- drafts normative/technical and instructive/methodological documents, associated with natural resources use.

The draft legislation of the Republic of Uzbekistan "On Changes and Amendments to the Law "On Ecological Expertise" is currently under consideration. It is aimed at formation of more advanced system of ecological safety on the basis of international legal experience.

Three main elements that make transfer of technologies more efficient include: favorable conditions, developed tools for transfer of technologies and capacity building on permanent basis.

5.1 Creation of Favorable Conditions for Transfer of Technologies

In the conditions of economy modernization and its innovative development, based on wide use of the advanced technologies in both private and state sectors, the main actions of the Uzbekistan's government are aimed at:

- encouragement of direct foreign investments;
- development of small scale business and private entrepreneurship;
- formation of innovative infrastructure in industrial sector;
- strengthening of the national scientific and research institutions and networks;
- improvement of intellectual property rights system.

Encouragement of direct foreign investments. Owing to availability of highly qualified human resources, ample raw materials stock, developed industry and productive infrastructure, as well as convenient geographic location on crossroads between Europe and Asia, Uzbekistan is attractive for foreign investors.

Over the recent ten years the Laws have been adopted in Uzbekistan to create favorable investment environment for the activities of national and foreign investors, which guaranty and protect their rights in carrying out activities in Uzbekistan, in particular the Laws "On Investment Activities"[2],"On Foreign Investments"[3], "About Guarantees and Measures for Protection of

[1] In the context of UN FCCC the term EST is defined as techniques and technologies capable of environmental conservation through processes and materials that generate fewer potentially damaging substances, recover such substances from emissions prior to discharge, or utilize and recycle production residues in compliance with the national social, economic, cultural and ecological priorities, use all types of resources in more sustainable manner.

[2] Law of the Republic of Uzbekistan "On Investment Activities", № 719-I, dated 24 December 1998.

[3] Law of the Republic of Uzbekistan "On Foreign Investments", № 609-I, dated 30 April 1998.

Foreign Investor Rights"[4], "On Free Economic Zones".[5] The legislation has established a broad system of privileges, preferences and guarantees to protect the rights and interests of the foreign investors.

In order to simplify business management in the country, it was significantly reduced number of procedures, time and costs associated with issuance of licenses and permissions. As a result, over 5 thousand joint ventures, established by investors from more than 90 countries, are successfully operated in the republic. More than USD3.0 billion of foreign investments are disbursed every year. These are mainly direct investments with share of around 20% from the total investments in the country's economy[6], indicating growing interest and trust of foreign investors to sustainability of country's economy. There are five banks with participation of foreign investments and representative offices of six large international banks in the republic that contribute substantially to increasing banking system assets, introducing new technologies and creating essential infrastructure on financial market.

On initiative of the First President, the "Uzinfoinvest" Agency was established in 2007 to provide informational support and assistance to foreign investments, which is independent institution with the legal entity rights under the Ministry of Foreign Economic Relations, Investments and Trade. Activities of the Agency are aimed at attraction of direct foreign and local investments in the country's economy, promotion of information about investment capacity of Uzbekistan in foreign countries.

Currently on initiative of the President, the Law of the Republic Uzbekistan "About Innovations and Innovative Activities" is being developed. The draft of this Law envisages:

- development of mechanisms for legal regulation of relations between entities of innovative activities and attraction of investments;
- establishment of innovation and venture funds, infrastructural innovative organizations;
- further improvement of taxation and crediting system;
- creation of conditions for increasing motivation and incentives for participants of innovative activities, implementing and introducing priority high-tech innovative projects.

The Program for privatization of the state property for 2015-2016[7] is of the special importance. In accordance with this document during two years it is envisaged cardinal reduction in state participation in various sectors of economy and transfer of 1247 enterprises and objects to private ownership.

For presentation of investment capacity of Uzbekistan, the International Investment Forum was held in Tashkent on 5-6 November 2015, with participation of representatives from more than 300 foreign companies, European Union, Governments of Korea, Germany, Poland, Japan, Kuwait and other countries, various banks, investment funds, agencies, analytical centers, representatives of financial and business groups from 33 countries of the world, as well as Asian Development Bank, World Bank, International Financial Corporation, etc. Following the results of Forum it was signed more than 100 agreements and memorandums on procurement by the foreign investors of the state share packages and implementation of new investment projects in oil and gas, chemistry, electro-technical sectors of economy, food processing industry, production of construction materials and other sectors for the total amount of more than USD12.0 billion, including around USD5.0 billion of direct foreign investments.

Development of small scale business and private entrepreneurship. NGOs and private business are involved in activities associated with climatic technologies. In 2011, it was established the "Association of enterprises of alternative types of fuel and energy". The Association unites on voluntary basis enterprises of the republic dealing with development, production and use of the alternative types of fuel and energy (use of solar and wind energy, biological fuel, development of small scale power industry, etc.) into the integrated system for further development as a separate sector of national economy, capable of implementing all its tasks including scientific researches and design preparation and their practical implementation. The Association comprises 35 enterprises and institutions. The Scientific and Technical Council has been established for considering the main directions of biological technologies development and expert conclusions on project documentation, issues associated with development of projects and formation of program for project financing.

Formation of innovative infrastructure. The Government of Uzbekistan implements measures aimed at formation of innovative infrastructure in industrial sector, the main elements of which are free economic zones (FEZs) and special industrial economic zones (SIEZs), technological parks, and business incubators.

[4] Law of the Republic of Uzbekistan "About Guarantees and Measures for Protection of Foreign Investor Rights", № 611-I, dated 30 April 1998.
[5] Law of the Republic of Uzbekistan "On Free Economic Zones", № 220-I, dated 25 April 1996.
[6] Report of the President of the Republic of Uzbekistan, Mr. Islam Karimov, on extended session of Cabinet of Ministers devoted to results of social and economic development of the country in 2015, and the most important priority directions of economic program for 2016, Tashkent, 16 January 2016.
[7] Decree of the President №PP-2340, dated 28 April. 2015 "On Measures for Increasing Share and Importance of Private Ownership in Economy" // Collection of Laws of the Republic of Uzbekistan, 2015, № 17(I) (216)

Creation in 2008 of the "Navoi"[8] free industrial economic zone (FIEZ), and in 2012 and 2013 of the "Angren"[9] and "Djizak"[10]special industrial zones (SIZs) with provision of investors with broad package of tax exemptions and preferences, as well as with all required external engineering and transport infrastructure on account of the state budget, became the high-power impulse for development of high-tech enterprises.

Figure 5.1 | *LLC "Quyosh Issiqlik Energiyasi", FIEZ Djizak*

According to the Decree of the Cabinet of Ministers of the Republic of Uzbekistan "On Approval of Provision for Order of Establishing Small Scale Industrial Zones and Arrangement of Their Activities"[11] during the recent two years it was decided to create technological parks and zones of technological development to facilitate enhancement of cooperation between research institutions and production enterprises. The Provision on order of the state property leasing was amended.[12] It was introduced the concept of "technological park" and identified measures and incentives regulating the state property leasing. As of now three technological parks have been established. For example, the technological park for renewable energy sources is being created in Parkent city (Tashkent province) for scientific and technological capacity building, attraction of local and foreign investors, increase in export share of knowledge-intensive high-tech production.[13]

Association of Business Incubators and Technological Parks of the Republic of Uzbekistan (ABIT) is a network comprising 33 business incubators and other institutions and companies located throughout territory of the republic with the main task to provide practical assistance to the entrepreneurship entities at the first stage of their activities: business-process arrangements, provision of extension services, assistance in implementation of investment and innovative projects. The Decrees of the President of Uzbekistan[14,15] have become the important program documents, stipulating development of this infrastructure segment.

Strengthening of the national scientific and research institutions and networks. There is an understanding in the country of need to develop the advanced national innovative system, establish its own scientific and technological basis and relevant arrangements for commercialization of research and technology projects. During the recent years the purposeful activities are carried out in the republic for retention and development of scientific, technological and innovative capacities.

The system of economic measures promoting transition of economy to innovative development pathway is being formed in Uzbekistan. This is envisaged in the Decree of the President of the Republic of Uzbekistan № PP-916, dated 15 July 2008 "On Additional Measures for Promoting Introduction of Innovative Projects and Technologies in Production". The annual republican fairs of innovative ideas, technologies and projects are begun to hold in order to integrate science, education and production. Tax exemptions are provided to scientific institutions dealing with development of innovative projects. Funds allocated for these purposes are practically exempted from all taxes apart from the unified social charge.

According to the "Provision on Fund for Modernization and New Technologies" (12 May 2009) and in support of the above Decree, it was established funds for modernization and new technologies under economy management bodies and large enterprises to support researches and introduce innovative technologies. Sources of funds formation are part of depreciation

[8] Decree of the President of the Republic of Uzbekistan № UP-4059, dated 2 December 2008 "On Establishment of Free Industrial Economic Zone in the Navoi Province" // Collection of Laws of the Republic of Uzbekistan, 2008, № 49, p 478; 2011, № 9, p 84; 2012, № 3-4, p 26; 2014, № 29, p. 356

[9] Decree of the President of the Republic of Uzbekistan № UP-4436, dated 13 April 2012 "On Establishment of Special Industrial Zone "Angren" // Collection of Laws of the Republic of Uzbekistan, 2012, № 16, p. 177

[10] Decree of the President of the Republic of Uzbekistan №UP-4516, dated 18 March 2013 "On Establishment of Special Industrial Zone "Djizak" // Collection of Laws of the Republic of Uzbekistan, 2013, № 12, p. 151

[11] Decree of the Cabinet of Ministers of the Republic of Uzbekistan № PKM-378, dated 31 December 2014 "On Approval of Provision for Order of Establishing Small Scale Industrial Zones and Arrangement of Their Activities" // Collection of Laws of the Republic of Uzbekistan, 2015, № 1, p. 10; 2016, № 17, p. 176; № 18, p. 197

[12] Decree of the Cabinet of Ministers №PKM-126, dated 20 May 2014 "On Amendments to Provision on Order of the State Property Leasing" / Collection of Laws of the Republic of Uzbekistan, 2014, № 21(625)

[13] Trostyansky D.V., Islamova O.A. Formation of Innovative Infrastructure in Industrial Sector of Uzbekistan. Bulletin of USUES. Science. Education. Economy. Economy Series № 3 (9), 2014, pp. 15-19.

[14] Decree of the President of the Republic of Uzbekistan № PP-325, dated 17 April 2006 "On Measures to Speed up Development of Services Sector in Uzbekistan for 2006–2010" / Collection of Laws of the Republic of Uzbekistan, 2006, №16.

[15] Decree of the President of the Republic of Uzbekistan № PP-640, dated 21 May 2007 "On Additional Measures to Speed up Development of Services Sector in Uzbekistan for period up to 2010" // Collection of Laws of the Republic of Uzbekistan, 2007, № 21, p. 213; 2008, № 14–15, p. 99, № 52, p. 515; 2011, № 52, p. 561.

charges and net profits of economic entities, as well as targeted contributions from customers. This allows to domestic commodity producers to modernize more actively their technologies by both their own efforts and attract to this job specialists from the Academy of science and various ministries and agencies.

Supervision of projects implementation in provinces is carried out by independent territorial centers on innovation activities and transfer of technologies. Currently there are eight territorial centers, including in the Republic of Karakalpakstan, and in Andijan, Bukhara, Kashkadarya, Namangan, Surkhandarya, Fergana and Khorezm provinces.

Therefore, as of now all necessary institutions for innovative development have been established in the country, such as:

- Agency on Intellectual Property,
- Agency on Technologies Transfer (2006-2015),
- Agency "Uzstandard",
- State Unitary Enterprise "Scientific and Technological Information".

5.2 Assessment of Technological Requirements for Mitigation of and Adaptation to Climate Change Impact

The conducted greenhouse gases inventory has allowed identifying the main sources of GHGs emission that have the highest capacity for introduction of EST (Figure 5.2).[16]

The largest source of GHGs emission in Uzbekistan is the "Energy" sector, where the maximum capacity for introduction of EST has the following sub-sectors: generation of electric and thermal energy; extraction, processing and transportation of natural gas; combustion of fuel by automobile transport. The sectors "Buildings" and "Waste" should be considered as perspective and important for use of advanced EST, in particular, "solid domestic waste" with rapidly increasing emissions due to growth of population and its demands.

Existence of large capacity (around 51 billion t.o.e.) of RES (hydropower, solar and wind energy) in Uzbekistan is a sound pre-conditions for development and transfer of ecologically clean technologies. According to the ADB data, level of modern RES technologies allows to use 179 billion t.o.e., which exceeds the current annual volume of fossil fuel consumption.[17]

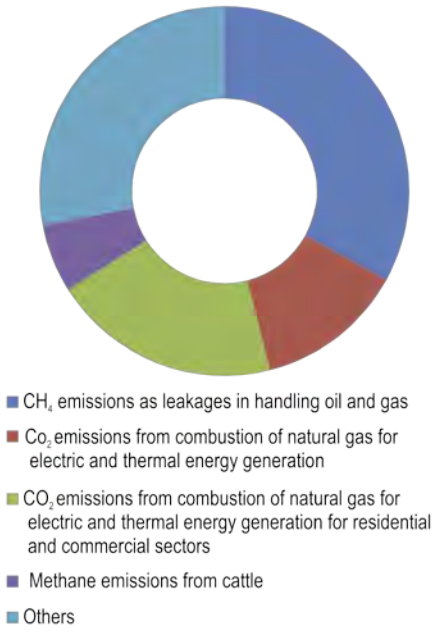


Figure 5.2 | *Main Sources of GHG Emissions in Uzbekistan*

Prioritization of the economy sectors, analysis of technological requirements to mitigate climate change impact has been conducted in Uzbekistan within the framework of the following international projects:

- GEF/UNDP/Uzhydromet Project "Firtst National Communication of the Republic of Uzbekistan on United Nations Framework Convention on Climate Change (UNFCCC), Phase 2", 2001;
- UNDP/Ministry of Economy Project "Capacity Building for Clean Development Mechanism in Uzbekistan", 2007-2009;
- UNDP/Ministry of Economy Project "Support to Uzbekistan in Transition to Low Carbon Development of National Economy", 2011-2015.

The outputs of these projects have allowed identifying for the country's current level of development the priority directions for transition to new resource-efficient level of production, i.e. with decreased carbon consumption (or decarbonization of economy). List of priority technological requirements is provided in Table 5.1 below.

[16] GEF/UNEP Project "Uzbekistan: Preparation of the Third National Communication under the UNFCCC": National Report "Inventory of Anthropogenic Emission Sources and Sinks of GHGs in the Republic of Uzbekistan (1990-2012)", Tashkent – 2016.

[17] ADB Project TCN°4173-UZB "Development of Renewable Energy Sources in Republic of Uzbekistan", Final Report, 2005, 41 pages.

It is worth to mention that in practice measures, aimed at introduction of ecologically clean technologies for reduction in CO_2 emissions and/or reduction in vulnerability to climate change impact, are implemented in integration with other actions aimed at support to sustainable development of the country's economy within the framework of investment and development programs.

Table 5.1 *|Requirements in Technologies for Mitigation of and Adaptation to Climate Change Impact in Priority Economy Sectors of Uzbekistan*

Energy Sector	**Technologies**
Generation of electric and thermal energy	Introduction of: – new gas-turbine units (GTU) and steam-gas generators (SGG) – gas-expansion generator units (GEGU) in thermal electric power plants (TEPP) – cogeneration technologies with generation of additional electric energy – efficient modular water treatment units (MWTU) and high efficiency boiler units in boiler plants Construction of new coal steam power plants with over supercritical steam parameters (SCSP).
Transportation of electric and thermal energy	Reconstruction and new construction of – transformer substations: introduction of more cost-efficient electrical equipment, and automatic voltage regulation devices in operation mode – main and distribution electric grids – indoor heating and hot water supply systems Modernization of heat supply pipelines Decentralization of heating systems
Metering and regulating electric and thermal energy consumption	Countrywide introduction of computer-aided systems for electric energy metering (CASEEM) Installation of equipment controlling and regulating heat consumption in residential buildings
Leakages with extraction and transportation of natural gas	Use of accompanying and exhaust gases for generation of secondary electric and thermal energy Introduction of systems for natural gas metering
RES	Introduction of photoelectric power plants and solar collectors Construction of: - small and micro hydropower plants in remote mountain and hard-to-reach areas, - wind driven electric power plants, - biogas power units for energy supply to private farms
Agriculture Sector	**Technologies**
Climate resistant technologies	Technologies for efficient water use: - introduction of water metering systems and improvement of water distribution systems; - improvement of traditional irrigation method; - application of water saving irrigation technologies (drip irrigation). Technologies for efficient land use: - minimum soil tillage with prior rehabilitation of plow horizon; - improvement of soil preparation with use laser-guided land leveling and soil deep ripping. Agro-afforestation measures: - decrease in load on desert pastures on account of fodder production arrangements; - efficient use of pastures through use of pasture rotation; - land improvement in arid zones through establishment of pistachio plantations.

5.3 Technologies Transfer Mechanisms

The main tools for EST transfer in Uzbekistan are:

- sectoral development and investment programs;
- projects being implemented with support from development partners (ADB, WB, GEF, UNDP, GIZ);
- CDM Projects;
- national innovation systems: innovative fairs, farmers' field days;
- international, territorial and sectoral industrial fairs, forums, exhibitions, cooperative stock exchanges.

Innovative transformations of the national economy require large technical, financial and intellectual inputs (beginning from project preparation stage, studies, and ending by commercial implementation of scientific developments), which can be supported by the state only.

At the current stage share of internal innovation costs from the country's GDP equals to 0.13-0.15% (in the developed countries this figure reaches 3 and more percent). Therefore, Uzbekistan, as the other countries (Japan, South Korea, South-East Asian Countries) is oriented not only to development but also to adoption of new technologies, their adaptation and distribution. The main emphasis is put on introduction of innovative technologies. Large events are being conducted under Investment and sectoral programs for technical modernization, adopted by the Government.

Cooperation with the international financial institutions (IFIs) and donor-countries occupies one of the central places in the investment policy of Uzbekistan. Currently the IFIs and foreign governmental financial organizations participate actively in implementation of programs for modernization of industry, construction of infrastructure and transportation and communication facilities, improvement of social infrastructure. Over the years of cooperation with the World Bank, Asian and Islamic Development Banks, Japan Agency for International Cooperation, German Development Bank "KfW", Ecsim bank of China, Arab Funds, Commission of the European Union and others, it was gained considerable experience in joint activities for implementation of investment projects, set up tool for consistent implementation of project on the basis of established medium-term cooperation programs.

Amongst the priority directions in cooperation, supporting actions aimed at mitigation of and adaptation to climate change impact, are:

1. increase in energy efficiency of production enterprises, broad introduction of energy saving technologies and development of energy generation based on renewable energy sources;
2. promotion of activities aimed at environment protection, including Aral Sea littoral zone and other regions with endangered ecological situation, development and introduction of the "green economy" technologies.

According to the Fifth IPCC[18] Assessment Report, the joint projects, implemented and being implemented in the country together with WB, ADB, IBD to the great certainty degree are measures, aimed at mitigation of climate change impact. These projects, associated with energy supply, end use of energy and changes in the sector "Agriculture, forestry and other types of land use", are aimed at:

- decarbonization (i.e. decrease in carbon consumption) in energy generation;
- implementation of technical measures relevant to all types of cargo transportations, development of new infrastructure, which facilitate decrease in demand for secondary energy and GHGs emissions;
- stabilization or decrease in energy consumption in building sector with use of recent achievements in technology and know-how;
- decrease in energy consumption of industry sector versus the current level through broad scale modernization, replacement or introduction of the most advanced available technologies.
- land productivity improvement, reforestation and afforestation.

