Second National Communication of the Republic of Uzbekistan under the United Nations Framework Convention on Climate Change

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National institutions agencies and bodies that assisted in the preparation of the report included:

- Centre of Hydrometeorological Service under the Cabinet of Ministers of the Republic of Uzbekistan (Uzhydromet)
- Ministry of Economy of the Republic of Uzbekistan
- Centre for Social and Economic Research of the Republic of Uzbekistan
- Ministry of Agriculture and Water Resources of the Republic of Uzbekistan
- Ministry of Finance of the Republic of Uzbekistan
- Republic Center of State Epidemiological Surveillance at the Ministry of Public Health
- Ministry of Higher and Secondary Special Education of the Republic of Uzbekistan
- State Statistics Committee of the Republic of Uzbekistan
- State Committee for Nature Protection of the Republic of Uzbekistan
- "Uzbekenergo" State Joint Stock Company
- "Uzkimyosanoat" State Joint Stock Company
- "Uztransgaz" Joint Stock Company
- "Uzbekneftegaz" National Holding
- "Uzkommunhizmat" Joint Stock Company
- "Uzkurilishmaterial" Joint Stock Company
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- Centre for Science and Technology of the Republic of Uzbekistan
- Agency for Technology Transfer
- National University of Uzbekistan named after Mirzo Ulugbek
- Nukus National University
- Samarkand National University
- Ferghana National University
- Andijan National University
- Namangan National University
- Samarkand Institute of Agriculture
- Non-Government Organizations

Centre of Hydrometeorological Service under the Cabinet of Ministers of the Republic of Uzbekistan

Address: 72, K. Makhsumov Street, Tashkent 100052, Uzbekistan
Telephone: (998 71) 233 61 80
Fax: (998 71) 233 20 25
E-mail: uzhymet@meteo.uz

Contact information:
Ms. T. Ososkova, National Project Coordinator
Tel./Fax: (998 71) 233 61 17
E-mail: ososkova@meteo.uz
info@climate.uz

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Summary

Second National Communication of the Republic of Uzbekistan under the UN Framework Convention on Climate Change is presented in accordance with the Articles 4.1 and 12.1 of the Convention. The National Communication is developed in compliance with the Guidelines for Non-Annex I Parties under UNFCCC (2003).

Second National Communication is prepared by the Centre of Hydrometeorology under the Cabinet of Ministers of the Republic of Uzbekistan in cooperation with key ministries, a number of scientific-research institutions and business entities.

National Circumstances

Geographical Situation, Climate, Water Resources and Ecosystems

Uzbekistan is situated in Central Asia and borders with Kazakhstan, Turkmenistan, Afghanistan, Tajikistan and Kyrgyzstan. Total area makes up 448.9 thousand km^2 and the main part of the territory falls on the desert plains. The Eastern part and the North-East consist of mountains and foothills accounting for 1/5 of the country territory.

The Climate of Uzbekistan is arid continental. The Northern part of the Republic is located in the temperate climatic zone and the Southern part is in the subtropical zone. Precipitation mainly occurs during cold period of the year while warm period is extremely arid.

Surface Waters. The main rivers the Amudarya and Syrdarya are transboundary and belong to the Aral Sea Basin. Cumulative average multiyear flow volume of the Amudarya is 76.66 km^3 and that of the Syrdaya is 38.83 km^3. Quality of surface waters is sufficiently good in the mountainous zone and the level of mineralization grows considerably higher in the zone of intensive flow consumption.

Uzbekistan is the main water consumer in the region and uses about 90% of surface water for irrigation.

The Aral Sea. By 2007, water-level dropped to 30-meter mark due to intensive water consumption, the sea practically split into three parts and the volume of water decreased by 10 times.

Underground Water. Underground water resources in Uzbekistan make up 24 km^3, out of which 14% is used for irrigation purposes, 43% – for domestic tap water supply and remaining 43% – for technological purposes.

Biodiversity and Ecosystems. Ecosystems of Uzbekistan are represented by the desert ecosystems of the plains, foothill, mountain, river and coastal ecosystems. Ecosystems and biodiversity are under threat due to high anthropogenic pressure.

Forests Resources occupy 8.17 million hectares of land with desert forests accounting for 78% of the territory. Coniferous and nuciferous plants are spread in the mountains and riparian forests locate along the rivers. Forests experience significant anthropogenic load and their productivity is quite low. There is a certain capacity for forestry development in Uzbekistan but it is limited due to absence of water quotas.

Socio-economic Conditions

Population. Uzbekistan has a high population growth rate (1.3% per year in average) that mostly accounts for rural population. Population of the country was 26.7 million at the end of 2006. A share of 64% of the population resides in rural areas and 36% are urban dwellers. Average density of the population is 59.4 persons/km^2.