Realization of the ADB initiative to develop solar energy generation in the Asian region becomes one of the perspective directions of bilateral cooperation. Use of alternative energy sources complies with the country's priorities and is the developing direction in energy sector. Currently institutional structures have been established and legal framework identified for this direction of development. In particular, the International Solar Energy Institute (ISEI) has been established with ADB support. Its tasks include implementation of high-tech designs for industrial use of solar energy; creation of laboratory for certification of solar modules in accordance with the international standards, etc.

The Project "Construction of 130-150 MW power generating unit with thermal clamping for combustion of high-ash coal in Angren thermal electric power plant (TEPP)" is carried out with attraction of preferential credit from the Export-import Bank of China. This will allow using as a fuel for power plant about 1.0 million ton of low grade coal accumulated in process of coal mining in "Angren" open-pit mine. This technology is being used on 25 thermal power stations in the world only. Commissioning of a new energy unit will allow not to only improve ecological situation due to decrease in volume of huge spoil bank of low grade coal, but also two-fold increase in capacity of operating energy plant.

Various enterprises have been commissioned as a result of implementing 19 investment projects for the total amount of USD110.0 million with participation of such countries as South Korea, China, Singapore, India, United Arab Emirates, etc. in the Navoi FIEZ. These enterprises manufacture electronic electric energy consumption meters, heating and water boilers. It is planned to commission enterprise for production of solar panels initially with capacity of 50MW with its subsequent increase up to 100MW and the total cost of USD10.0 million.

[18] Climate change, 2014: Mitigation of Impact on Climate Change (Resume for politicians and Technical resume), Contribution of Working Group III to Fifth Intergovernmental Panel on Climate Change Assessment Report, IPCC, 2015

Production of energy saving LED lamps has been commenced in the "Angren" FIZ. The "EGL-NUR" Uzbek-South Korean Joint Venture, established in December 2013 is a result of cooperation between JSC "Uzbekenergo" and the South Korean "EG Lightings" company. It specializes on production of diode lamps for outdoor and indoor lightening, as well as for industrial enterprises lightening. Currently output of this enterprise is 4 thousand 120-175W lamps per month. These diode lamps, manufactured on the basis of advanced technologies, have certificates and comply with the international standards ISO 9001:2008. By the end of 2016, it is envisaged to produce products for the total value of USD35.0 million.[19]

Production of solar water heaters has been commenced in the "Djizak" FIZ by the "Kuyosh Issiklik Energiyasi" Uzbek-Chinese joint venture, established jointly with the "Hangzhou zhongwu electronic meters co.Ltd" (China). The total Project cost exceeds USD3.3 million.[20] The planned production capacity is up to 50 thousand heaters with volume of 150, 250 and 300 liters per year, capable of water heating up to 70^0C and 40^0C in summer and winter respectively. They can be used for both water and house heating. Initially production will be oriented to domestic market with perspective expansion to external ones.

A number of technologies has been approbated and introduced at the local level with support from the GEF Small Grants Program (GEF SGP). In particular, introduction of water saving technologies has allowed to save more than 43 million m3 of irrigation water, and to save more than 4.5 billion kWh on account of introduction of clean technologies for energy generation.[21]

The annual Republican and Regional fairs of innovative ideas, technologies and projects, organized by the Committee on coordination of science and technology development, is the important tool for promotion and commercialization of the national scientific and technological designs. The fairs promote processes of integration of science, education and production, introduction of innovative Academy of Science designs in large industrial enterprises and other spheres of business. More than 100 scientific and educational institutions of the Academy of Science, Ministry of Higher and Specialized Secondary Education, Ministry of Health, Ministry of Agriculture and Water Resources and other organizations, as well as private enterprises and independent inventors participate in these fairs. They broadly present innovative solutions on improvement of energy efficiency and energy saving in buildings, introduction of passive solar technologies, efficient use of RES, increase in agricultural crop yields, processing of local raw material, application of new technology for production of microcrystalline silicon and others. During 2008-2015 within framework of eight fairs conducted, it was presented more than 4000 domestic designs and signed over 3200 contractual agreements. Serial production of 23 new commodity products for the total amount of over 1.0trillion Uzbek Soum has been commenced as a result of these contractual agreements implementation.

Growing popularity of the Fairs indicates great interest of domestic producers in scientific designs. The established relations between scientific institutions of Academy of Science, universities and educational institutions of the republic and NHC "Uzbekneftegaz", JSC "Uzkimyosanoat", JSC "Uzbekenergo", JSC "Uzbekugol", AMMP, NMMP, provincial departments of MAWR and other large concerns and enterprises may serve as an example of successful integration of science and production.

Workshops, round tables, conferences are conducted within the framework of these Fairs to discuss perspectives for efficient development and introduction of renewable energy sources, problems of energy efficiency and energy saving, improvement of innovation system.

The JSC NVK "Uzexpocentre" with assistance from sectoral ministries and agencies organizes on a regular basis fairs and exhibitions of products manufactured by domestic producers with use of advanced energy saving technologies, equipment and tools of both locally and foreign made.

5.4 Capacity Building and Development for Broad Expansion and Application of Ecologically Sound Technologies and Know-How

Capacity building for development and transfer of technologies is mainly carried out by various bilateral and multilateral programs and projects with assistance from international institutions. Within the framework of such programs and projects it is conducted field farmer days, on-site educational seminars and trainings, exchange of the best experience, implementation of demonstration and pilot projects on practical realization and use of EST, publication of information bulletins.

For example, within the framework of UNDP/Ministry of Economy Project "Support to Uzbekistan in Transition to Low Carbon Development of National Economy" and in partnership with SGP GEF, Khorezm Agro-consulting center and khokimiyats of

[19] "Conditions and Perspectives for Development of Free Economic Zones in the Republic of Uzbekistan": Analytical Report, Institute of Forecasting and Macroeconomic Studies with UNDP Assistance, Tashkent – 2014

[20] http://news.uzreport.uz/news_4_r_123693.html

[21] "Simple Technologies – Great Benefits", Collection of info-graths, Publication of SGP GEF and UNDP, Tashkent – 2015

Syrdarya and Khorezm provinces, 2 demonstration centers have been established. On the basis of these centers 25 thematic trainings for promotion of biogas technologies have been conducted.

The SGP GEF Projects essentially include informational component for dissemination of experience amongst population in use of energy efficient equipment and practice. During life of the program more than 5800 people have passed training in use of innovative approaches and practice.

Within the framework of EC TEMPUS IV Program (2007-2013), aimed at assistance to innovative activities, development of integration between science and production, elaboration of new educational specialties, renewal of existing programs, the considerable work has been completed for capacity building in transfer of technologies, enabling mitigation of and adaptation to climate change impact, including:

- modernization of training courses in higher educational institutions,
- introduction of new classroom disciplines on a number of applied sciences, including:
- environment conservation,
- introduction of sustainable agricultural technologies,
- natural resources protection,
- application of innovative approached in industrial development.[22]

Under the TEMPUS Project "Enhancement of universities role in transfer of innovations to production enterprises (UNIVENT)", the department of technology transfer has been opened in the Tashkent Institute of Textile and Light Industry (2007). In 2011, based on experience study of the leading universities of Germany, Spain and Portugal, the general model of Center for Innovations Transfer (CIT) has been developed and successfully introduced in the Fergana State University and Fergana Pedagogical Institute.[23] The CITs are equipped with the modern information technologies, allowing to introduce scientific/research designs into production.

From 2012, the Center AgroEcoBiotechnology operates in the National University of Uzbekistan, named after Mirzo Ulugbek. Activities of the Center are aimed at participation in solution of food security and ecological sustainability issues based on the programs being implemented by university jointly with wide circle of partners. The Center implements fundamental, applied and innovative projects in such directions as:

- achievement of rational use and protection of land resources,
- improvement of crop husbandry production,
- crops diversification,
- pastures improvement,
- adaptation to climate change,
- introduction of information and agro-bio-technologies, etc.

For capacity building in technologies transfer by lines "south-south" and "north-south" the specialists from Uzbekistan participate in various international organizations and activities, related to ways of cooperation for solution of problems with mitigation of and adaptation to climate change impact, such as high level forum "Way to cooperation between European Union and Central Asian countries in the area of clean technologies" (Green Bridge Forum, 2015), economic and ecological forum of OSCE, etc.

Uzbekistan is the member of UN and UN Economic and Social Commission for Asia and the Pacific (UN ESCAP), playing leading role in mobilization, dissemination and support to "green" development[24] in the whole region and beyond. It participates in conferences, programs and events on public awareness in this topic.

Non-governmental organizations are also involved in transfer of technologies. In 2013, the Association of international business and technologies (AMBiT)[25] was established in Uzbekistan. The Club of Alternative Energy has been created under this Association. Initiators of the Club establishment are entrepreneurs interested in development of alternative energy sector, and transfer of advanced international experience in this area, which may be efficiently applied in Uzbekistan. The Club supports implementation of joint with GIZ Project for manufacture and promotion of solar driers for fruits and vegetables.

[22]Digest "TEMPUS IV IN UZBEKISTAN", Prepared by the National Office of program EC"Erasmus+"in Uzbekistan, Tashkent, 2015

[23]"Activization of Corporative Relations Between Science, Education and Production in Uzbekistan Based on Example of the "Tempus" Project "Enhancement of Role of Universities in Transfer of Innovations Into Enterprise (UNIVENT)"' //Prof. Dr. Klaus Haenssgen, assistant professor A. Yunusov et alia // Digest "TEMPUS IV IN UZBEKISTAN", Prepared by the National Office of Program EC"Erasmus+" in Uzbekistan, Tashkent, 2015

[24]"Green" Development is Economic Growth and Development with Account of Necessity for Decrease in Energy and Water Consumption, Conservation of Non-Renewable Nature Resources, Limitation Of Wastes

[25]Association of International Business and Technologies: http://ambit.uz/

In 2016, the partner platform StartupMix, devoted to problems of "green" business (Green Business Platform) commenced its operation with support from the Inha University. The Platform was established in partnership between the SGP GEF, Club of Alternative Energy, and IT-company Brand.uz with support from StartupFactory.uz. Purpose of the "Green Business Platform" Project is to discuss and promote "green" technologies, which provide benefits to nature and business.

From 2013, Uzbekistan is a member of the Climate Technology Centre and Network on technologies associated with climate change. The Centre for Hydrometeorological Service under Cabinet of Ministers of the Republic of Uzbekistan (Uzhydromet) is the National Designated Entity for development and transfer of technologies. Its specialists participate in trainings and seminars on improvement of awareness about activities of the Climate Technology Centre and Network (CTCN), associated with climate change, transfer of technologies and state-private partnership in this area.

The WOCAT[26] global network approaches and criteria are used in Uzbekistan for dissemination of experience in adaptation to climate change and Sustainable Land Management (SLM). It comprises the documented SLM technologies and approaches with their scientific validation, combining capability of scientists, local technical experts and institutions. As of today, 4 unique technologies and 2 SLM approaches from Uzbekistan have been included in the WOCAT database (see Chapter 4.3.4).

Development and introduction of ICT technologies play special role in capacity building for the EST transfer. The ICT technologies may impact the climate change process by the following three main directions:

- decreasing emissions in the ICT sector itself through introduction of more efficient equipment and networks;
- decreasing emissions and ensuring energy efficiency in other sectors of economy through, for example, elimination of need to travel to fix a problem by replacing physical objects with electronic ones (decrease in materials consumption);
- providing assistance in adaptation to adverse impacts of climate change through application of ICT-based systems for weather and environment monitoring.

The ICT technologies allow access for the broad communities of population to important information about changes in environment conditions, which is necessary for ensuring their basic needs, such as availability of foodstuff and water. In an ideal case this may be achieved by use of ecologically sound technologies, as for example solar energy operating mobile communication devices and base stations. That's why business is now more frequently interested in the ICT technologies. The large cellular operator in Uzbekistan, "Beeline" company, has made next serious step in this direction, installing 24 solar panels 200W each at its base stations in the Syrdarya province. During solar radiation peak the total capacity of this system equals to 4.8kW.

In all in Uzbekistan on the initiative of the Government and with its support the favorable conditions for development and introduction of technologies facilitating mitigation of and adaptation to climate change impact have been created. There is a relevant capacity in the country and NGOs are involved in this process. Nevertheless, there are a number of problems, gaps and requirements for evaluation, selection and broad introduction of the EST. Among the main barriers are:

- high cost of equipment and technologies;
- barriers, associated withobjects of intellectual property;
- insufficient degree of commercialization of existing and developing local ESTs;
- lack of specialists in the area of technologies transfer.

For solution of the abovementioned problems it will be required enhancement of measures and actions in the following areas:

- mobilization of local and external sources of financing, including innovative climatic financing;
- decision makers capacity building and increase in awareness of society;
- development of tools for dissemination and transfer of information about ESTs;
- up-to-date assessment of requirements in the area of development and application of innovative technologies, facilitating mitigation of and adaptation to climate change impact;
- further improvement of institutional, and regulatory and legal framework for transfer, dissemination and introduction of ecologically sound technologies;
- further development of innovation infrastructure, including identification of clear criteria for selection of climate-resistant technologies and their commercial evaluation for subsequent broad introduction and transfer.

[26] World Overview of Conservation Approaches and Technologies: https://www.wocat.net/
WOCAT is the Universally Recognized Global Network, Operating Since 1993 and Comprising Database of the Best Practices in the Area of Soil and Water Conservation. The WOCAT Objective is Prevention and Reduction of Land Degradation through Application of Sustainable Land Management (SLM) Technologies and Approaches.

RESEARCHES AND SYSTEMATIC OBSERVATIONS

6 RESEARCHES AND SYSTEMATIC OBSERVATIONS

Systematic observations of characteristics and various parameters of climatic system is an informational basis for assessment of vulnerability, impact and development of measures for prevention and adaptation to climate change impacts for the country' development sake.

The climatic monitoring in Uzbekistan is carried out by Uzhydromet, which has extensive network of meteorological, hydrological and agro-meteorological observations, as well as observations over pollution of atmospheric air, surface waters and soils. Pursuant to recommendations of the WMO programs[1], which combine countries efforts in area of climate change monitoring, provision of reliable information and understanding climatic processes, and complying with obligations under the UN FCCC, Uzhydromet applies the considerable efforts for improvement of systematic observations, develops and implements a range of scientific and technical programs, aimed at provision of hydrometeorological information for the country's economy sectors.

6.1 Systematic Observations in Uzbekistan

On a background of increased demand for climate information due to development of agriculture and industry, introduction of the renewable energy sources, and environment deterioration, etc., necessity for further development of the system for climate and environment monitoring is arising. Assessment of compliance of the observed parameters with rising requirements of climatic service is becoming an issue of vital importance.

Amongst the priority activities of Uzhydromet in provision of climatic services are:
- collection and processing systematic climate observations data;
- improvement of information presentation methods and quality of climatic services;
- assessment of environment vulnerability to climate change and possible risks;
- monitoring dangerous hydrometeorological phenomena and probable changes in dangerous phenomena due to climate warming;
- assessment of climate change for the long-term perspective in the conditions of anthropogenic load growth.

Hydro-meteorological Observation Network. History of establishment and development of the hydrometeorological observation stations network in Uzbekistan counts more than 130 years, when observations have been carried out with various degree of regularity. (Figure 6.1). By the mid of 1980s of the XXth century, number of meteorological station and hydrological posts (gage stations) reached its maximum. Number of agro-meteorological stations has also been increased. Aviation[2] was widely used for exploration surveys of snow cover and glaciers in mountains.

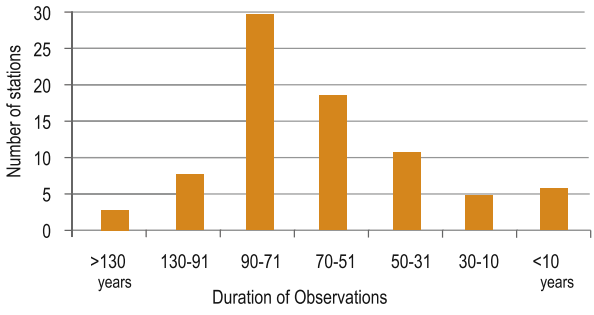


Figure 6.1 | *Distribution of Meteorological stations by Duration of Observations*

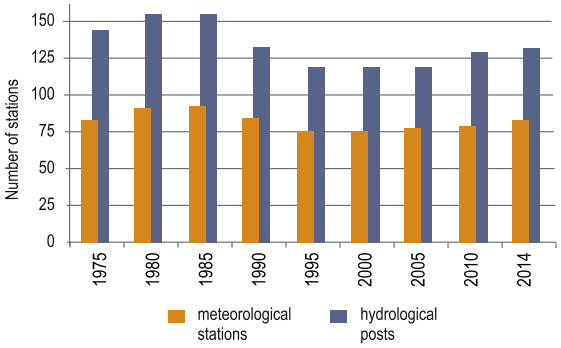


Figure 6.2 | *Total Number of Meteorological Stations and Gage Stations*

After 1991, part of hydrological stations and posts, subordinated to Uzhydromet, was handed over to the National Hydro-meteorological Services of Kyrgyzstan, Kazakhstan and Tajikistan. Number of hydrological posts and meteorological stations was reduced by 26% and 9% respectively (Figure 6.2). Nevertheless, during these difficult years Uzbekistan has managed to retain

[1]National Meteorological or Hydrometeorological Services for Sustainable Development Goals. Guiding Management Principles. WMO/TD-947

[2]"Outline of Hydrometeorology Development in the Republic of Uzbekistan". Editorial staff: V. E. Chub, B. Sh. Kadyrov, S. V. Myagkov, S. I. Inogamova et alia, 2011 - 330 pages.

maximum hydrometeorological observation network and volume of conducted observations. After adoption of the Decree of Cabinet of Ministers "On Improvement of Hydrometeorological Service of the Republic of Uzbekistan",[3] it was commenced a new period in development of hydrometeorological observation network: i.e. several meteorological stations were commissioning in the Khorezm, Bukhara, Navoi and Djizak provinces, opened additional gage stations.

The current observation stations network of Uzhydromet performs functions of climatic, meteorological, hydrological, agro-meteorological and environmental monitoring (Ref. Table 6.1). 50 representative meteorological stations with full observations program, characterizing territory of the country, have been included in the reference climatic stations network. The reference climatic stations network includes also stations of international data exchange (21 stations) and stations of the Global Climate Observation system (3 stations).

Table6.1 |*Structure of Ground-based Observation Stations Network of the Republic of Uzbekistan*

Ground-based Observation Stations Network	Number of Stations / Posts
Meteorological observations for synoptic network	83/86
Hydrological observations	19/131
Agro-meteorological observations	61/33
Environmental:	
– Air pollution observations	66
– Surface water resources pollution observations:	85/107
– Soil pollution observations:	
– agricultural land	261
– industrial cities	15 (according to five-year scheme)
– Radioactive contamination:	
– control points over radioactive fallouts	25
– control points over level of gamma radiation	42
– Integrated background monitoring	1
National reference climate observations network	50

The most important characteristic of ground-based meteorological observations system is density of observation stations. According to the WMO recommendations, ground-based observations network is considered as optimal if distance between meteorological stations is 50-60 km[4] on average (density index is 3 and less).[5] By territory of Uzbekistan density index of meteorological observations network varies from 1.1 in Tashkent and Andijan provinces to 16.7 in Karakalpakstan. Decrease in density index occurs mainly due to non-uniformity of meteorological stations distribution by topographic features, i.e. sparse location of meteorological stations in desert and mountainous areas of the republic.

Set of the standard ***near the ground meteorological observations*** in accordance with WMO recommendations and primary processing of results are carried out on meteorological stations. The main objective of near the ground meteorological observations is production of hydrometeorological information used for development of hydrometeorological forecasts, preparation of reports/analytical materials (reference books, atlases, yearbooks, monthly weather bulletins), climatic studies. Practically all data of meteorological observations, received from meteorological stations, are processed in automated mode.

Actinometric observations over direct, diffused, reflected and total solar radiations are carried out on 6 meteorological stations only.

Hydrological observations are carried out on rivers, lakes and reservoirs. Hydrological observation *on rivers* include measuring of water levels, discharges and temperatures, sediment load and monitoring general conditions of water body and dangerous hydrological phenomena. Observations on *lakes and reservoirs* comprise measuring of water levels and temperatures near shores and on various depths, water surface commotion, ice phenomena. Periodicity of water level observations is twice a day, with availability of automatic water level recording gauge – every hour; conditions of water body and temperature – twice a day; sediment load – 3-4 times per month. Apart from standard one, there is a specialized observations network comprising water balance station and 10 stations for measuring evaporation rate from open water surface.

The territory of Uzbekistan is characterized by extremely irregular distribution of water courses. The main volume of surface runoff is formed in the transboundary river basins. Despite the fact that substantial part of gauging stations have rather long hydrological observation data series, 39% of these stations were relocated and 43% require capital repair and renewal of instrumentations.

[3]Decree of Cabinet of Ministers of the Republic of Uzbekistan dated 14.04.2004 r. №PKM-183 "On Improvement of Hydrometeorological Service of the Republic of Uzbekistan" // Law Book of RUz, 2004, № 15, Article 179; 2005, № 7, Article 59; 2010, № 23, Article 183

[4] Strategy for development of Hydrometeorological Services of Countries – members of Commonwealth of Independent States/Approved by the Council of Head of the Governments of Independent States on 30 May 2012

[5] Density index equal to 3 means that an average of 3.0 thous. km of the territory there is one meteorological station

Agro-meteorological observations are carried out once in two days by the following parameters:

- soil temperature and moisture content on agricultural fields at rooting and plowing depth;
- conditions of soil and snow cover during winter period, depth of soil freezing and thawing;
- observations over agricultural crop development stages;
- assessment of crop productivity and yields;
- exploration of winter agricultural crops;
- observations over crop damages, unfavorable meteorological phenomena, agricultural pests and diseases;
- observations over implementation of crop operations;
- overall and quantitative assessment of agricultural crops conditions.

Ensuring hydrometeorological security is also priority direction of the Uzhydromet activities. Timely getting reliable information is essential for ensuring hydrometeorological security, i.e. warning about dangerous hydrometeorological phenomena to protect people's life and property, and prevent possible damage to economy. Department of monitoring over the dangerous hydrometeorological phenomena jointly with the representatives from the Ministry of Emergency Situations (MES) carry out seasonal flights over mountains and piedmonts areas for exploration of mudflow dangerous districts, conditions of breakthrough dangerous lakes and monitoring snow cover boundaries. Prior to school holidays and summer vacations, the ground surveys of children recreational camps, leisure areas and vacation hotels are carried out to assess mudflow danger with subsequent issuance of instruction regarding elimination of the revealed drawbacks.

In accordance with the "Program for Stabilization and Safe Water Releases through Water Courses of Uzbekistan for Period 2014-2015 and up to 2020", the MES together with MAWR, Uzhydromet and Gosvodkhoznadzor, and other ministries and agencies concerned, carry out the detailed survey of water courses and waterworks, settlements and irrigated lands located along water courses to find out reasons of damages, existence of flood threat and identify priority protective and rehabilitation works. Based on the survey results, it is developed the General targeted program for ensuring stabilized and safe release of floods and mudflows through water courses of Uzbekistan for the coming year.

Economic difficulties at the end of 1990s and beginning of 2000s, entailed reduction in number of observation stations, adversely impacted procurement of instruments, equipment, spare parts and material for hydrometeorological observation network of Uzbekistan. Therefore, modernization and technical re-equipment of observation network are priority issues for Uzhydromet.

6.1.1 System for Collection, Processing and Dissemination of Hydrometeorological Information

At the current stage all primary information, collected in monitoring stations by manual or automated mode, is transmitted through communication channels for processing and entering into database of the "METEOINFOSISTEM" - specialized division of Uzhydromet.

The METEOINFOSISTEM is also the Regional (for Central Asia) Telecommunication Center for collection, processing and dissemination of hydrometeorological and satellite information in the Global Telecommunication Network (GTN) of the WMO's World Weather Watch (Figure 6.3). The Regional telecommunication center ensures collection and processing of synoptical, aerological, hydrological, agro-meteorological, stormy, ionospheric data, as well as aviation information for the region and their transmission to the World Meteorological Center (Moscow).

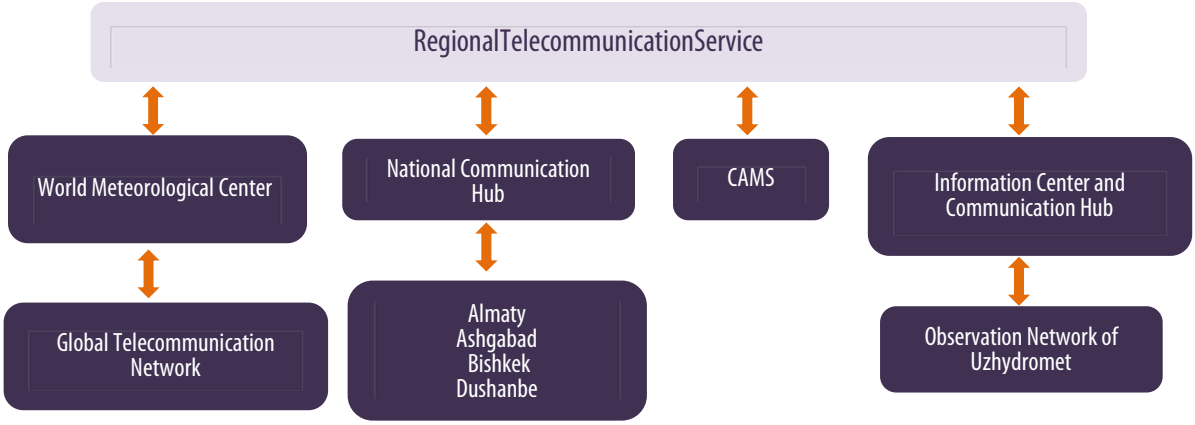


Figure 6.3 *|Scheme of Collecting and Disseminating Hydro-meteorological Data*

The Tashkent Regional Telecommunication Center is equipped with Meteorological Telecommunication System (MTS) and Universal Meteorological Abonent System (UniMAS), developed by the Intelcom-Delta Ltd (Moscow, Russia). The "METEOINFOSISTEM" carries out daily acceptance and dissemination of 174 types of forecasting and analytical products, as well as daily collection, processing and dissemination of the operational information from 158 observation stations, located on territory of the Central Asia, as well as from 1600 meteorological stations and 320 aerological stations located in the Northern hemisphere. The retrospective hydrometeorological information, stored in Uzhydromet in hard copies is currently being transferred into digital format.

Use of Remote Sensing Data. Uzhydromet receives and processes satellite data from the US NOAA earth satellites and geostationary earth satellites of the European Space Agency (Metesat-7, Meteosat-9), Chinese satellites Feng Yun-2C and FengYun-2D (system for data reception and processing has been provided by the China Meteorological Administration).

The following types of works are carried on the basis of remote sensing data:

- twenty-four-hour reception, processing and archiving of data;
- analysis and forecasting of synoptic processes and associated with them weather conditions in the CA region;
- forecasting of transfer and development of cloud layers;
- monitoring of snow cover in the mountains of Central Asia and Afghanistan.

Equipment for reception of data from the MODIS type satellites, procured under the Investment program of the Republic of Uzbekistan for 2010[6] allows Uzhydromet to receive data from the TERRA and AQUA satellites. Based on MODIS data it is carried out: the operational assessment of snow cover conditions in the Amudarya and Syrdarya rivers upper water sheds; monitoring of cropping land area; operational assessment of conditions and degradation degree of agricultural lands and pastures; early detecting and monitoring development of forests and steppe fires, dust storms; operational monitoring of the Aral Sea aquatory, Aidar-Arnasay lake system, large reservoirs located both on the territory of republic and beyond its boundaries.

In order to carry out ***meteorological radar-locator observations***, intended for collection of primary data on cloud systems and precipitations, intensity, speed and directions of drifting lighting storms, windflaws and cloudbursts, in 2012, it was put into operation 3 meteorological locators (in Tashkent, Nukus and Samarkand). The "Baron Services" company (USA) has procured the mobile Doppler meteorological radar with 150km coverage radius to carry out observation in the mountainous area of the republic. The radar is capable to transmit information in the real time mode, allowing provision of more reliable and qualitative services to various sectors of industry, agriculture and aviation.

Figure 6.4 | *Mobile Meteorological Radar Locator*

6.1.2 State Environmental Monitoring System

The efficient and sustainable State environmental monitoring system has been established and operates in the Republic of Uzbekistan. The following ministries and agencies monitor conditions and quality of environment components under general coordination from the State Committee for Nature Protection (Goskompriroda):

- the State Committee for Nature Protection – monitoring pollution sources and terrestrial ecosystems;
- the Uzhydromet – hydrometeorological monitoring, monitoring pollution of atmosphere, surface waters and soils, baseline monitoring;
- the Ministry of Agriculture and Water Resources – monitoring quality and quantity of irrigation and drainage waters;
- the State Committee on Land Resources, Geodesy, Cartography and State Cadastre – monitoring conditions and quality of land resources;
- the State Committee on Geology And Mineral Resources – monitoring conditions of underground waters and dangerous geological processes;
- the Ministry of Health – sanitary and hygienic monitoring of environment.

Agencies responsible for environmental monitoring possess relevant material and technical base, observation stations network and trained personnel. Amongst the tasks of these agencies are creation and maintenance of specialized observation databases. Industrial environmental monitoring is carried out in large industrial enterprises.[7]

[6] Decree of President of the republic of Uzbekistan dated 28.10.2009 #PP-1213 "On Investment Program of the Republic of Uzbekistan for 2010"

[7] Law of the Republic of Uzbekistan "On ecological control", No. ZRU-363, dated 12 November 2013, // Law Book RUz, 2013, No52, p. 688

State cadastres of natural resources are maintained in Uzbekistan for recording of quantitative, qualitative and other parameters of natural resources and metering of volumes, types and regime of their use. The Unified State Cadastre System (USCS), comprising all types of state and sectoral cadastres, has been established as multipurpose information system. The State committee on land resources, geodesy, cartography and state cadastre is coordinating body for the USCS. The USCS comprises documented information about each cadastral land plot within defined boundaries and data on natural resources and economy infrastructure, i.e. land, water, forests resources, fossil mineral resources, buildings, structures and other facilities with indication of their geographical location, legal and economic status.

Summarized information about conditions of surface and underground waters and volumes of their use is published in the Chapter "Resources of Surface and Underground Waters, their Use and Quality" of the State Water Cadastre - interagency publication of Uzhydromet, State Committee on Geology and Mineral Resources and Ministry of Agriculture and Water Resources.

The USCS also comprises the State Cadastre of Zones with Enhanced Natural Danger, which includes Chapter "Zones of Enhanced Danger of Hydrometeorological Phenomena" prepared by the special department of Uzhydromet. The Cadastre of Dangerous Hydrometeorological Phenomena is regularly updated with the following information: extreme air temperatures, frosts, heavy rains, strong winds, atmospheric droughts, floods, water logging, hydrological droughts, mudflows, avalanches, etc.

Based on monitoring results, ministries and agencies publish on regular basis informational bulletins, yearbooks and reports, namely:

- Uzhydromet – monthly bulletins, year books on condition of air, water quality in the main water courses and soils pollution;
- the State Committee on Geology and Mineral Resources – Informational bulletins on inventory of available underground water resources, volumes of their extraction and levels of pollution;
- the State Committee on Land Resources, Geodesy, Cartography and State Cadastre – National reports on conditions of land resources;
- the State Committee for Nature Protection – National Reports on Conditions of Environment and Natural Resources Use.

However, monitoring system requires solution of issues associated with improvement of financial mechanisms, renewal of technical/instrumentation base and capacity building of meteorological station's specialists. There is also a problem with insufficiently efficient system of information exchange between parties involve in monitoring process.

6.1.3 Climatic and Hydrometeorological Servicing

Based on data from observation network Uzhydromet on a regular basis provides the governmental authorities and administrations, economy sectors and population with hydrometeorological and climatic information, weather forecasts, warnings about dangerous natural phenomena, etc. Information is provided in form of hydrometeorological and agro-meteorological bulletins, reviews, notes, forecasts, as well as in electronic format on the official website of Uzhydromet (Figure 6.5)[8].

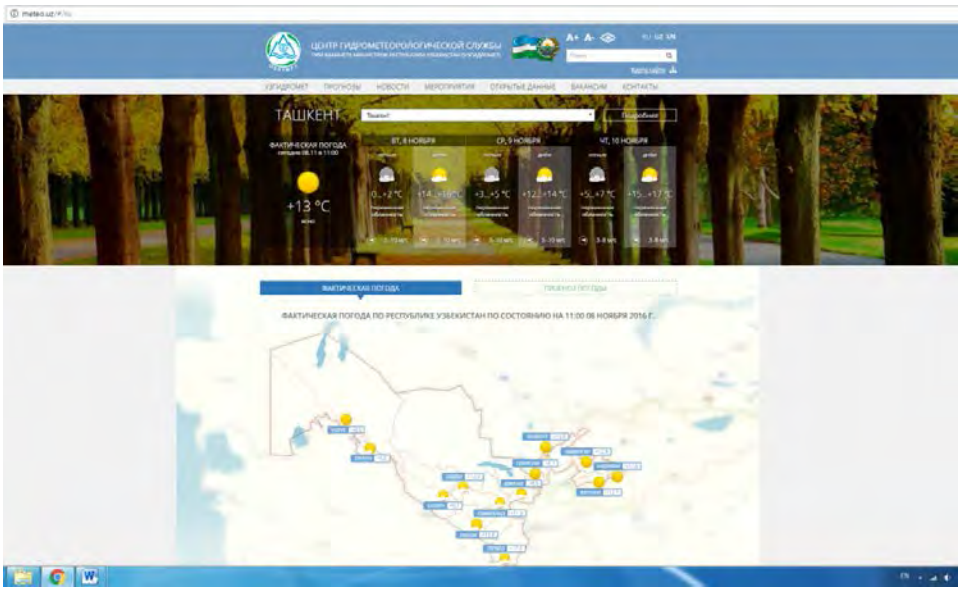


Figure 6.5 | *Main Page of Uzhydromet's Official Website*

[8] http://www.meteo.uz

Owing to climate change there is an increasing users' demand for hydrometeorological and climatic information. Therefore, improvement in quality of climatic services remains an issue of high priority. For solution of system-level problems of the national hydrometeorological services on 30 May 2012, the Council of Head of the Governments of the Commonwealth of Independent States approved the Strategy for Development of Hydrometeorological Services.[9] This document is aimed at improvement in quality of systematic observations, earliness and accuracy of storm warnings and weather forecasts in the CIS countries.

6.1.4 Priority Tasks and Requirements for Development of Observation Network

Modernization and development of observations network in accordance with the WMO recommendations assume increase in number of hydrometeorological stations, especially in piedmonts and mountainous areas of the republic with high frequency of dangerous hydrometeorological occurrence, and equipping it with advanced computer-aided observation devices, instruments and analytical equipment, as well as reliable communication systems. Resources from the state budget and international grants are attracted for solution of these tasks.

In November 2011, the Memorandum of Understanding was signed between Uzhydromet and the Finnish meteorological institute on implementation of the project aimed at: technical upgrading of hydrometeorological services in the Central Asian counties; capacity building through carrying out the regional trainings and equipping the Regional Training Center (RTC) in Tashkent with advanced equipment.

In November 2012, under the CAWA (Central Asian Water) program the automated meteorological station was installed in the Shakhrisyabz town in Kashkadarya province as part of the regional hydrometeorological monitoring network.

The important aspect in development of the national hydrometeoroloqical service is increase in earliness and accuracy of forecasts, development of methods for forecasting dangerous hydrometeorological phenomena, as well as development of approaches and introduction of methodologies for estimation of economic benefits from the national hydrometeorological service activities. Therefore, it will be requires to develop integrated plan for scientific researches in the area of optimization of observation network, weather forecasts, methods for assessment of climatic risks for ensuring the national security and introduction of scientific research outputs in practice.

Creation of efficient staff training and advanced training system with attraction of both local and international trainers is of significant importance in Uzhydromet activities.

In 2011, in accordance with recommendations of the WMO experts the Tashkent hydrometeorological college, included in Uzhydromet structure, was acknowledge as the Regional WMO training center for the next eight years. Training materials and technical facilities of this educational center comply completely with the current WMO standard in area of training/educating staff for work in hydrometeorological institutions. The training observation station is equipped with set of measurement devices for observation of weather parameters and environment conditions (building, observation qrounds, measurement instrumentation, visualization tools, and communication equipment). In 2014, the automated hydrometeorological training station of Finnish firm "Vaisala" was installed. All these efforts allow resolving problems with staff training for observation network of Uzhydromet.

The following measures will be required for further improvement of current type of services:

- expansion of scientific applied researches associated with regional climate change and assessment of its impact on economy sectors, development and introduction of methods for weather and dangerous hydrometeorological phenomena forecasts with various earliness that meet users requirements;
- development of mechanisms and communication facilities (network technologies, Internet, etc.) and provision of user with required climatic information for decision making;
- further development of systems for data processing and storage, which will allow to efficiently use large volumes of various data;
- development of climatic, hydrometeorological and other databases, which will allow improving reliability of future climate changes;
- development of the applied climatology methods for provision of users with specialized computed climatic information and upgrading relevant technical documentation;
- use of new approaches to modeling, such as systems of collaborative and holistic forecasting;
- development and enhancement of national, regional and international partnership relations and cooperation.

[9] Strategy for Development of Hydrometeoroloqical Services of Countries – Members of Commonwealth of Independent States / Approved by the Council of Head of the Governments of the Commonwealth of Independent States on 30 May 2012

6.2 Climate Change Studies

Uzbekistan possesses considerable scientific and research capacity comprising well-developed research material/facilities base, comprehensive scientific fund, and qualified research staff. The scientific and research complex comprises 362 academic, educational and sectoral institutions.

Great attention is paid in the country to implementation of legislative and administrative measures enabling development and adaptation of technologies and knowledge, protection of intellectual property rights with use of broad set of economic tools.

The Government has formed a basis for the state scientific/technical and innovative policy, which enable solution of problems associated with climate change and support scientific researches, designs and innovative projects in such directions as:

- ecologically acceptable increase in production of fuel/energy and mineral raw materials resources;
- development of competitive resources saving technologies and methods, including alternative energy sources;
- development biotechnologies;
- selection of highly productive crop varieties and animal breeds;
- development of new ecologically friendly technologies for production agricultural products, remedies for control plant and animal diseases; etc.