Education. The literacy rate of the population in Uzbekistan is over 99%. The education system includes compulsory 9-year education, 3 years of professional education, and higher education based on "Bachelor's" and "Master's" degrees. Expenses for education make up 6.5-7.5% of gross domestic product (GDP).

Healthcare. The healthcare system includes 1,113 hospitals, there are 28.4 physicians per 10.000 persons. Healthcare cost makes up 3.7% of GDP. Overall mortality rate has decreased by 20% during the last decade and average life expectancy is 72.5.

Economy Structure. Uzbekistan is a country in economic transition. Service sector accounts for 39.5% of GDP, industry (22.1%), agriculture (24.1%), taxes (9.2%) and construction (5.1%).

Economic Sectors

Agriculture. Up to 80% of foodstuffs required for the country population are produced by the agrarian sector. Irrigated farming is the base of agriculture. Reforms in this sector have been implemented since 2000 with private farms becoming prevalent in agriculture. Significant growth in agricultural production is obvious, however, the country faces a number of problems due to lack of water resources and land degradation.

Over 50% of **land resources** are used for agricultural purposes. This includes irrigated and dry land as well as pastures. By the beginning of 2006, natural ***pastures*** occupied the territory of 21 million hectares, however, they are characterized with low productivity. Increase in livestock amount during the last few years has lead to significant increase of load on pastures and their degradation. Irrigated area of Uzbekistan is 4.2 million hectares of land with low productivity and high salinity rates. Wind and water

erosions are widespread. Arable lands located in the lower reaches of the rivers are especially saline.

The Energy Sector

Natural gas accounts for 85% of primary energy production. Reserves of gas are estimated to be 60-85 billion м^3 a year. Population is the largest consumer accounting for 41% of the total consumption. Uzbekistan has 1.95 billion tons of explored *coal* reserves of which brown coal accounts for 80%. All of the mined coal is consumed completely within the country with the Energy Sector the largest consumer (90%). Volume of *oil* extraction in Uzbekistan achieved 5.1 million tons by 2006.

Electric power. Natural gas (90.8%), fuel oil (5.3%) and coal (3.9%) are used for electric power and heat production. Annually, 48 billion kWh of electric power and more than 10 million Gcal of heat are produced. Thermoelectric Power Stations (TES) producing 85% of electric power are the core of the Energy System. About 12% of electric power is produced by Hydroelectric Power Stations. Over 30% of the facilities in place are outdated and none-efficient.

Heating and hot water supply are provided by boiler-houses (with more than 7.500 of those in the country) of various capacities. About 5 million tons of fuel in oil equivalent is used for heat production in Uzbekistan annually, which makes up about 10% of the total fuel consumption. Natural gas is the major type of fuel. Centralized heating systems are developed in all cities of Uzbekistan.

Industry

Industry of Uzbekistan includes machinery construction, metallurgical works for ferrous and none-ferrous metals production, and chemical factories for mineral fertilizers manufacturing; cement works; textile factories and food processing plants.

In 2006 the share of Energy Sector (power and fuel industry) made up 27.0% of the total volume of industrial production, metallurgy equaled to 0.8%, light industry – 14.6% and machinery construction – 13,8%. Industry Sector is experiencing a steady growth since the country started implementing Industrial Investment Programmes.

Transport, Tourism and Waste

Transportation Sector. *Motorized vehicles* are the prevalent type of transport accounting for 84.9% of passengers and cargo transportation in 2006. The number of motorized vehicles increased 2.5 times in the last 15 years. The share of vehicles running on diesel fuel is 6% in the overall structure of transport, and of those using compressed or liquefied gas make 2%. Due to a low technological level, motorized transport is a significant source of GHG. *Railway transport* ferries 6% of all passengers and cargo while *air transport* accounts for less than 1% of such transportation.

Tourism. Presently, travel industry in Uzbekistan is intensively developed, and it is expected that the number of tourists will increase by 3.5 times in 2010.

Waste. 100 million tons of *industrial solid waste* is produced in the country annually. Volumes of hazardous industrial waste have increased by 33.6% in 2006 due to increase in industrial production. About 30 million м^3 of *household solid waste* are formed annually. About 170 dumps were created and occupy the territory of 1.14 thousand hectares. The industry of solid wastes utilization has not been created yet.

Legal and Institutional Base for UNFCCC Implementation in Uzbekistan

Uzbekistan joined UNFCCC in 1993 as a non Annex I Party and ratified the Kyoto Protocol in 1999.