Approximately half of all scientific researches, carried out in the country, is financed from the state budget on competitive basis (through grants) and coordinated by the Committee on Coordination and Development of Science and Technology (CCDST) under the Cabinet of Ministries of the Republic of Uzbekistan. Research projects of various institutions are integrated into programs by direction of studies (Tables 6.2, 6.3).

Table 6.2 | *State Scientific and Technical Programs of Studies Facilitating Decrease in Greenhouse Gases Emissions Development of Adaptation Measures to Climate Change*

Program Name	**Study Tasks in Context of Climate Change Mitigation**
Development of scientific basis for further deepening democratic reforms, formation of civil society, modernization and liberalization of the national economy	Formation of society capable to resolve problems with efficient use of energy resources, rational use of natural resources, and environment conservation, etc.
Energy generation, energy and resource saving, transport, machine and instrument manufacturing industry	Development and introduction of energy efficient technologies, improvement of legislative framework for optimization of energy resources use
Development of methods for use of renewable energy sources, creation of technologies and devices on the basis of nanotechnologies, photonics and other technologies	Manufacturing equipment for renewable energy sources based on efficient advanced technologies and their introduction in various economy sectors.
Rational use of natural resources, and environment conservation	Energy saving, decrease in greenhouse gases emissions
New technologies for production of organic, non-organic, polymer and other materials	Use of energy and resources saving technologies in production of construction materials
Development of efficient methods for exploration, assessment, extraction and integrated processing of fuel and mineral resources, utilization and use of wastes of mining enterprises	Decrease in energy consumption on account of introduction of efficient technologies for use of technogenic wastes and out of balance ores.
Development of information technologies, telecommunication networks, hardware/software means, methods and systems of intelligent management and training aimed at increase in level of society informatization	Public awareness and knowledge increase in climate change issues, its impact and adaptation. Improvement of system for timely warning about dangerous hydrometeorological phenomena
Program Name	**Study Tasks in Context of Adaptation Measures**
Development of biotechnologies, based on achievements of advanced modern genomics, proteomics, metabolimics and bio-informatics.	Assistance to sustainable development of the country, including solution of food safety problems with use of advanced biotechnologies. Adaptation of cattle and crops to adverse impacts of climate change
Preservation of plants and animals genofond, pathogeny, selection of new crop varieties and highly productive cattle breeds	
Creation of highly efficient ecologically clean agro-technologies for production of agricultural production, methods of its storage, processing and control of deceases and pests	
Rational use of natural resources, and environment conservation	Ensuring food security through rational use of land and water resources, improvement of land quality, biodiversity conservation in climate change conditions
Protection of population health on account of development new technologies, diagnostic methods, diseases treatment and prevention	Population health promotion as adaptation measure in the conditions of climate extremeness enhancement
Development of highly efficient technologies for production of new medicines based on local natural and synthetical raw materials	

Over the recent years a number of technologies was developed in the country, e.g. technologies aimed at production of new highly efficient ecologically clean fertilizers, low-toxic defoliants, medical products, growth stimulants and plant protection chemicals, sewage waters purification, establishment of cultivated pastures on the dried Aral Sea bottom with use of mineralized water, phytomelioration technologies, etc. which may considerably increase adaptation capacity of the country.

The following projects, implemented in 2012-2014, may serve as examples of studies for prevention of and adaptation to climate change, carried out under the State Scientific and Technical Programs. [10]

- *"Use of Solar Batteries for Drinking Water Extraction from Underground Aquifers in the Muinak District of the Republic of Karakalpakstan"* – project is aimed at development of solar batteries to pump water from vertical wells for drinking water supply for the Kyzyldjar settlement in Muinak district.
- *"Development of Methods and Technical Solutions for Increase in Efficiency of Hydropower Use in Small Rivers and Water Courses, use of Wind Energy in Near the Ground Layers of Atmosphere, Solar Energy Use in the Energy Supply Systems for Agriculture and Water Management Sectors, Food Processing and Light Industries, Social Facilities"* – project is aimed at increase in efficiency of electric energy generation and its cost decrease, assessment of economic risks associated with introduction of RES.
- *"Increase in Efficiency of Electric and Thermal Energy use in Ferrous Metallurgy Enterprises"* – development of energy saving technologies.
- *"Estimation of Current Conditions of Pasture Ecosystems in the Central Kyzylkum"* – study of processes leading to degradation of pasture vegetation under influence of anthropogenic climate change.
- *"Increase in Water Availability and Soil Fertility of Irrigated Lands Based on Drainage Water Reuse for Irrigation"* – rational water use in climate change conditions.

Historically the NIGMI and other Uzhydromet departments carry out the considerable volume of climatic studies and practical application of gained climatic knowledge and data. This is also relevant to organization of system for monitoring climate characteristics and its forming factors, fundamental researches of climatic system and solution of wide scope of applied tasks. During more than a century long history of the hydrometeorological service of Uzbekistan it is gained research and methodological instrumentations that allow to assess the occurred climate changes and use these results in practical activities.[11]

As a result of studies carried out during the recent years in the Scientific and research hydrometeorological institute within framework of the state scientific and technical programs, and projects of Uzhydromet the following tasks have been accomplished: assessment of expected climate change for perspective in accordance with GHGs emission scenarios; assessment of climate change impact on the key economy sectors; climatic and agro-climatic zoning of territory; set of bioclimatic maps of territory prepared; helio and wind energy cadastres completed; proposals on adaptation measures prepared.

In aid of increase in efficiency of GHGs inventory, which includes collection and analysis of information, its archiving, calculation of emissions and sinks, studies are carried out in the country aimed at improvement of methodologies, approaches and estimation of GHGs emissions for new categories of emission sources. Studies are carried out for development of the national GHGs emission coefficients, optimization of cadastral information collection, verification of data quality, assessment of uncertainties in computations and paper works procedure. Considerable part of studies in area of adaptation to and mitigation of climate change impacts is carried out with framework of projects with the international financing (see Annex 4).[12]

Despite availability of high scientific capacity, there are some complications in the republic associated with shortage of financial resources for modernization and/or replacement of outdated and broken technical equipment in scientific institutions. This restricts possibilities for development and adaptation of the advanced study approaches and methods. Attention should be given to issues of cooperation and interaction between scientific institutes.

There is no sufficient practical use of results of scientific studies, and experience/achievements of pilot projects financed by the international institutions and aimed at testing and demonstration of new technical and environmentally sound solutions, methods and highly efficient technologies.

Along with growing risks of climate change to the country's population and economy there is an increasing need for studies aimed at assessment of climatic risks and methods to withstand against these risks.

[10] http://fan-portal.uz/Projects/

[11] Outline of hydro-meteorology development in the Republic of Uzbekistan. Editorial staff: Chub V.E., Kadyrov B Sh., Myagkov S.V., Inogamova S.I. et alia. – Tashkent: Uzhydromet, NIGMI, 2011. – 330 p.

[12] http://www.uz.undp.org/content/uzbekistan/ru/home/operations/projects/environment_and_energy/;
http://www.vsemirnyjbank.org/projects;
http://www.adb.org/projects;
http://www.fao.org.

Development of climatic studies should in general facilitate decrease in existing level of uncertainties in assessments of future climate change and its impacts on ecosystems and population with the aim of timely decision making regarding adaptation measures, which may have tremendous economic and social effect.

There is a need for further studies, development, adaptation and introduction of renewable energy sources, soil conservation and water saving technologies, methods for regeneration of biological resources of forests and pastures, and technologies for genofond conservation, GIS technologies and remote sensing methods for environmental monitoring, etc.

It is also necessary to carry out comprehensive analysis of the country's capabilities and resources for adaptation to climate change impacts. Results of studies presented in the Fifth IPCC assessment report and other foreign researches indicate quite considerable adaptation capacity. However, there are some limitations.

Obviously, it will be required the efficient governmental management and support to priority climatic studies through:

- development and implementation of strategy/plan of the national climatic studies;
- procurement of the advanced computer hard/software for priority climatic studies.

Integration of climatic study components into the State scientific and technical program may become the first step towards solution of the above problems. Amongst the components of climatic studies are: development of information technologies for processing and managing climatic data; monitoring climatic system and assessment of changes for perspective; studies aimed at mitigation of climate change impacts, assessment of vulnerability and adaptation to climate change impacts (Table 6.3).

Table 6.3 | *Proposals for Program of Study of Climate Change Problems*

Development of information technologies for processing and managing climatic data
– Development of electronic climatic and hydrological databases (daily, monthly and annual timescale) based on computer-aided data bank from observation network.
– Development of methods for computer-aided processing of actinometric observation data.
– Establishment of unified database of dangerous hydrometeorological phenomena with updating statistical characteristics and maps of their distribution.
– Development of software "Climatologist working place" on the basis of data bank from observation network and computation of statistical and specialized climatic characteristics.
Monitoring climatic system, assessment of changes for perspective
– Studies of regional atmosphere circulation in climate change conditions.
– Development of methodological guidelines for calculation of specialized climatic parameters and their zoning; upgrading technical documentation for use of specialized climatic parameters.
– Development of models and scientifically based recommendations allowing to assess situations arising in formation and use of water resources in climate change conditions.
– Development of models for prediction of regional climate change.
– Improvement of methods for forecast of dangerous hydrometeorological phenomena (mudflows, floods, avalanches, droughts, etc.) and early warning systems with use of remote sensing data (satellites, locators).
Studies aimed at mitigation of climate change impacts
– Development and introduction of information system for inventory of greenhouse gases emissions and sinks.
– Development of national coefficients of greenhouse gas emissions.
– Assessment of technological requirements associated with climate change.
– Updated assessment of RES resources in the republic (solar energy, hydropower, wind energy, bioenergy), zoning and mapping RES capacity, perspectives for RES development in climate change conditions.
Studies and assessments of vulnerability and adaptation to climate change
– Assessment of adaptive capacity of the country in climate change conditions.
– Development of methods and approaches to assessment of risks and vulnerability of population and economy sectors to climate change impacts.
– Study of climate change impacts in climate-depending economy sectors (industry, water resources management, agriculture, forestry, construction, transport, fuel and energy, housing and utilities and healthcare sectors).
– Predictive estimates of climate change impacts on social and economy sectors depending on climatic scenarios, population growth and plans of social and economic development of the country.
– Assessment of climate change and anthropogenic factor impacts on land desertification processes and droughts.

EDUCATION AND PUBLIC AWARENESS

7 EDUCATION AND PUBLIC AWARENESS

7.1 Education System in Uzbekistan

Structural reforms, involved all levels and components of educational system, have been implemented in Uzbekistan during independence years. These reforms are aimed at: a) retention of educational level, achieved in pre-reform period; b) its transformation in accordance with the new requirements and conditions, including reorganization of the entire structure and process of education and staff training.

Reformation of educational system of Uzbekistan is regulated by the Law "On Education"[1], which declares education as the state priority and guarantees equal rights for education to all citizens. The National Program for staff training[2] was adopted in Uzbekistan in 1997. It was developed on the basis of analysis of national experience taking into account world achievement in the educational system. The Program is aimed at formation of a new staff generation with high level of general and professional education, ensures possibility to get higher education based on governmental grants or on payable contractual basis. Within the framework of education reformation the state educational standards have been introduced, developed up-to-date educational plans, programs, textbooks and didactical materials. Network of educational institutions and university education have been expanded in higher education. Test methods for selection of applicants and rating evaluation of knowledge quality of students/trainees became a regular practice. Higher education system has been transformed into two levels system. Development of labor market has predetermined more active participation of scientific institutions and production sector in the process of specialist education, including participation of foreign partners.

Analysis of education system development, presented in such documents as the "Report on Millennium Development Goals: Uzbekistan 2015" and World Bank Report "Uzbekistan: Modernization of Higher Education System" (2014) have indicated achievement of substantial progress as a result of education system reformation being carried out in the Republic. Charge-free 12-year education is obligatory in Uzbekistan. It comprises primary, general secondary and secondary specialized education. Coverage of population by general secondary education is estimated at the level 98-99.8%, that of secondary specialized education is 99.6% (during the period from 2002 to 2013 it was increased by 68.4%). Over the period from 2001 to 2013 number of secondary specialized professional educational institutions was increased by 4 times. In particular, number of academic lyceums and professional colleges was increased by 3 and 4.7 times respectively. Share of teachers with higher education was increase in primary and secondary schools by 10.8% and 20.7% respectively.[3]

Over the recent years reforms in higher education system were aimed at modernization of higher education institutes, ensuring quality of education and improvement of management processes.[4]

In order to improve quality of academic and research activities and increase level of education in higher education institutes in compliance with requirements of economy and labor market it was introduced rating system for evaluation of higher education institutes.[5] The state standards have been developed and introduced in the system of higher education[6], fundamentally new, improved system of regular retraining of teaching staff[7] is used. It is carried out teaching of qualified specialists for various sectors of economy and social sphere in such directions as economy and legislation, production technologies and humanitarian education, agriculture and water resources management, healthcare and social security, sphere of services.

Annual education expenditures in Uzbekistan are around 10-12% from the GDP, which by almost 2 times higher than investments in education recommended by the UNESCO (6-7%), necessary for ensuring the sustainable development of country. Only in 2015, it was completed some activities for further development and strengthening material and technical base of 384 educational institutions for the total amount of 423 million Soums.

In the structure of state expenditures for education the largest share is for general secondary education (56.1%), then go expenditures on the secondary specialized professional education (21.4%), preschool education (10.2%) and higher education (5.4%).

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[1] Law No. 464-I, dated 29 August 1997 "On Education" // Bulletin of the Oliy Majlis of the Republic of Uzbekistan, 1997, No 9, page 225; 2013, No 41, page 543

[2] National Program for staff training. – Law-book of the Republic of Uzbekistan, 2007, No 15, page 150; 2013, No 41, page 543

[3] Report on Millennium Development Goals: Uzbekistan 2015 – Tashkent: Center for economic studies, 2015. – 100 p.

[4] Decree of the President of the Republic of Uzbekistan No. PP-1533, dated 20 May 2011 "On Measures for Strengthening Material and Technical Base of Higher Educational Institutions and Drastic Improvement of Training Quality of Highly Qualified Specialists"

[5] Decree of the Cabinet of Ministers of the Republic of Uzbekistan No. PKM-371, dated 29 December 2012 "On Introduction of Rating System for Evaluation of Higher Educational Institutions of the Republic // Law book of RUz, 2013, No 1, page 10

[6] Uzbekistan. Modernization of higher education system. – World Bank Report No 88606-UZ. – 2014.

[7] Report of the first President of RUz, Mr. I.A.Karimov, at the extended session of the Cabinet of Ministers devoted to the results of social and economic development of the country in 2015, and the most important priority directions of economic program for 2016,Tashkent, 16 January 2016.

7.2 Ecological Education, Outreach and Staff Training

Great attention is paid in the country to ecological education, as one of the most important factors of sustainable development. The first President of the Republic of Uzbekistan, Mr. I.A. Karimov, in his book "Uzbekistan on the verge of 21 century: security threats, conditions and warranties of progress "has stressed that "…at the turn of the century mankind and population of our country have faced with the global ecological threat. Take no notice of it, be inactive – means to doom ourselves to extinction". One of the factors influencing improvement of ecological situation is formation of modern ecological world view in each member of society.

Box 7.1

Strategy of UNECE on Education for Sustainable Development (ESD)
Objective of the ESD strategy "is to encourage member-countries to develop and include ESD in their systems of formal education in framework of all relevant teaching disciplines, as well as in informal education and enlightenment".
This strategy contains recommendations regarding development of policy and preparation of measures for inclusion of sustainable development issues into the national educational systems with participation of all the parties concerned, first of all, educational institutions, and representatives from civil societies, business and government.

Ecological education in the country is coordinated by the Ministry of education and State committee on nature protection. Recognizing importance of education the Concept "On development of ecological education,…."[8] has been adopted by the joint resolution of Ministry of Public Education, Ministry of Higher and Secondary Specialized Education and State Committee for Nature Protection. The Concept is based on the Strategy of United Nations Economic Commission for Europe (UNECE) on Education for Sustainable Development (ESD) (Box 7.1).

For further promotion of sustainable development principles into educational system, the Concept on Education for Sustainable Development (ESD) of the Republic of Uzbekistan[9,10] has been adopted. In July 2015, the Cabinet of Ministers of the Republic of Uzbekistan approved "Program of Actions for Staged Introduction of Principles of Education for Sustainable Development in Educational System of the Republic of Uzbekistan for 2015-2017". In accordance with this program educational plans and programs are being improved at all levels of teaching.[11]

Measures for development of ecological education are carried out in accordance with implementation of the Environmental Action Program. For further development of educational system for sustainable development, the following measures have been included in the "Environmental Action Program of the Republic of Uzbekistan for 2013-2017[12]:

- implementation of the Strategy of UNECE and Concept of the Republic of Uzbekistan on education for sustainable development (item 53);
- study and dissemination of advanced experience of non-governmental non-commercial organizations (NGOs) in the area of ESD projects implementation (item 54);
- establishment of educational and methodological center on ESD under the Ministry of Higher and Secondary Specialized Education (item 55).

Within the framework of this Program and ESD Concept implementation, training manuals on environmental issues and sustainable development for schools, colleges, lyceums and higher education institutes have been published, training programs improved, and ESD elements and components incorporated into the state educational standards.[13,14]

The system of higher education and advanced training prepares educators who will integrate ESD principles in educational process.

Educational/training center in the aid of sustainable development operates under the National University of Uzbekistan named after M. Ulugbek. Sector "Education in sustainable development"[15] has been established within educational and methodological association on production technologies and environment conservation in the Ministry of Higher and Secondary Specialized Education.

In 2011, Tashkent hydro-meteorological professional college, included in the structure of Uzhydromet, was identified as the WMO Regional training center for subsequent eight years. Currently around 800 students are studied in the college. There are 6

[8] Implementation of UNECE Strategy on Education for Sustainable Development (ESD). http://www.uznature.uz/?q=ru/node/420
[9] Current aspects of environmental culture formation in family. http://www.uznature.uz/?q=ru/node/88
[10] Joint resolution of Ministry of Public Education, Ministry of Higher and Secondary Specialized Education and State Committee for Nature Protection No 2/20/305, dated 19 July 2011.
[11] National Report on Environment Conditions and Use Of Natural Resources in the Republic of Uzbekistan (2008-2011) / Edited by N.M .Umarov; The State Committee on Nature Protection. – Tashkent: Chinor ENK, 2013. – 260 pages.
[12] Decree of the Cabinet of Ministers of the Republic of Uzbekistan No. PKM-142, dated 27 May 2013 "On Environmental Action Program of the Republic of Uzbekistan for 2013-2017" // Law book of RUz, 2013, No 22, page 282
[13] S.Sanginov. Education is Nature Ally. http://narodnoeslovo.uz/index.php/homepage/fan-va-talim/item/6669-obrazovanie-soyuznik-prirody
[14] Report on progress with implementation of Strategy on education for sustainable development (ESD) within the framework of the UN conducted Decade of education for benefit of sustainable development (2005-2014). Submitted by Uzbekistan.
[15] I.Dolenko. Improving Regulatory and Legal Framework. http://uza.uz/ru/society/sovershenstvuetsya-normativno-pravovaya-baza-21-12-2015

departments with over 50 teachers. The college facilities comply with the WMO requirements for staff training to work in the hydro-meteorological organizations.