The Government delegated functions related to UNFCCC implementation in Uzbekistan to the Centre of Hydrometeorology under the Cabinet of Ministers. More than twenty Government and Non-Government Organizations are involved in this activity.

The ***National Authority*** for Clean Development Mechanism under the Kyoto Protocol in Uzbekistan was created at the Ministry of Economy and an ***Interdepartmental Council*** was formed.

Legal acts on Clean Development Mechanism related projects development and approval of CDM on the National level were developed and endorsed.

Inventory of Greenhouse Gas Emissions

The inventory presents data on GHG emission and absorption not controlled by Montreal Protocol for the period of 1990-2005. Overall emissions as well as emissions of separate gases are presented in the table.

The main GHG is carbon dioxide. It accounted for 54% of total emission in 2000. Methane accounted for 45% and nitrous oxide for 5% of all emissions. *Increase of overall emissions is 10% in 2000 compared to the baseline year.* GHG emissions in CO_2-equivalent per capita were reduced during 1990-2005 from 8.9 tons per capita in 1990 to 7.6 tons per capita in 2005. The reduction occurred due to increase of gas share in fuel industry, growth of non-power-consuming industries and population growth.

Carbon dioxide emission reduction during the period from 1990 to 2005 equals 11.4% and occurred due to decrease in volumes of production in 1990s and growth of nonproductive sector's share. Increase in

volumes of *methane* emission occurred due to enlargement of natural gas extraction and transportation, boost in number of livestock and increase in waste amount associated with the population growth. Reduction of *nitrous oxide* occurred due to decrease in use of nitric fertilizers.

GHG Emission in Uzbekistan (Million tons CO_2-equivalent)

Gas	1990	1994	2000	2005
CO_2	**113.3**	101.4	**108.6**	100.4
CH_4	**56.7**	73.6	**81.7**	89.3
N_2O	**12.9**	12.0	**10.8**	10.0
HFC			**0.0**	0.0
Total emission without account of Land Use Change and Forestry sector	**182.9**	187.0	**201.2**	199.8
Total emission with account of Land Use Change and Forestry sector	**181.3**	185.6	**200.2**	200.3

Emissions of gases with indirect greenhouse effect and sulfur dioxide were reduced in the period from 1990 to 2005 due to increase in use of natural gas as fuel in all sectors of economy. Most significant gas out of this group is CO, emissions of which make up more than 1 million tons. Emissions of other gases make up from 200 to 700 thousand tons.

The Energy Sector is responsible for the highest volume of emission. Its share accounted for 84-87% of total emissions in various years. Agriculture accounted for 8-9% of emissions, Industrial Processes account for 2-4 % and Waste account for 2%.

GHG Emissions/removals per Sectors (Million tons in CO_2-equivalent)

Sector	1990	1994	2000	2005
Energy Sector	153.7	159.3	**175.5**	172.3
Industrial Processes	8.1	5.9	**5.0**	6.4
Agriculture	17.1	17.5	**16.1**	16.4
Waste	4.1	4.3	**4.5**	4.7
Emissions/removals in Land Use Change and Forestry Sector	- 1.6	- 1.4	**- 1.0**	+ 0.4

Uncertainty was assessed only for CO_2 emissions related to burning of fuel as well as CO_2 and N_2O emissions in Industrial Processes Sector. The uncertainty makes 10.9% of the total estimated emissions.

Policy and Measures for GHG Emissions Reduction

National Mitigation Strategy

The National GHG emissions reduction strategy approved by the Government includes pricing policy in the Energy Sector, equipment of fuel and energy consumers with measuring devices, introduction of national GHG emissions standards, promotion of energy saving, implementation of inventory of emissions and sinks, distribution of emission quotas among economic sectors and creation of market infrastructure allowing for transfer of reduced volumes of emissions.

Capacity for Emissions Reduction

In *2005* the volume of overall emissions in Uzbekistan made 199.8 million tons of GHG in CO_2-eq. Carbon dioxide accounted for 50.3% of emissions and methane for 44.7%. The largest sources of emissions are the Energy Sector (86.2% of overall volumes of emissions) and agriculture (8.2%). Significant share of the *Energy Sector* assumes existence of a considerable potential for GHG reduction, especially in oil and gas industry in fuel and energy conversion and household spheres. Overall capacity for energy saving is estimated to be 23 million tons of conditional fuel per year (over 40% of the country current energy consumption). Implementation of this capacity provides an opportunity to reduce GHG emissions by more than 40 million tons in CO_2-equivalent per year.

Priority Mitigation Measures

The Energy Sector. Introduction of energy saving measures and technologies is considered to be the most appropriate way of providing the country with energy resources. They include construction of new and reconstruction of the existing power-intensive facilities (steam-to-gas, gas-turbine power stations, and TES). Energy loss reduction during its production, transportation and distribution is a priority issue in the Energy Sector.