10 higher educational institutes provide engineering/ecological education in Uzbekistan. Discipline "Ecology" and the relevant ones are included in all educational plans. Every year around 320 specialists on ecology graduate from these institutes, however the only base for training specialists in hydrometeorology remains the National University of Uzbekistan. Students get knowledge in such disciplines as land hydrology and water resources; meteorology; climatology; agro-meteorology; atmospheric air pollution; hydrochemistry; glaciology and snow cover monitoring, etc.

Environmental education. The State Committee for Nature Protection (Goskompriroda) in cooperation with the key ministries, agencies and NGOs play important role in the environmental education. Forms of governmental support to NGOs, their interaction with governmental bodies, business and other institutions are identified by the following Laws: "On Public Associations" (1992), "On Non-Governmental Non-Commercial Organizations" (1999), "About Warranty of Non-Governmental Non-Commercial Organizations Activities" (2006). Goskompriroda has developed the "Recommendations for Management and Implementation of Joint Activities With Non-Governmental Non-Commercial Organizations".

In 2008, for enhancement of public engagement activity the environmental scientists and public figures established the Ecological movement – public association that has 15 permanent representatives in the Legislative Chamber of Oliy Majlis. The Ecological movement of Uzbekistan has combined more than 260 NGOs.[16] It carries out its activities on the basis of "Program of Ecological Movement of Uzbekistan" [17]. The main task of this movement is to mobilize public forces for deepening reformations in the country aimed at observance of citizen rights to live in favorable natural environment, improvement of population health, protection and rational use of natural resources. The Ecological movement of Uzbekistan considers development of ecological education as the most important priority for educational institutions, state nature protection and public ecological organizations.

The international conference "Transboundary Environmental Problems in Central Asia: Use of International Legal Tools for their Solution" has become the important event arranged by the Ecological Movement. Tashkent ecological declaration (2010) became the outcome of this event. It specified the main region's environmental problems, such as environment degradation and climate change, irrational use of transboundary water resources, as well as recommendations for solution of these problems.[10] Year by year the Ecological Movement of Uzbekistan widens scope of its activities in education and public awareness raising. So, e.g. over the period from 2008 to 2011, it was conducted 1500 events, in 2014 – 887 events, which were attended by more 94.4 thousand people. In 2015 it was conducted more than 1000 events with the total number of participants over 110 thousand people. These events are aimed at improvement of ecological literacy of population, development of system for ecological education and training, broad involvement of youth and public for participation in nature protection activities, enhancement of ecological and sanitary conditions of territories.

7.3 Public Awareness in Climate Change Issues

Coordination of activities associated with raising public awareness in climate change issues is entrusted on Uzhydromet – organization responsible for implementation of the UNFCCC in Uzbekistan. Secretariat on implementation of the UNFCCC and Information Center on climate change issues have been established in Uzhydromet.

Informational and outreach activities carried out during the recent years allowed to various groups of population to improve significantly level of their knowledge in issues associated with risks of climate change, adaptation to and mitigation of its impacts. Capacity building activities have included holding of training seminars for various target groups of specialists, development of methodological guidelines and training materials for schoolchildren, students, teachers, establishment of pilot plots for training of farmers, creation of multimedia products, carrying out TV and radio broadcasts, issue of thematic bulletins and infographics, preparation of articles and publication for the local press.

For improvement of population awareness about climate change and its possible impacts and risks, Uzhydromet cooperates closely with leading journalists of the country, publishes articles in periodical publications, and participates in TV and radio broadcasts. A number of press conferences have been conducted in course of preparation of the Third national communication on climate change. Considerable activities on outreach and education in the area of climate change, development of measures for decrease in climatic risks and adaptation to climate change are carried out within the framework of international projects.

Implementation of the UNDP/Uzhydromet Project "Climate Risk Management in Uzbekistan (CRM)" has allowed: to strengthen staff capacity; to improve awareness of various target population groups; to carry out campaign for dissemination of knowledge and practical experience in the area of climate risks management. On the basis of pilot plots information resource:

[16] National Report On Environment Conditions and Use of Natural Resources in the Republic of Uzbekistan (2008-2011) / Edited by N.M. Umarov; The State Committee for Nature Protection. – Tashkent: Chinor ENK, 2013. – 260 pages.

[17] Program of Ecological Movement of Uzbekistan http://eco.uz/ru/biblioteka/programmnye-dokumenty/10-programma-ekologicheskogo-dvizheniya-uzbekistana

http://climatechange.uz/ has been developed, "round" tables, trainings, educational seminars, various practical trainings conducted, including:

- in the Kashkadarya province (southern arid part of Uzbekistan) 43 training seminars have been conducted for more than 3000 trainees, including farmers, representatives from ministries, agencies and local communities, specialists and journalists. Examples of good water saving practice and mitigation of drought impacts have been demonstrated on these seminars;[18]
- quarterly bulletins on issues of climate risk management under the Drought early warning system have been published and distributed. These bulletins provides farmers with various useful information in understandable terms;[19]
- in the Karshi institute of engineering economy it was opened resource-information center and constructed greenhouse with drip irrigation system in aid of testing and selecting drought and salt resistant plants in the conditions of irrigation by water with various levels of mineralization. Similar educational and production base have been established in the Surkhandarya agricultural college (300m^2 greenhouse) and in school No.102 in Shakhrisyabz city;[20]
- the following publications have been prepared: "Profile of Climate Risks", "Manual for Evaluation of Climate Risks in Uzbekistan", "Approaches to Assessment of Water Availability and Water Consumption in Uzbekistan in the Conditions of Climate Change" and Practical Guide on Laser Guided Land Leveling;[21]
- it has been developed training course "Climate Change and Risks Management" for students of higher educational institutes in Uzbekistan to familiarize them with climate change problem and its impact, dangerous climate phenomena, possibilities for climate risk management. Approbation of this training course is carried out in the "Land Hydrology" department of the National university of Uzbekistan named after M. Ulugbek. The training course is being integrated into educational plan for IV course students of "Hydrometeorology" department;[20]
- electronic training aid has been developed, allowing teachers from secondary specialized and higher education institutions, advanced training and retraining specialists to improve level of their knowledge in area of climate change and risk management by themselves;
- popular-science film "Learning to Manage Climate Risks" has been shot.

Electronic training course on climate change intended for participants of the international climate negotiations, students and public at large has been developed within framework of the UNDP Project "Support to Uzbekistan in Transition to Low Carbon Development of National Economy". On the Project site http://www.leds.uz/ it is posted publications, presentations and infographics aimed at improvement of knowledge level for decision makers, representatives from ministries, agencies and public on climate change prevention through development of "green" growth strategy, strengthening institutional capacity and improvement of legal base in the area of energy efficiency and renewable energy. Within the framework of the Project it was also conducted popularization of biogas technologies in private farms of Uzbekistan.

The joint Project of UNDP/GEF/State committee of Uzbekistan on architecture and construction "Improvement of Energy Efficiency of Social Objects in Uzbekistan" has also prepared a series of publications, bulletins and infographics.[22] Supplementary manual "Climate and We" in Uzbek and Russian languages for pupils of general secondary schools, student of academic lyceums, professional colleges and higher education institutes has been prepared with support from Goskompriroda and ecological publishing company "CHINORENK".

The Small Grant Program of Global Environment Facility in Uzbekistan on its site http://sgp.uz/ presents regularly a number of publications aimed at awareness rising of broad layers of population in issues associated with energy sector and climate change, biodiversity and land degradation, adaptation to climate change.

Under the WHO/UNDP pilot Project "Adaptation of Healthcare System to Climate Change" it has been developed informative and practical site www.meteomed.uz, presenting booklets and brochures with popular information on topic "Climate Change and its Impact on Environment and Population Health", prepared and approved training program for general practice doctors "Climate Change Impact on Health Conditions of Uzbekistan's Population" (Section 4.5).

Substantial contribution has been made to improvement of population awareness during preparation of the Third National Communication on Climate Change. Uzhydromet has prepared and published collection of articles (Bulletins No.9, No.10) with results of studies on evaluation of possible climate change impacts and response measures at the national level. The articles present: analysis of conditions and requirements for development of the national system for climate observations; analysis of

[18] http://www.ca-crm.info/ru/ca-crm-programme/ca-crm-programme-in-uzbekistan
[19] http://climatechange.uz/
[20] http://www.ca-crm.info/ru/library/prezentatsii
[21] P. Umarov, O. Egamberdyev, M. Serkaev. Practical Guide for Private Farmers "Seven Steps to Independent Use of Laser Guided Equipment for Leveling of Irrigated Lands" – Tashkent: Baktriapress, 2014. – 32 p.
[22] http://uz.beeca.net/projects

climatic trends by territory of Uzbekistan; results of preparation of climate change scenarios depending on rates of increase in GHGs concentration in atmosphere; assessment results of change in water and agro-climatic resources, vulnerability of agriculture, energy sector and certain sectors of economy to climate change; negative and positive impacts of climate change for agriculture, measures and actions for adaptation of agriculture to climate change; comparative assessment of vulnerability to climate change of Uzbekistan's provinces; review of biodiversity conditions assessment and its vulnerability, possible measures for conservation and adaptation; assessment of climate change impact on increase in risk of disease incidence and result of test introduction of the Early warning system; assessment of risks with occurrence of dangerous hydro-meteorological phenomena (droughts, high air temperatures, mudflows, floods, etc.) in accordance with climatic scenarios; assessment of changes in glaciation degradation in the Chirchik, Chatkal, Kashkadarya and Surkhandarya river basins; anthropogenic and climatic impact on runoff of suspended sediments in the Amudarya river. Results of studies and assessments, presented in the bulletins, are in general the basis for development of adaptation and mitigation measures (Figure 7.1).

Use of information and communication technologies in implementation of the UNFCCC. Development of information and communication technologies (ICT) is becoming the one of priority directions for governmental policy of Uzbekistan. Strategy for ICT technologies development is being implemented in accordance with the *Integrated Program for Development of the National ICT System of the Republic of Uzbekistan for 2013–2020*. In aid of further improvement of management it was established the Ministry on development of information technologies and communications.[23] Development of the country's telecommunication technologies and infrastructure is carried out by expanding networks of fixed and mobile broadband access, increasing number of data communication centers and voice traffic, upgrading of main telecommunication networks, as well as creating infrastructure for development of multimedia services.

Pursuant to the Decree of the President "On measures for further introduction and development of advanced IT technologies"[24], the large-scale work is carried out in the country for provision of general education schools with all necessary equipment and computer hardware/software, teaching and advanced training pedagogical staff, creating new informative and training resources, electronic databases and libraries.

Almost all education institutions of the country are connected to the National public educational informative network ZiyoNET. This network has been established in accordance with the Decree of the President of RUz "On Establishment of the Public Educational Informative Network of the Republic of Uzbekistan"[25] and functioning from 2005. The library in ZiyoNET network comprises already around 80 thousand of informative and training resources, including academic materials, educational books, dissertations, scientific articles. Solution of task for coordination of joint use of informative resources on the basis of integrated information and library network is assigned at the state level.[26]

The main indices of ICT development in the republic are:

- share of households having computers reached 37.4%;
- share of households having access to Internet is 58.1%;
- share of ICT sector in the country's GDP is 1.9%;
- number of Internet users exceeds 12 million, including 11.2 million of mobile Internet users.[27]

There are Internet resources, where up-to-date information is posted (amongst the most frequently accessed resources are: www.econews.uz, www.meteo.uz, www.ekomaktab.uz, www.gazeta.uz, www.anxor.uz, www.12news.uz, www.uz24.uz, www.podrobno.uz and others).

Wide population coverage by mobile communication allows to the Ministry of Emergency Situations to warn timely about possible occurrence of dangerous hydrometeorological phenomena and other risks. Information about meteorological and synoptic situation, dangerous hydrometeorological phenomena is posted on a regular basis on the Uzhydromet site: http//meteo.uz.

Development in Uzbekistan of ICT and electronic mass media creates preconditions for population and decision makers awareness raising, improving access to information and facilitating involvement of population in solution of priority tasks, associated with the national, global and regional climate change problems, combat desertification and drought control, conservation and rational use of biodiversity.

[23] Decree of the President of the Republic of Uzbekistan No. UP-4702, dated 04 February 2015 "On Establishment of Ministry on Development of Information Technologies and Communications" // Law Book RUz, 2015, No 5, p 52

[24] Decree of the President of the Republic of Uzbekistan No. PP-1730, dated 21 March 2012 "On Measures for Further Introduction and Development of Advanced IT Technologies" // Law book RUz, 2012, No 13, p. 139; 2013, No 44, p. 578, No 45, p. 584

[25] Decree of the President of the Republic of Uzbekistan No.PP-191, dated 28 September 2005 "On Establishment of the National Public Educational Informative Network of the Republic of Uzbekistan" // Law Book of RUz, 2005, No 40, p. 305; 2013, No 45, p. 584

[26] Ministry on Development of Information Technologies and Communications of the Republic of Uzbekistan. Brief review of information technologies and communications development in Uzbekistan. – Tashkent, 2015.

[27] http://infocom.uz/2015/09/29/o-sostoyanii-i-perspektivax-razvitiya-ikt-v-uzbekistane/

Figure 7.1 | *Publications on Climate Change Problem*

7.4 Capacity Building Requirements for Awareness Raising in Climate Change Issues

Constant efforts are required for implementation of the UNFCCC Article 6[28] "Outreach, Staff Training and Public Awareness". Integration of climate change issues into educational program for secondary schools, higher educational institutes and specialized educational institutions remains the most urgent task. Its solution requires an additional financial and technical resources and constant support from the government side.

Insufficient level of awareness and interaction between the parties concerned (governmental and non-governmental organizations) also hinders in development of the efficient policy for prevention of climate change. Situation with training and retraining of teachers in climate change issues at all levels of educational system and insufficient quantity of training and informative materials, especially in the state language, remains problematic. Considerable part of the developed educational and informative materials is available only on the Internet resources, which certainly decreases awareness level of some population groups.

Box 7.2

The New Delhi work program for Article 6 of the Convention is in force since 2002 and aimed at support/fulfillment of UNFCCC Article 6 by countries.

The Program is a flexible framework basis for measures being adopted on countries' own initiative, which aimed at outreach; staff training; public awareness; public participation; access to information; international cooperation.

At the current stage in aid of implementation of the UNFCCC Article 6 and New Delhi program (Box 7,2) the following activities are of priority importance in Uzbekistan:

- improvement of existing and development of new training programs in the topics of UNFCCC and other global conventions, introduction them into the educational system and public awareness process;
- development and introduction of training modules in issues of climate change and its impact for schoolchildren and students of colleges, lyceums and higher education institutes;
- development of tool for informing especially vulnerable population groups (farmers, dekhkans, dwellers of regions with increased ecological risk, etc.) about dangerous nature phenomena and measures on adaptation to and mitigation of their impacts;
- capacity building for especially vulnerable population groups through trainings aimed at increase of awareness in climate change issues, such as climate change impact on agriculture, about possibility for adaptation to climate change impact, including best practices for water saving and soil conservation technologies, growing of salt and drought resistant crops, introduction of RES;
- strengthening and widening sub-regional, regional and international cooperation in exchange of experience and introduction of advanced training methods in education and public awareness;
- improvement of mechanisms for cooperation in management of nature conservation information, as well as information required for regular GHGs inventory;
- establishment of new and support to existing training centers and advanced training programs, aimed at study of climate change issues, climate change impact on environment, adaptation and mitigation measures for decision makers and various target groups;
- integration of results of activities on fulfillment of UNFCCC commitments into informative programs and outreach campaign;
- strengthening of human and technical capacity in area of:
  - climatic, hydro-meteorological monitoring and information management;
  - assessment and management of climate risks;
  - assessment of impact on natural ecosystems, economy infrastructure and population health.

The abovementioned activities in area of education and awareness raising are essential for development of citizens and national institutions capacity in aid of the country's sustainable development and fulfillment of commitments to the Global Environmental Conventions.

[28] Article 6 "Outreach, Staff Training and Public Awareness" of the UNFCCC (adopted on 09 May 1992)

INTEGRATION OF CLIMATE CHANGE ISSUES INTO NATIONAL DEVELOPMENT STRATEGIES AND PLANS

8 INTEGRATION OF CLIMATE CHANGE ISSUES INTO NATIONAL DEVELOPMENT STRATEGIES AND PLANS

Uzbekistan has signed and ratified the UN Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol thereby assuming responsibilities for their implementation. Vulnerability of Uzbekistan's natural resources and economy to the on-going global climate change identifies necessity for consideration of changes in climatic characteristics affecting sustainable development of the republic and puts forward formation of consistent climatic policy as priority task.

Activities for implementation of the UNFCCC in the country are regulated by regulatory and legal framework. These activities are directly or indirectly aimed at solution of issues associated with adaptation to and mitigation of climate change impacts on the natural resources use and environment conservation, providing therefore conditions for practical actions aimed at decrease in GHGs emission and adaptation of economy sectors and population to unfavorable impacts of climate change. These actions are in turn reflected /integrated in the national and sectoral development programs.

Prevention of climate change (mitigation measures). Based on milestones of the long-term country's development strategy, by 2030 Uzbekistan should ensure its transition to the group of countries with population income above average, accomplish structural transformation of economy with increase in share of services and processing industry from 45% to 55% and from 9% to 22%[1] respectively. The following economic priorities have been identified for the country: modernization, technical and technological renewal of fuel-and-power and metallurgy sectors; countrywide introduction of the advanced efficient energy saving technologies; development of chemical, light and construction materials producing industries.

Special attention is paid in the country to issues of energy efficient and low carbon development of economy sectors. This is confirmed by the fact that over the period 1994-2012, energy consumption of GDP was decreased by almost 2.5 times. Accomplishment of measures included in the "National Strategy of the Republic of Uzbekistan for Reduction in greenhouse Gases Emission for 2000-2010"[2] and "Strategy for Improvement of Population Welfare for Period 2013-2015"[3] has contributed substantially to achievement of this index.

Enhancement of measures for mitigation of and adaptation to climate change impacts was indicated as priority direction in the National strategy for reduction in GHGs emission, which will be achieved through:

- further stabilization of greenhouse gases concentration in atmosphere at the level preventing dangerous anthropogenic influence on climatic system, and in time period sufficient for the natural adaptation of ecosystems to climate change, which will allow avoiding threat to foodstuff production and ensuring further sustainable economy development;
- intensification in attraction of financing for innovative projects aimed at reduction in greenhouse gases emission, inter alia through the Clean Development Mechanism (CDM). In the mid-term perspective amongst the priory sectors for implementation of CDM projects will be (I) traditional and renewable power generation; (II) oil and gas sector; (III) chemical industry; (IV) public utilities sector; (V) agriculture;
- improvement of investments mechanism for implementation of programs for modernization, technical and technological re-equipment of economy sectors, aimed at increase in share of the country's own financial resources for introduction of energy efficient equipment ensuring achievement of target energy saving milestones as the most important factor of reduction in greenhouse gases emission;
- governmental support aimed at broad involvement of small-scale business and private enterprises in utilization and processing of wastes with use of advanced conversion technologies.

Priorities, measures and actions, indicated in the abovementioned strategies are still of a current relevance. Amongst the main outputs of their implementation are:

- Strengthened legal basis (a number of Laws, Decrees of the President and Cabinet of Ministries has been adopted (see Annex 1));
- In large thermal electric power station (TEPS) large-scale works have been accomplished for introduction of new technologies for electric energy generation based on the advanced steam-gas generator (SGG) and gas-turbine units, modernization and computer-aided system for electric energy metering are being introduced. According to expert opinion, this system will allow to save around 2.75 billion kWh of electrical energy per year, and to reduce green house gases emission by 1.9 million ton per year;
- Test solar power station with capacity of 130MW has been constructed in the Namangan province. Construction of the first large 100MW photovoltaic electric power station is in completion stage in the Samarkand province. For perspective it is

[1] UNDP/Center for Economic Studies "Transition to Resources - efficient Development Model. (Vision-2030)" – Tashkent, 2015.
[2] Decree of Cabinet of Ministers of RUz No. PKM-389, dated 09 October 2000
[3] Strategy for Improvement of Population Welfare of the Republic of Uzbekistan for 2013-2015 – Tashkent, 2013.

planned to commence construction of another six solar power stations with attraction of credit resources from the international financial institutions. It is more and more wider introduced biogas power units (42 operational units), systems for hot water supply of residential houses and social facilities based on solar water heating units, wind power generators and other types of RES. Solar energy institute has been established on the basis of SPA "Solar Physics" with participation of JSC 'Uzbekenergo" as co-founder;[4,5]

- More than 500 investment projects have been implemented in industry sector for modernization of existing and commissioning new production capacities;
- Energy consumption in buildings has been reduced by 5-10% on average, 10 key normative documents have been revised, assistance in construction/reconstruction of 8 pilot objects has been provided.[6] Level of equipping gas and water uses with metering devices was increased substantially; pilot zones are being established for demonstration of energy efficiency, possibilities for decrease in consumption of natural gas and CO_2 emissions on account of solar and other sources of renewable energy.
- Considerable number of vehicles has been changed-over to run on liquefied natural gas[7], transport infrastructure has been improved and expanded, transport park is being constantly renewed, railroad transport are being gradually electrified, facilitating decrease in greenhouse gases emission;
- Recycling of solid municipal wastes is carried out;
- Forest plantations are being established on the dried Aral Sea bottom and in desert areas, and pistachio and almonds plantation in piedmont belts on rainfed lands.

Based on analysis of existing development trends, available resources and possibilities, Uzbekistan has indentified the target task to increase by 2030 the GDP volume by 2 times with simultaneous decrease in its energy consumption by 2 times on account of broad introduction of energy saving technologies.8 Electric energy and public utilities sectors, as well as residential and public buildings have the most considerable capacity for energy saving.

The mid-term priorities for prevention of climate change have been reflected in a number of programs and legislative acts. Main program document is the "Program of Measures for Reduction in Energy Consumption, Introduction Energy Saving Technologies in Economy Sectors and Social Sphere for 2015-2019" (Decree of the President of the Republic of Uzbekistan No PP-23439), which identifies priority actions for decrease in energy consumption, introduction of energy saving technologies in economy sectors and social sphere for nearest five years. The Decree envisages inclusion in the sectoral Development Programs implementation of planned administrative and technical measures for fuel and energy resources saving. The "Road Map" has been developed identifying target parameters for decrease in energy consumption in the main sectors of economy, and schedules prepared on gradual modernization and reconstruction of enterprises, etc.

Department of energy efficiency and development of renewable energy sources has been created in the Ministry of economy to monitor implementation of measures and coordinate activities of governmental administrations and economy management bodies aimed at introduction and development of energy efficiency and renewable energy sources. In addition, the Republican Commission on issues of energy efficiency and development of renewable energy sources has been established under the Ministry of economy. Functions of this Commission are specified in the Decree of the Cabinet of Ministers of the Republic of Uzbekistan No PKM-238.10

Large scale works are carried out in the republic for development of renewable energy generation, including use of hydropower potential, which is reflected in the "Program for Development of Hydropower sector for 2016-2020". Besides, JSC "Uzbekenergo" carries out works for inclusion of renewable energy sources in the fuel-energy balance. Use of the RES on commercially important scale will allow decreasing considerably consumption of natural gas in the republic for generation of electrical and thermal energy, and therefore reducing harmful substances emission.

The Decree of the Cabinet of Ministers of the Republic of Uzbekistan No PKM-343[11], dated 26 November 2015, gave a new impulse to development of market for and promotion of biogas technologies in the country. According to this Decree it is

[4] Decree of the President of the Republic of Uzbekistan No. UP-4512, dated 01 March 2013 "On Measures for Further Development of Alternative Energy Sources"
[5] Decree of the President of the Republic of Uzbekistan No. PP-1929, dated 01 March 2013, "On Establishment of International Solar Energy Institute"
[6] GEF/UNDP/CES/Gosarkhitektsroy RUz Project "Improvement of nergy efficiency in social buildings of Uzbekistan", 2015.
[7] Decree of the Cabinet of Ministers No.PKM-30, dated 10 February 2007 "On Measures for Developing Network of Automobile Gas Filling Compressor Stations and Gas Refilling Stations, and Gradual Change-over of Automobile Transport to Run on Liquefied Natural Gas"
[8] Report of the First President of the Republic of Uzbekistan, Mr. I.A. Karimov, at the Extended Session of the Cabinet of Ministers Devoted to the Results of Social and Economic Development of the Country in 2015, and the Most Important Priority Directions of Economic Program for 2016, 16 January 2016
[9] Decree of the President of the Republic of Uzbekistan No. PP-2343, dated 05 May 2015 "On Program of Measures for Reduction in Energy Consumption, Introduction Energy Saving Technologies in Economy Sectors and Social Sphere for 2015-2019"
[10] Decree of the Cabinet of Ministers of the Republic of Uzbekistan No PKM-238, dated 13 August 2015 "On Approval of Provision on the Republican Commission on Energy Efficiency Issues and Development of Renewable Energy Sources" // Law Book RUz, 2015, No 32, p. 433
[11] Decree of the Cabinet of Ministers of the Republic of Uzbekistan No PKM-343, dated 26 November 2015 "On Measures for Promotion of Biogas Plants Construction in Cattle Breeding and Poultry Farms of Republic"

planned to implement measures for: improvement of regulatory and legal framework; formation of market for biogas power units; ensuring accessibility of information and specialists training; organization of equipment manufacturing and technical maintenance; creation of conditions for access to and attraction of credits. In particular, the lax credit lines for the amount of USD8.0 million for construction of biogas power units have been opened within framework of the World Bank/GEF Project "Mitigation of Climate Change Impacts and Sustainable Agriculture".

The "Road map for transition towards low carbon development of Uzbekistan" is a conceptually important document in the context of mitigation of and adaptation to climate change impacts. It has been developed under the UNDP Project "Support to Uzbekistan in transition to low carbon development of national economy" and based on results of deep and comprehensive studies of situation in the area of energy efficiency in the key economy sectors (electric and thermal energy sectors and buildings). Share of these sectors is around 40% from the total greenhouse gases emission. It is assumed that measures and actions specified in the Strategy will allow identifying not only sources of emissions but also the most efficient ways for their reduction, as well as assisting in improvement of framework conditions for attraction of private investments for projects/programs on greenhouse gases emissions reduction/sink increase.

Uzbekistan demonstrates its striving for transition towards resources saving development model. The main recommendations for transition towards resources saving development model have been developed and presented in the document "Vision 2030".[12] The recommendations include increase in energy efficiency of economy, development of solar energy generation, which should became a main driver for development of energy sector by 2030, as well as institutional changes, which will play a crucial role for integrated and coordinated solution of all assigned tasks.

Policy in the area of adaptation to climate change adverse impacts. Studies of vulnerability and development of adaptation measures to climate change impacts are carried out in accordance with the requirements of UNFCCC Article 3 (Principles), as well as Articles 4.8 (c), (f) and 4.10.

Especial National program of adaptation to climate change adverse impacts in Uzbekistan has not been developed yet. However, adaptation measures and actions have been integrated into completed, being implemented and planned national and sectoral development plans. Currently the UNDP jointly with the parties concerned have commenced preparation of application to the Green climatic fund (in accordance with decision of 22nd Session of the Conference of Parties to the UNFCCC) for development of the National adaptation plan.

Water resources and agriculture sectors are the most vulnerable to climate change in Uzbekistan due to predicted potential increase in water requirement and degradation of land resources and natural ecosystems, which have lost the substantial part of their biodiversity as a result of degradation. These negative trends require improvement in water resources management, introduction of innovative technologies and transition towards rational and economic water use at all levels.

In the set of measures for reformation of agriculture the special attention is paid to radical improvement of ameliorative condition of irrigated lands. This task was and still remains for perspective as one of the most important priority.13 As a result of implemented measures the amelioration conditions of irrigated lands have been improved on the area of 1.7 million ha. Land area with critical groundwater table depth has been decreased by more than one third, and area of severely and moderately saline land was decreased by 12%. It has been implemented the State Program for Ameliorative Improvement of Irrigated Lands for Period 2008-2012, approved by the Decree of the President of the Republic of Uzbekistan No. PP-817, dated 19 March 2008. The Program for period 2013-2017, with the main objective to improve ameliorative conditions of irrigated land during 5 years on the area of 1.4 million ha is being implemented.14

Within framework of the five-year Program for agriculture development for 2015-2019, it was envisaged further agricultural crops diversification, establishment and expansion of land area under intensive orchards, planned measures aimed at further development of crops selection and seeds production, breeding new highly productive salt and drought resistant varieties of cotton and cereals. The special attention will be paid to increase in fertility of irrigated lands, which will facilitate retention and accumulation of carbon in soils. In area of cattle breeding it is planned to carry out further works for improvement of animals breed, development of fodder base that in turn will facilitate decrease in methane emissions from enteric fermentation.

Improvement in water use efficiency is achieved on account of implementation of irrigation and drainage projects aimed, in particular, at modernization, rehabilitation, increase in efficiency of irrigation systems, decrease in water losses from waterworks, introduction of water saving irrigation technologies (drip, sprinkler and others irrigation methods). Currently more 20 I&D investment projects are being implemented with support from international agencies and donor-countries.

[12] UNDP/Center for Economic Studies Project "Uzbekistan towards 2030: Transition to the Resource-efficient Growth Model" – Tashkent, 2015.

[13] Report of the first President of RUz, Mr. I.A. Karimov, at the extended session of the Cabinet of Ministers devoted to the results of social and economic development of the country in 2014, and the most important priority directions of economic program for 2015.

[14] http://podrobno.uz/cat/obchestvo/uzbekistan-programma-razvitiya-selskogo-hozyastva

Some other mid- and short-term action programs and strategies, which directly or indirectly associated with agriculture adaptation to climate change, have been developed and being implemented in the country. The most important from them are: the Strategy for Improvement of Population Welfare for Period 2013-2015[15]; National Environmental Action Program (NEAP)[16] for period 2013-2017; annual investment programs of the Republic of Uzbekistan.

Forestry is managed within framework of the annual sectoral Programs. Amongst the forestry development priorities are: enhancement of measures for conservation and accelerated reproduction of forest resources, improvement of ecological and protective functions of forests, rational use of forestry land fund, increase in forest-land percentage, sustainable use of forest resources and development of social sphere in forestry sector. It has also been adopted a number of legislative acts in support of forestry development.[17,18,19] The draft Program for forestry development in the Republic of Uzbekistan for period 2016-2026, has been developed within the framework of "FLERMONECA" Project, implemented with the GIZ financial and technical assistance.

The Integrated Program for mitigation of the Aral Sea disaster impacts, rehabilitation and socio-economic development of Priaralie Region for 2015-2018 is being implemented in the country.[20]. Within framework of this program it is planned to establish forest plantations on around 1.0 million ha of the dried Aral Sea bottom, with annual planting of 40-50 thousand ha. Implementation of such works is the main direction for the long-term development of this region.

Under the UNDP/GEF Project "Decrease in load on natural resources from competitive types of non-irrigated land use in arid mountainous, semi-desert and desert landscapes" it has been developed and being discussed the "Long-term strategy for development of non-irrigated lands use (forestry, rainfed crops husbandry, pastures) for period 2016-2026, and its supporting Programs, which may become the basis for development of the National action plan of adaptation to climate change adverse impacts.

The most important condition and source in the country for implementation of measures reflected in the abovementioned programs are the active investment policy, legislative and institutional improvements, and introduction of innovative technologies. For attraction of the strategic foreign investors the unique guarantees system has been established in Uzbekistan for both investors themselves and enterprises with foreign investments. First of all, the Government guarantees all rights of investors, protection of their investments, and immunity of property created by them on the territory of the country. The consistent work is carried out for expansion and liberalization of privilege and preferences furnished to investors.

The Law "Guarantees and protection of foreign investors rights"[21] enacts that in case of change in legislation norms towards worsening investment conditions, legislation in force at the date of investing shall be applicable to foreign investors during the coming ten years. Furthermore, in case of adoption by the state authorities or local administrations the normative acts infringing investors' rights, as well as in case of illegal interference in investors' activities, the incurred losses shall be reimbursed by these bodies in a judicial procedure. There are no any limitations for foreign investors in the conditions for reinvestments of incomes gained on the country's territory, they can be used for any purpose at the foreign investor own discretion.

It is necessary to stress one more time that in accordance with abovementioned Law the foreign investments and other assets of foreign investors are not subject to nationalization, apart from cases generally accepted in international legislation (natural disasters, accidents).

Establishment of the Fund for reconstruction and development in many ways enables attraction of foreign investments. The main task of the Fund is to participate actively in financing of strategically important investment projects jointly with the foreign partners in the main economy sectors and in the road and communications sphere. Over the short time period of its operations the Fund has turned out to be the powerful financial institute with the available assets in the amount of more than USD15 billion, which is comparable with total annual investments volume in the country's economy.

Carrying out the active, targeted investment policy enables increasingly higher participation of direct private investments in implementation of investment program on account of enterprises' own funds. Only in 2014, these funds were increased by 10.3% and became equal to 4.3 billion in USD equivalent or almost 30% from the total investments amount.

[15] Strategy for Improvement of Population Welfare of the Republic of Uzbekistan for 2013-2015 – Tashkent, 2013

[16] Decree of the Cabinet of Ministers of the Republic of Uzbekistan No PKM-142, dated 27 May 2013 "Environmental Action Program of the Republic of Uzbekistan for 2013-2017"

[17] Decree of the Cabinet of Ministers of the Republic of Uzbekistan No PKM-115, dated 15 June 2012 "On Measures for Further Development of Forestry in 2012-2013"

[18] Decree of the Cabinet of Ministers of the Republic of Uzbekistan No PKM-5, dated 19 January 2015 "On Development of Forestry and Measures for Expansion of Growing, Harvesting and Processing Medicine and Food Raw Materials in 2015-2017".

[19] Decree of the Cabinet of Ministers of the Republic of Uzbekistan No PKM-6, dated 19 January 2016 "On Measures for Rational Use of Forestry Potential, Possibility for Expansion of Growing, Harvesting and Processing Medicine and Food Raw Materials and Strengthening Forestry Material and Technical Base in 2016"

[20] Decree of the Cabinet of Ministers of the Republic of Uzbekistan No PKM-255, dated 29 August 2015 "On Integrated Program for Mitigation of the Aral Sea Disaster Impacts, Rehabilitation and Socio-economic Development of Priaralie Region for 2015-2018"

[21] Law of the Republic of Uzbekistan "Guarantees and protection of foreign investors rights", No 611-I, adopted on 30 April 1998

Investment activities of commercial banks have been intensified. Around USD1.7 billion were allocated to these banks for investment purposes during this year, or by 20% more than in previous year.

Development and transfer of ecologically clean technologies (ECTs)[22] is the important part of the country's activities aimed at inter alia, prevention of and adaptation to climate change impacts. Broad introduction of new technologies is stipulated in the Decree of the President of the Republic of Uzbekistan "On Priority Directions for Industry Development of the Republic of Uzbekistan in 2011-2015"[23], as well as in the Decree of the Cabinet of Ministers of the Republic of Uzbekistan No PKM-2343.[24] Currently there is a great demand in the country for innovative technologies in such areas as: electric energy generation (steam-gas units, gas- turbine plants); electric energy transmission by grids and thermal power delivery by networks; metering of electric energy and natural gas consumption; introduction of RES; climate resistant technologies for efficient land and water resources use in agriculture, agricultural afforestation, etc. There is a need for studies, development, adaptation and introduction of soil conservation and water saving technologies, methods for regeneration of forests and pastures biological resources, biotechnologies and technologies for genofond protection, GIS and remote sensing technologies for environmental monitoring. Development and introduction of informational and communication technologies play special role in transferring of ecologically clean technologies (ECTs).

Successful completion of projects portfolio within framework of the Kyoto clean development mechanism (CDM) in the country has established a basis for implementation of measures aimed at reduction of greenhouses gases emission based on introduction of the advanced technologies. It has been established the procedure for selection and approval of projects under Clean Development Mechanism (CDM) and prepared 8 manuals on issues of CDM activities financing, conducting negotiations with the foreign CDM investors, assessing and mitigating risks of CDM projects and preparing CDM programs.

During the recent years within framework of negotiation process on UNFCCC a new architecture of the global approach to reduction of greenhouse gases emission is being formed. One of the important points of the new policy enhancing roles of developing countries in actions aimed at global decrease in GHGs emissions becomes the Nationally appropriate mitigation actions (NAMA). The "Road Map for Transition from Clean Development Mechanism to NAMA" and "Guidelines for Nationally Appropriate Mitigation Actions" has been developed for promotion of NAMA within framework of the Project "Support to Uzbekistan in Transition to Low Carbon Development of National Economy".[25] A number of proposals on NAMA have been prepared. As of now, the NAMA document "Development of Solar Energy Sector in Uzbekistan" [26] and request for establishment under NAMA pistachio plantations in Uzbekistan[27] are registered in the UNFCCC secretariat.

In general, from the above analysis it is possible to ascertain that Uzbekistan creates preconditions for improvement of approaches, mechanisms and measures ensuring further smooth and sustainable fulfillment of commitments to UNFCCC.

Implementation of the existed, developed, discussed plans and strategies requires considerable financial and technical resources. Allocation of the climate funds resources can be of great support. In particular, serious attention should be given to the development of cooperation with the Green Climate Fund. The mission of this Fund is to provide financial support to the developing countries in implementation of their low-carbon development strategies/plans and adaptation to unfavorable consequences of climate change. It should be noted that the grant in the amount up to 250 thousand USD can be provided by this Fund.

[22] In the context of UNFCCC ECT refers to technology that reduces negative environmental impacts through significant energy efficiency improvements, the sustainable use of resources, environmental protection activities, more residual wastes recycling and processing by nationally accepted methods in compliance with social-economic, cultural and environmental priorities.

[23] Decree of the President of the Republic of Uzbekistan No. PP-1442, dated 15 December 2010 "On Priority Directions for Industry Development of the Republic of Uzbekistan in 2011-2015"

[24] Decree of the President of the Republic of Uzbekistan No. PP-2343, dated 05 May 2015 "On Program of Measures for Reduction in Energy Consumption and Introduction of Energy Saving Technologies in Economy Sectors and Social Sphere for 2015-2019"

[25] UNDP/Ministry of Economy of RUz Project "Towards sustainable energy: Strategy for low carbon development of the Republic of Uzbekistan" – Tashkent, 2015. www.uz.undp.org

[26] UNDP/Ministry of Economy of RUz "Lessons, achievements, strategy for further sustainable and large-scale use of project outputs" (UNDP Project "Support to Uzbekistan in Transition to Low Carbon Development of National Economy") – Tashkent, 2015.

[27] NS-249 "Rainfed Mountain Belt Reforestation" http://www4.unfccc.int/sites/nama/_layouts/un/fccc/nama/NamaSeekingSupportForPreparation.aspx?ID=169&viewOnly=1

ABBREVIATIONS

ABBREVIATIONS

ABIT	Association of Business Incubators and Technological Parks
ADB	Asian Development Bank
AMBiT	Association of International Business and Technologies
ARS	avalanche research stations
BISA	Basin Irrigation Systems Administration
BPP	biogas power plants
BMZ	Federal Ministry for Economic Cooperation and Development of Germany
CACILM	Central Asian Countries Initiative for Land Management
CAMS	Civil Aeronautical Meteorological Station
CAREC	Regional Environmental Centre for Central Asia
CAWA	Regional Research Network "Water in Central Asia"
CBD	Convention on Biological Diversity
CCDST	Committee on Coordination and Development of Science and Technology
CDD	cooling degree-day
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CES	Center for Economic Studies
CIS	Commonwealth of Independent States
CIT	Center for Innovations Transfer
CoP	Conference of Parties
CRM	climate risk management
CTCN	Climate Technology Centre and Network
DDHS	degree-days of heating season
DEWS	drought early warning system
EBRD	European Bank for Reconstruction and Development
ECA	Europe and Central Asia
ECTs	ecologically clean technologies
ESD	Education in aid of Sustainable Development
EST	ecologically sound technologies
EU	European Union
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
EWS	Early Warning System
FAO	Food and Agriculture Organization of the United Nations
FEC	fuel and energy complex
FER	fuel and energy resources
FEZ	free economic zone

GACMO	Greenhouse Gas Abatement Cost Model
GCOS	Global Climate Observing System
GCM	Global Climate Models
GDP	gross domestic product
GEF	Global Environment Facility
GEGU	gas-expansion generator units
GEOS	Global Earth Observation System
GHGs	greenhouse gases
GIS	geographic information system
GIZ	German Corporation for International Cooperation
GM	Global Mechanism
GMP	Good Manufacturing Practice
Gosarkhitektsroy	State Committee on Architecture and Construction
Goskompriroda	State Committee for Nature Protection
Goskomzemgeodezkadastr	State Committee on Land Resources, Geodesy, Cartography and State Cadastre
Govodkhoznadzor	State Inspection on Control and Supervision over Technical Condition and Safe Operation of the Largest and Most Important Water Economy Objects
GPP	gas processing plant
GTN	Global Telecommunication Network
GTU	gas-turbine unit
HDD	heating degree-day
HEPS	hydro-electric power stations
HFCs	hydrofluorocarbons
IAEA	International Atomic Energy Agency
ICARDA	International Center for Agricultural Research in the Dry Area
ICSD	Interstate Commission on Sustainable Development
ICT	information and communication technologies
ICWC	Interstate Coordinating Water Commission
I&D	Irrigation and drainage
IDB	Islamic Development Bank
IEA	International Energy Agency
IFAD	International Fund for Agricultural Development
IFAS	International Fund for Saving the Aral Sea
IFIs	international financial institutions
IPCC	Intergovernmental Panel on Climate Change
ISEI	International Solar Energy Institute
IUCN	International Union for Conservation of Nature
ISA	Irrigation System Administrations

IWACO	International Workshop on Aliasing, Capabilities and Ownership
IWRM	integrated water resources management
IWMI	International Water Management Institute
JSC	Joint Stock Company
KMK	Construction norms and rules
LED	light-emitting diode
LUCF	Land Use Change and Forestry
MAF	Main Administration on Forestry
MAWR	Ministry of Agriculture and Water Resources
MCA	Main Canals Administration
MES	Ministry of Emergency Situations
MFA	Ministry of Foreign Affairs
NAMA	National Appropriate Mitigation Actions
NAPA	National Adaptation Programme of Actions
NAP	National Action Program
NEAP	National Environmental Action Program
NGOs	non-governmental non-commercial organizations
NHC	National Holding Company
NIGMI	Scientific Research Hydrometeorological Institute
NMVOC	non-methane volatile organic compounds
NOAA	National Oceanic and Atmospheric Administration
O&M	operation and maintenance
OPP	oil processing plants
OSCE	Organization for Security and Cooperation in Europe
PFCs	perfluorocarbons
PNT	protected nature territories
PPP	purchasing power parity
PPP	photovoltaic power plants
Priaralie	Aral Sea littoral zone
QA/QC	Quality Assessment/Quality Control
RCP	Representative Concentration Pathways
RES	renewable energy sources
RHC	Rural Health Center
RTC	Regional Telecommunication Center
RTC	Regional Training Center
SDII	Simple Daily Intensity Index

SGG	steam-gas generators
SGP	Small Grants Program
SIEZ	special industrial economic zone
SLM	sustainable land management
SNC	Second National Communication on Climate Change
SMW	solid municipal waste
SRES	Special Report on Emissions Scenarios
TEPP/TEPS	thermal electric power plants/stations
TNC	Third National Communication on Climate Change
UNCCD	UN Convention to Combat Desertification
UNDAF	UN Development Assistance Framework
UNDP	United Nations Development Program
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Program
UN ESCAP	UN Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	UN Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USCS	Unified State Cadastre System
UWS	upper watersheds
Uzgipromeliovodkhoz	State Design and Research Institute
ZIRC	Zone of Intensive Runoff Consumption
WB	World Bank
WCA	Water Consumer Association
WCAP	World Climate Applications Program
WEAP	Water Evaluation and Planning System
WEP	wind energy potential
WHO	World Health Organization
WMO	World Meteorological Organization
WOCAT	World Overview of Conservation Approaches and Technologies

MEASUREMENT UNITS

m^2	square meter
m^3	cubic meter
t.o.e.	tonne of oil equivalent
GW	gigawatt
MW	megawatt
kW	kilowatt
Gcal	gigacalorie
kWh	kilowatt/hour
Gbit	gigabit
Gg	gigagram (10^9 g or 1000 tonnes)
kV	kilovolt
mamsl	above sea level
Mt	megatonne (= 10^6 tonne)
ppm	parts per million (measuring unit of the relative value equal to $1 \cdot 10^{-6}$ from the base index)

CHEMICAL FORMULA

CO_2	carbon dioxide
CH_4	methane
N_2O	nitrous oxide
CH_2F_2; C_2HF_5; $C_2H_2F_4$; $C_2H_3F_3$	hydrofluorocarbons (HFCs)
CO	carbon monoxide
NOx	nitrogen oxides
SO_2	sulphur dioxide
SF_6	sulphur hexafluoride

ANNEXES

Annex 1 | Environmental Regulatory and Legal Framework, Including Mitigation of and Adaptation to Climate Change Issures, Adopted in Period from 2008 to 2015

Date and Number	Name
2009	The Law "On electrical energy industry" secures the existing legal base in this sector. It is specified in the Law that TEPS/TEPP and power stations that use renewable energy sources and connected to the unified power grid, may belong to the state or private companies (Article 10). Enterprises of territorial electrical grids, which belong to the JSC "Uzbekenergo", "may transfer to private operators some issues related to sale of electric energy within district or city" in accordance with order, established by the Cabinet of Ministers of RUz (Article 18).
Decrees and Resolutions of the President	
6 December 2006, № PP-525	On Measures for Implementation of Priority Investment Projects within Clean Development Mechanism of the Kyoto Protocol
15 December 2010, № PP-1442	On Priority Directions for Industry Development of the Republic of Uzbekistan in 2011-2015
4 October 2011, № PP-1623	On Program of High Priority Measures for Expansion of Production Volumes and Manufacturing New Competitive Types of Products
1 March 2013, № UP-4512	On Measures for Further Development of Alternative Energy Sources
1 March 2013, № PP-1929	On Establishment of International Solar Energy Institute
4 March 2015, № UP-4707	On Program of Measures for Ensuring Structural Transformation, Modernization and Diversification of Production for 2015-2019
6 March 2015, № PP-2313	On Program for Development and Modernization of Engineering Communication and Motor Road Infrastructure for 2015-2019
5 May 2015, № PP-2343	On Program of Measures for Reduction in Energy Consumption, Introduction Energy Saving Technologies in Economy Sectors and Social Sphere for 2015-2019
20 October 2008, №UP-4041	On Measures for Optimization of Crop Areas and Increase in Food Crops Production
22 October 2012, №UP-4478	On Measures for Further Improvement of the Organization Activities And Development of Farming In Uzbekistan
18 July 2006, № PP-420	On the Programme of Measures To Increase Production And Export of Phosphorus-Containing Fertilizers on the Basis of the Djeroy-Sardara Deposits for the Period Up To 2010
Presidential Decree, 1 March 2013	On Measures for the Further Development of Alternative Energy Sources
Decrees of Cabinet of Ministers	
DCM No 508 dated 28.10.2004	On Strengthening of Control Over the Rational Use of Biological Resources, Import and Export them Outside the Republic of Uzbekistan
DCM № 610 dated 28.12.2004	On the Parameters of the State Budget of the Republic of Uzbekistan for 2005
DCM № 183 dated 14.04.2004	On the Improvement of the Hydro-Meteorological Service of the Republic of Uzbekistan
DCM № 126 dated 18.05.2005	On Making Additions to the Regulations About the Order of Application of Compensation Payments for Environmental Pollution and Waste Disposal On the Territory of the Republic of Uzbekistan
DCM № 251 dated 15.11.2005	On Improvement Measures of Mechanisms for the Approval and Monitoring of Investment Projects Implementation, Accounting and Control of Cargo of Humanitarian Aid and Technical Assistance Funds
DCM № 15 dated 06.02.2006	On Improving the System of Payments for Special Nature Use
DCM № 48 dated 16.03.2006	On Approval of the Programme of Environmental Monitoring In the Republic of Uzbekistan for 2006-2010
DCM № 9 dated 10.01.2007	Provision on Procedure for Preparation and Implementation of Investment Projects Under Clean Development Mechanism (CDM) Within the Kyoto Protocol Framework
DCM № 212 dated 19.09.2008	On the Programme of Actions On Environment Protection of the Republic of Uzbekistan for 2008-2012
DCM № 78 dated 19.03.2009	On Measures for Development of Concept for Reformation of Heat Supply System and Program of Modernization and Development of Heat Supply System in the Republic for 2009-2015
DCM № 245 dated 22.08.2009	On Approval of Rules for Use of Electrical and Thermal Energy
DCM № 23 dated 17.02.2010	On Measures for Implementation of Law of the Republic of Uzbekistan "On Electrical Energy Industry"
DCM № 66 dated 27.04.2010	Changes in "Rules of Electrical and Thermal Energy Use "
DCM № 294 dated 13.12.2010	On Program for Modernization and Renewal of Low Voltage Electrical Grids for 2011—2015
DCM № 62 dated 02.04.2010	On Measures for Normalization of Contribution Funds on Non-Budgetary Funds of Ministries and Departments
DCM № 220 dated 28.07.2011	On Approval of the Regulations on State Control over Geological Study, Use and Protection of Subsoil Resources

DCM №243 dated 26.08.2011	On the Organization of Activity of the Lower Amudarya State Biosphere Reserve of the Main Department of forestry Under the Ministry of Agriculture and Water Management of the Republic of Uzbekistan
DCM №358 dated 20.12.2012	On Approval of Regulation About Unified State System of forecasting, Early Detection and Response To Radiation Accidents
DCM № 158 dated 05.06.2013	On Measures for Gradual Renewal of Pump/Power Equipment In Water Management Departments of the Ministry of Agriculture and Water Resources of the Republic of Uzbekistan In 2014- 2018
DCM №161 dated 06.06.2013	On Approval of Program for Modernization, Technical and Technological Re-Equiping of Coal Mining Industry Enterprises and Its Balanced Development for 2013-2018
DCM № 176 dated 21.06.2013	On Measures for Efficient Introducing and Financing Drip Irrigation System and Other Water Saving Irrigation Technologies
DCM № 300 dated 06.11.2013	On Measures for Financial Recovery of Water and Heat Supply Agencies of Republic
DCM № 52 dated 05.03.2014	On Approval of Provision on Order for Licensing of Energy Supply
DCM № 169 dated 24.06.2014	On Approval of Gas Use Rules In Economy Sectors
DCM № 86 dated 09.04.2015	On Measures for Introduction In the Republic of System for Obligatory Labeling and Certification of Selling Household Electric Appliances and Newly Constructed Buildings and Structures
DCM № 238 dated 13.08.2015	On Approval of Provision on the Republican Commission on Energy Efficiency Issues and Development of Renewable Energy Sources
DCM № 255 dated 29.08.2015	On Integrated Program for Mitigation of the Aral Sea Disaster Impacts, Rehabilitation and Socio-Economic Development of Priaralie Region for 2015 — 2018
DCM № 299 dated 20.10.2015	On Measures for Development of Domestic Production of Energy Saving Lamps
DCM № 309 dated 02.11.2015	Improvement of System for Metering Electric Energy and Natural Gas Consumption
DCM № 331 dated 16.11.2015	On Program for Development of Hydropower Industry for 2016-2020
DCM № 343 dated 26.11.2015	On Measures for Promotion of Biogas Plants Construction In Cattle Breeding and Poultry Farms of Republic
DCM № 362 dated 15.12.2015	On Measures for Optimization of Land Plots Size Allocated To Private Farmers

Sources: www.uznature.uz, www.lex.uz, www.gov.uz, www.uza.uz, www.pravo.uz and data of Main Administration on Forestry under MAWR

Annex 2 | List of International Conventions and Agreements in Area of Environment Conservation, Climate Change and Natural Resources Use, Signed by Uzbekistan

	Convention
1.	Convention on wetlands of international significance mainly as habitat of waterfowl from 1971
2.	Convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction of 1972.
3.	Convention on international trade of wild fauna and flora species, being under threat of extinction (CITES) from 1973.
4.	Convention of the World Meteorological Organization from 1974.
5.	Convention on the prohibition of military or any other hostile use of environmental modification techniques, of 1976.
6.	Convention on the conservation of migratory species of wild animals, from 1979.
7.	Convention on the protection and use of transboundary watercourses and international lakes of 1992.
8.	The Vienna Convention for the protection of the ozone layer of 1985.
9.	The Montreal Protocol on Substances that Deplete the Ozone Layer of 1987.
10.	The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal of 1989.
11.	London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer of 1990.
12.	United Nations Framework Convention on climate change from 1992.
13.	The Convention on biological diversity from 1992.
14.	The Copenhagen amendment to the Montreal Protocol on substances that Deplete the ozone layer from 1992.
15.	Convention on the prohibition of the development, production, Stockpiling and use of chemical weapons and on their destruction form 1993.
16.	Convention to Combat Desertification in those countries experiencing serious drought and / or desertification, particularly in Africa from 1994.
17.	The agreement on establishment of the Educational Centre for space science and technology for Asia and the Pacific (UN-supervised) from 1995.
18.	Convention for the protection of the world cultural and natural heritage from 1995.
19.	The Treaty on comprehensive ban of nuclear tests from 1996.
20.	The agreement on the conservation of African-Eurasian Migratory Waterbirds from 1996.
21.	Convention on the law of non-navigational uses of international watercourses from 1997.
22.	The Kyoto Protocol of 1997 and the amendment to Annex B of the Protocol on the inclusion of Belarus from 2006.

Source: Contractual-law Department's Information of the MFA of Uzbekistan, www.uznature.uz

Annex 3 | GHG Inventory Tables

Table 3.1 | *National Inventory of Anthropogenic Emissions by Sources and Sinks of All Greenhouse Gases Non-controlled by Montreal Protocol and Greenhouse Gas Precursors, 1990*

GHG SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	CO	NOx	NMVOC	SO_2
	Gg							
total National Emissions and Removals	113286.81	-1566.25	2580.63	41.42	1934.84	411.80	409.49	654.28
1. Energy	107009.45	NO	2095.85	0.57	1904.21	410.04	380.85	649.09
A. Fuel Combustion Activities (Sectoral Approach)	107009.45		18.32	0.57	1903.48	409.56	336.59	503.57
1. Energy Industries	55099.71		1.15	0.26	16.95	150.98	4.41	302.40
2. Manufacturing Industries and Construction	10168.40		0.84	0.04	5.66	29.36	1.01	27.59
3. Transport	16491.33		2.42	0.10	1567.63	158.12	272.43	34.65
4. Other Sectors	24747.18		13.90	0.17	313.25	71.09	58.75	138.94
5. Other (Lubricants)	502.83		NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	NE		2077.53		0.72	0.48	44.26	145.52
1. Solid Fuels			22.33		NO	NO	NO	NO
2. Oil and Natural Gas			2055.20		0.72	0.48	44.26	145.52
2. Industrial Processes	6277.36	NO	0.00	5.38	1.38	0.77	28.64	5.19
A. Mineral Products	3007.26				0.00	NA	0.00	1.92
B. Chemical Industry	2271.70		0.00	5.38	1.38	0.74	8.16	3.25
C. Metal Production	998.40		0.00	0.00	0.00	0.03	0.02	0.03
D. Other Production	NO				NO	NO	20.46	NO
E. Production of Halocarbons and Sulfur Hexafluoride								
F. Consumption of Halocarbons and Sulfur Hexafluoride								
G. Other								
3. Solvents and Other Product Use	NE			NE			NE	
4. Agriculture			311.31	33.93	29.26	1.00	0.00	0.00
A. Enteric Fermentation			277.76					
B. Manure Management			19.98				NA	
C. Rice Cultivation			12.46				NA	
D. Agricultural Soils			NE	32.97			NA	
E. Prescribed Burning of Savannas			NO	NO	NO	NO	NO	
F. Field Burning of Agricultural Residues			1.11	0.03	29.26	1.00	0.00	
G. Other			NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry	0.00	-1566.25	NO	NO	NO	NO	NO	NO
A. Changes in Forest and Other Woody Biomass Stock	0.00	-420.84						
B. Forest and Grassland Conversion	NO	NO	NO	NO	NO	NO		
C. Abandonment of Manages Lands		0.00						
D. CO_2 Emissions and Removals from Soil	0.00	-1145.42						
E. Other								
6. Waste			173.47	1.54	NO	NO	NO	NO
A. Solid Waste Disposal on Land			150.20		NO		NO	
B. Wastewater Handling			14.27	1.54	NO	NO	NO	

GHG SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	CO	NOx	NMVOC	SO_2
	Gg							
C. Waste Incineration					NE	NE	NE	NE
D. Other			NO	NO	NO	NO	NO	NO
7.Other								
Memo Items								
International Bunkers	2818.49		0.02	0.08	3.98	11.95	1.99	1.86
Aviation	2818.49		0.02	0.08	3.98	11.95	1.99	1.86
Marine	NO		NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	855.74							

Notes: Shaded cells do not require entries.
[a]The following standard indicators should be used, as appropriate, for emissions by sources and removals by sinks of GHGs:
NO (not occurring) for activities and processes that do not occur for a particular gas or source/sink category within a country;
NE (not estimated) for existing emissions and removals which have not been estimated;
NA (not applicable) for activities in a given source/sink category which do not result in emissions and removals of a specific gas

Table 3.2| *National Inventory of Anthropogenic Emissions by Sources and Sinks of All Greenhouse Gases Non-controlled by Montreal Protocol and Greenhouse Gas Precursors, 2012*

GHG SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	CO	NOx	NMVOC	SO_2
	Gg							
total National Emissions and Removals	105529.27	-2857.48	4211.56	36.14	1035.43	275.64	270.54	201.25
1. Energy	99580.92	NO	3260.02	0.30	1034.37	274.81	230.33	197.46
A. Fuel Combustion Activities (Sectoral Approach)	99580.92		10.65	0.30	1033.96	274.54	205.25	107.01
1. Energy Industries	33938.34		0.66	0.12	11.16	92.70	2.85	71.18
2. Manufacturing Industries and Construction	8018.01		0.74	0.02	4.46	23.06	0.76	2.57
3. Transport	12355.26		3.13	0.05	921.39	105.24	185.16	6.86
4. Other Sectors	45079.84		6.12	0.11	96.96	53.53	16.49	26.40
5. Other (Lubricants)	189.47		NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	NE		3249.37				25.08	90.45
1. Solid Fuels			5.74		NO	NO	NO	NO
2. Oil and Natural Gas			3243.63		0.41	0.27	25.08	90.45
2. Industrial Processes	5948.35	NO	0.14	5.75	1.96	0.82	40.21	3.80
A. Mineral Products	2965.05				0.00	0.00	0.00	2.05
B. Chemical Industry	1783.33		0.14	5.74	1.06	0.79	6.65	1.72
C. Metal Production	1199.94				0.00	0.03	0.02	0
D. Other Production	NO				NO	NO	34	NO
E. Production of Halocarbons and Sulfur Hexafluoride								
F. Consumption of Halocarbons and Sulfur Hexafluoride								
G. Other								
3. Solvents and Other Product Use	NE			NE			NE	
4. Agriculture			616.48	28.07	0	0	0	0
A. Enteric Fermentation			573.41					
B. Manure Management			39.09	1.45			NA	
C. Rice cultivation			3.98				NA	

Annex 3.2 Continued…

GHG SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	CO	NOx	NMVOC	SO_2
	Gg							
D. Agricultural Soils			NE	26.62			NA	
E. Prescribed Burning of Savannas			NO	NO	NO	NO	NO	
F. Field Burning of Agricultural Residues			NA	NA	NA	NA	NA	
G. Other			NO	NO	NO	NO	NO	
5. Land-Use Change and Forestry		-2857.48	NO	NO	NO	NO	NO	NO
A. Changes in Forest and Other Woody Biomass Stock		- 3588.98						
B. Forest and Grassland Conversion	NO	NO	NO	NO	NO	NO		
C. Abandonment of Manages Lands		0						
D. CO_2 Emissions and Removals from Soil	731.50							
E. Other								
6. Waste			334.92	2.02	NO	NO	NO	NO
A. Solid Waste Disposal on Land			316.66		NO		NO	
B. Wastewater Handling			18.26	2.02	NO	NO	NO	
C. Waste Incineration					NE	NE	NE	NE
D. Other			NO	NO	NO	NO	NO	NO
7.Other								
Memo Items								
International Bunkers	725.52		0.01	0.02	1.03	3.08	0.52	0.49
Aviation	725.52		0.01	0.02	1.03	3.08	0.52	0.49
Marine	NO		NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	53.71							

Notes: Shaded cells do not require entries.

[a]The following standard indicators should be used, as appropriate, for emissions by sources and removals by sinks of GHGs:

NO (not occurring) for activities and processes that do not occur for a particular gas or source/sink category within a country;
NE (not estimated) for existing emissions and removals which have not been estimated;
NA (not applicable) for activities in a given source/sink category which do not result in emissions and removals of a specific gas;

Table 3.3| *National Inventory of Anthropogenic Emissions of HFCs, PFCs and SF6, 2012*

GHG SOURCE AND SINK CATEGORIES	HFC (Gg)					HFC (Gg)		SF_6 (Gg)
	HFC-32	HFC-125	HFC-134a	HFC-143a	Other	CF_4	Other	
total Emissions and Removals	0.000181	0.007932	0.036381	0.006515	NE	NE	NE	NE
2. Industrial processes	0.000181	0.007932	0.036381	0.006515	NE	NE	NE	NE
F. Consumption of Halocarbons and Sulfur Hexafluoride	0.000181	0.007932	0.036381	0.006515	NE	NE	NE	NE

Table 3.4 | *Trends of Greenhouse Gases Emission, Mt CO_2-eq.*

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2	113.2	113.3	106.3	106.8	101.4	101.0	104.0	102.3	100.0	104.1	108.6	107.9
N_2O	12.9	13.4	13.3	12.8	11.9	11.5	11.4	11.2	11.2	10.8	10.7	10.3
CH_4	54.2	56.5	56.7	83.5	70.3	71.7	73.6	65.9	62.4	67.3	78.7	81.6
HFCs	-	-	-	-	-	-	-	-	-	-	0.006	0.006
total	**180.4**	**183.2**	**176.3**	**203.1**	**183.6**	**184.2**	**189.1**	**179.4**	**173.6**	**182.2**	**197.8**	**199.8**
Change in emission by 1990,%	0.0	1.5	-2.3	12.6	1.8	2.1	4.7	-0.6	-3.8	1.0	9.7	10.7
Year	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Δ (2012-1990)**
CO_2	111.0	106.8	104.8	100.9	103.6	103.4	113.2	107.6	101.8	105.1	105.6	-6.7%
N_2O	10.6	10.5	10.5	9.4	9.1	9.1	9.5	9.9	10.4	11.0	11.2	-13.8%
CH_4	82.6	84.4	83.6	85.9	99.0	100.0	104.6	90.0	86.9	87.9	88.4	63.1%
HFCs	0.002	0.009	0.038	0.012	0.036	0.011	0.032	0.019	0.022	0.074	0.094	
total	**204.2**	**201.7**	**198.9**	**196.2**	**211.7**	**212.5**	**227.3**	**207.6**	**199.2**	**204.0**	**205.2**	**13.7%**
Change in emission by 1990,%	13.2	11.8	10.3	8.8	17.4	17.8	26	15.1	10.4	13.1	13.8	

Table 3.5 | *Trend of Greenhouse Gases Emission by Economy Sectors, Mt CO_2-eq.*

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Energy	151.2	153.0	145.9	173.6	155.9	157.9	162.7	153.4	147.6	156.6	172.4	174.5
Industrial processes	8.1	8.5	8.2	7.3	5.9	5.3	5.5	5.2	5.1	4.7	4.9	4.9
Agriculture	17.0	17.6	18.0	17.9	17.5	16.7	16.4	16.4	16.4	16.4	16.2	15.9
LUCF	-1.6	-1.7	-1.8	-1.6	-1.4	-1.4	-1.6	-1.6	-1.3	-1.4	-1.0	0.0
Waste	4.1	4.1	4.2	4.3	4.3	4.3	4.4	4.4	4.5	4.5	4.5	4.5
total (with removals in LUCF sector)	**178.8**	**181.5**	**174.5**	**201.5**	**182.2**	**182.8**	**187.4**	**177.8**	**172.3**	**180.8**	**197.0**	**199.8**
total (without removals in LUCF sector)	**180.4**	**183.2**	**176.3**	**203.1**	**183.6**	**184.2**	**189.0**	**179.4**	**173.6**	**182.2**	**198.0**	**199.8**
Год	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Δ (2012-1990)**
Year	178.3	175.2	171.4	169.2	184	183.7	195.1	173.9	164.1	167.6	168.1	**+11.2%**
Energy	5.0	5.3	6.0	6.2	6.6	7.1	7.5	7.6	7.9	7.8	7.8	**-3.7%**
Industrial processes	16.3	16.6	16.8	16.1	16.1	16.6	17.6	18.9	19.9	21.0	21.6	**+27.1%**
Agriculture	-0.3	-0.6	-1.0	0.4	0.1	0.5	-2.2	-2.6	-3.1	-2.5	-2.9	**+81.3%**
LUCF	4.6	4.6	4.7	4.7	5.0	5.1	7.1	7.2	7.3	7.6	7.7	**+87.8%**
Waste	203.9	201.1	197.9	196.6	211.8	213.0	225.1	205.0	196.1	201.5	202.4	**+13.1%**
total (with removals in LUCF sector)	204.2	201.7	198.9	196.2	211.7	212.5	227.3	207.6	199.2	204.0	205.3	**+13.7%**
total (without removals in LUCF sector)												

Annex 4 | List of Main Completed, On-going and Planned Projects (Grants), 2005 – 2016

Project	Funding agency/local stakeholders	Implement ation dates	Amount of funding, USD	The main results / project description
Preservation of Riparian Forests and Strengthening Protected areas system in the Amudarya Delta of Karakalpakstan	GEF/UNDP/Governmen t of the Republic of Karakalpakstan	2005-2011	1 220 000	Creating Lower-Amudarya State biosphere reserve, with the involvement of local population, through transfer of degraded forest areas for rent.
Assistance in Development of Renewable Energy Sector in Uzbekistan	GEF/UNDP/Ministry of Economy of RUz	2006-2007	63 000	Capacity of renewable energy development in the country has been assessed.
Assistance in Development of Biogas Technologies in Uzbekistan	UNDP/Ministry of Economy of RUz	2006-2008	221 900	Biogas plant at the "Milk agro" farm (Zangiata ditrict of Tashkent region), established fertilizer production has been built and put into operation.
Increasing Energy Efficiency in Public Buildings in Uzbekistan	GEF/UNDP/CER/ Gosarkhitektstroy	2006 -2015	13 638 000	The estimation of the prospects of enhancing efficiency of energy use in buildings, as well as potential energy savings and associated with its implementation of the socio-economic benefits for the period until 2050
Improving the Reliability of Energy Supply of Rural Health Units in Uzbekistan	UNDP/ Ministry of Economy of RUz	2007	50 000	Energy-saving technologies and renewable energy sources in a number of rural health units (helio-collectors and etc.) have been introduced
Capacity Building for Clean Development Mechanism	UNDP/ Ministry of Economy of RUz, Uzhydromet	2007-2009	1 390 300	Capacity building of specialists at all levels for the efficient use of Clean Development Mechanism.
Support for sustainable development of the livestock sector in Uzbekistan	UNDP/ MAWR	2007-2011	425 525	Legal and institutional framework of livestock has been improved; innovative practices of sustainable farming have been implemented in the pilot livestock farms.
Clean Development Mechanism Projects	Private investors/ Agencies of RUz	2007- 2016	24 400 000	15 CDM projects have been registered with the UNFCCC, another 2 - at the stage of registration. As a result of projects implementation, 15 Mt CO_2 eq. of CER have been put into circulation.
Strengthening National Capacity for Technology Transfer	UNDP/Ministry of Economy of RUz	2009	300 000	The optimal ways were offered to promote scientific and technological potential of the country to the other sources of sustainable growth.
Capacity Building for Economic Forecasting and Planning	UNDP/Institute of Market Reform of RUz	2009-2011	513 067	Development of the methodologies for the analysis of economic growth factors and low income indicators, balancing mid-term macroeconomic forecasting parameters and evaluation of regional development strategies.
Strengthening National Capacity for Implementation of Rio Conventions through Institutional Strengthening and Professional Development	GEF/UNDP/Goskomprir oda of RUz	2009-2011	475 000	Assistance through the establishment of national capabilities for integrating global environmental issues into national plans of development and environmental management.
Support to Innovation Policy and Technology Transfer	UNDP/Institute of Forecasting and Macroeconomic Research, Ministry of Economy of RUz	2010-2012	638 566	Strengthening of the capacity of administrative staff of the relevant ministries and agencies in the development, implementation, and monitoring of programs on innovation policies.
Supporting Uzbekistan in Transition to a Low-Emission Development Path	UNDP/Ministry of Economy of RUz	2011-2015	1 186 600	Strategy of Low-Emission Development of the Republic of Uzbekistan and Road map for the mid- and long-term have been developed
Solar Energy Development	ADB/Ministry of Finance of RUz	2011-2016	2 250 000	The legislative framework for the development of solar energy has been created; NAMA and the Road Map have been developed, the feasibility study has been prepared for the project "Samarkand solar power plant".
Preparation of the TNC of RUz under UNFCCC	GEF/UNEP/ Uzhydromet	2011-2016	480 000	Third National Communication on Climate Change and National Inventory of Greenhouse Gases have been submitted to UNFCCC Secretariat

Annex 4 Continued…

Project	Funding agency/local stakeholders	Implement ation dates	Amount of funding, USD	The main results / project description
Climate Change Economy in Central and Western Asia. Climate Change Mitigation Component, regional	ADB/Ministry of Economy of RUz	2013-2014	1 100 000	The cost of measures for climate change mitigation in the Energy sector and Transport has been estimated.
Sustainable Energy Program for Central Asia: RES-EE– CASEP	EC/GIZ/Ministry of Economy of RUz	2013-2016	4 000 000 euros	Creating the necessary legal and institutional mechanisms to facilitate the implementation of renewable energy and energy efficiency at the national level.
Large-scale Development of the Market for Sustainable Rural Housing Construction in Uzbekistan. Phase 1	GEF/UNDP/ Goskomarkhitectstroy, Goskomzemgeodezkadastr, Ministry of Economy of RUz, Ministry of Finance of RUz	2015-2016	150 000	Transformation of the developing housing sector in rural areas, construction of the more sustainable and low-carbon homes through the development, testing, distribution of the mechanism of green- mortgage loan.
Green Climate Fund (GCF) Readiness Programme	BMUB (Germany)/ GIZ/UNDP/UNEP/ WRI/Uzhydromet	2016-2017	1 372 458	The project is aimed to develop a national institutional architecture necessary for the efficient, productive and sustainable management of the resources of climate financing provided by GCF.
Supporting Implementation of UN Convention to Combat Desertification (UNCCD) in Asia, regional	BMZ/GTZ Kazakhstan, Uzbekistan	2001-2007	5 200 000	Support is provided to capacity building for the implementation of obligations under the UN Convention to Combat Desertification in Uzbekistan.
Central Asian Countries Initiative on Land Management (CACILM) – UNCCD Program	GEF/ADB, UNDP, UNCCD and other donors CACILM/ Government of RUz	2007-2010	30 000 000	A number of projects has been implemented to improve land productivity, while maintaining their ecological functions and increasing water use efficiency as an adaptation measure..
GEF Small Grants Programme (SGP)	GEF/UNDP	2008-2015	2 300 000	As of 30.10.2015, 78 projects were implemented to support activities of NGOs and local civil society on adaptation and mitigation to climate change.
Achieving Ecosystem Stability in the Republic of Karakalpakstan and Kyzylkum Desert	GEF/UNDP/MAWR of RUz	2008-2012	2 900 000	Evaluation and testing of innovative approaches to sustainable land management (fixing shifting sands and rehabilitation of degraded lands), strengthening of institutional and legal framework.
Project on Land Reclamation in Bukhara, Navoiy and Kashkadarya regions	GEF/ADB/CACILM Phase 1, MAWR	2008-2013	3 000 000	Land improvement through implementation of technical and institutional arrangements, as well as adaptation of technology and use of the best practices for SLM and water saving.
Supporting Capacity Building of the Irrigated Land Reclamation Fund	GEF/UNDP/ Ministry of Finance of RUz	2009-2011	631 052	Strengthening the capacity of the Department of Fund management in the planning of the program and project financing for the effective management of irrigated land in the country.
Supporting Capacity Development of the Irrigated Land Reclamation Fund	UNDP/ Ministry of Finance of RUz	2009-2012	749 252	Strengthening the capacity of the Fund to identify priority directions of project implementation based on modern principles of preparation and evaluation; a number of pilot projects to improve the legal framework have been implemented.
Strengthening Disaster Risk Management Capacities in Uzbekistan	UNDP, EC (ECHO)/MES of RUz, AS RUz, Uzhydromet	2010-2014	1 867 200	Assistance to the Ministry of Emergency Situations, the Academy of Sciences, the makhalla Foundation (community) in creating the sustainable mechanism for disaster risk reduction, improved qualifications of personnel, material and technical potential.
Sustainable Pasture Management in Farish District with the Participation of Local Community	GIZ/MAWR of RUz	2010-2014	1 180 000 Euros	Support has been provided to the local community to restore degraded pastures; additional benefits have been received as a result of the diversification of income sources.
CACILM Capacity Building	GEF/UNDP/UNCCD/ GIZ/RUz	2011-2013	780 000	Capacity strengthening to develop and implement integrated approaches and strategies to combat land degradation within CACILM National Framework Programs.

Annex 4 Continued…

Project	Funding agency/local stakeholders	Implement ation dates	Amount of funding, USD	The main results / project description
UNDP project "Climate Risk Management in Uzbekistan" (CA-CRM), regional	UNDP/Uzhydromet, Ministry of Economy of RUz and others	2011-2014	800 000	The project was implemented in Kashkadarya region: drought early warning system has been developed, water consumption for farmers has been improved at the local level. Staff of Drought Management Centre in Uzhydromet has been upgraded.
Supporting Agricultural Enterprises. Phase 2	GEF/WB/Government of RUz, MAWR	2011-2014	12 769 900	Development of RES, creation of credit lines to the local community for the implementation of biogas plants at the pilot sites in 7 regions. Advisory services.
Reducing Pressures on Natural Resources from Competing Land Use in Non-Irrigated Arid Mountain, Semi-Desert and Desert Landscapes of Uzbekistan	UNDP/Goskomzemgeod ezcadastre of RUz	2014-2018	2 513 600	It is planned to improve vegetation on 6 thous. ha of pasture and 1 thous. ha of forests through the use of best practices in rainfed agriculture. Preparation of the adaptation strategy and supporting action plans in forestry, rainfed agriculture and pastures.
Developing Climate Resilience of Farming Communities in the Drought Prone Parts of Uzbekistan	Adaptation Fund (AF) of UNFCCC, UNDP/ Uzhydromet	2014-2019	5 190 878	Development of institutional and technical capacity to manage drought and its early warning; implementation of measures to introduce climate-proofing practices within the framework of farms of the Republic of Karakalpakstan.
Integrated Management of Natural Resources in the Drought Affected and Saline Agricultural Landscapes (CACILM 2)	GEF/FAO/ Uzhydromet	2016-2018	2 000 000	The project is aimed at mitigation the effects of drought in areas of high risk of desertification in the context of climate change, improving the management of salinity, demonstration of climate-proofing agricultural technology (SMART).
Saving of Climate Data in Uzbekistan	Government of the Republic of Korea (via WMO)/ Uzhydromet	2015-2016	628 000	It is planned to transfer the archive of climate data of Uzhydromet from paper to digital format; to create a unified climate database.
Improvement of Hydrometeorological Monitoring in Uzbekistan	MFA of Germany/ Uzhydromet	2014-2015	260 000	Automated stations have been installed on Maydantal and Kumbel meteorological stations (Tashkent region.); tracking system for the Pakhtakor glacier mass balance has been installed (Tashkent region); trainings have been conducted.
Assistance in the Strenthening of Hydrometeorological Services in Central Asian countries, regional	Finnish Meteorological Institute/ Uzhydromet	2011-2013	526 225 euros	WMO Regional Training Center (Tashkent) has been equipped with modern facilities. Specialists of NHMS have been trained.
Strenthening of Hydrometeorological Services in Central Asia, regional	World Bank/ Uzhydromet	2012-2016	2 000 000	It is planned to strengthen the systems and methods for early warning of hazards in the mountainous regions of Central Asia; to provide equipment for international transmission and interpretation of weather data, including use of COSMO model.