This Communication presents priority mitigation measures in oil and gas, coal industry, household sector, chemical industry, ferrous and non-ferrous metallurgy, machinery construction, and other industries as well as agriculture and transportation. Renewable Energy Sources may contribute in GHG emissions reduction.

National and Sector Mitigation Programmes

National Mitigation Strategy is implemented through national and sector programmes.

In *oil and gas sector* the Energy saving Programme will help reduce energy resources consumption by 7 677 thousand tons of conditional fuel by 2012.

The Programme of 'Development and reconstruction of generating capacities in the Energy Sector' and a destination Programme on 'Energy Saving by 2010' are implemented in the *electric energy sector*. This will allow for 20% increase in energy production while preserving the existing fuel consumption level.

In the *Industry sector*, Programmes on 'Modernization and reconstruction of various industries by 2011' are implemented.

The *Household sector* is undergoing the Complex Programme 'On introduction of energy saving technologies' and the Programme 'On rehabilitation of worn-out heating networks'.

In *Transport* sector, Measures for development of natural gas compressor plants and natural gas stations with gradual transition of motorized vehicles to liquefied and compressed natural gas are implemented. It is assumed that 52% of all motorized vehicles will run on natural gas by 2012. Programmes on construction and rehabilitation of roads for the period of 2007-2010 are also implemented in the country.

Pricing Policy in the Energy Sector

Uzbekistan subsidizes prices of natural gas, electric and thermal energy. Petrol, diesel, fuel oil, kerosene, and coal are sold at controlled and exchange prices. The rest of the energy resources are sold by contractual market prices. From 2000-2007 prices significantly increased due to growth of prices for primary energy resources and subsidies reduction.

Legislative Initiatives for Mitigation

Legal base for enabling market environment in the Energy Sector is improved on the regular basis. Energy saving is promoted in every sector of economy, subsidies for different groups of consumers are being reduced and the level of responsibility for environmental damage development and utilization of fuel and energy resources is increasing.

Use of Clean Development Mechanism

National Body on Clean Development Mechanism under the Ministry of Economy is responsible for the preparation and selection of projects; coordination of projects assessment activities among ministries and other entities; presenting of investment projects to the Executive Council on Clean Development Mechanism under UNFCCC Secretariat after their approval by the Interdepartmental Council; the projects implementation monitoring.

GHG Emissions Forecast

Economic Development Strategy

Improvement in living standards and a sustainable and balanced economic development are the main goals of development. These goals correspond with the *"modernization"* development scenario, which assumes high GDP growth rates (9-9.5%) by 2020 and significant decrease of GDP energy intensity.

GHG Emissions Forecast

Four scenarios were considered in estimation of GHG emissions in economic sectors in prospect till 2020 with a precondition that the population will not exceed 30.2 million people by 2020:

- I scenario – baseline-scenario**,** with GDP growth rate 7.2-7.4%, without mitigation measures;
- II scenario – «modernization scenario», without mitigation measures;
- III scenario – modernization scenario, with mitigation measures;
- IV scenario – with GDP growth rates 13.2-13.0%, with mitigation measures.

Total GHG emissions in Uzbekistan might make up from 422.0 million tons (III scenario) to 675.9 million tons in CO2-eq. (II scenario) by 2020. The second scenario exceeds the level of 2005 by 3.4 times and emissions will equal 22.4 tons per capita. According to the base scenario, total emissions will make up 574.5 million tons and according to the fourth scenario – 645.2 million tons in CO_2-eq. The third scenario is considered the most attractive one.

It is assumed that GHG structure will not significantly change in Uzbekistan by 2020 and the Energy Sector will remain the largest source of GHG emissions. Thus, the energy saving policy and measures play a vital role for the country.

Vulnerability Assessment, Climate Change Consequences and Adaptation Measures

Observed Climate Trends and Accepted Scenarios

Intensive warming is observed on the whole territory of Uzbekistan. Average annual temperature increased by 0.29°C since 1951. Significant increase in repetition of high temperatures has been observed during the last decade.

Climate Scenarios have been developed using MAGICC/SCENGEN 4.1. Emission scenarios A2 and B2 were reviewed taking into account the impact of sulfate aerosols for three time intervals (2030, 2050 and 2080). Statistic downscaling was used for detailed elaboration of the scenarios.

Socio-Economic Scenarios. Two approaches were applied for demographic scenarios development: 1) National vision – preservation of current trends with achieving 44 million population by 2050 and 2) Trends according to SRES2000 for ASIA region with population achieving 34 million by 2050.

Agriculture sector development scenarios (national vision) were used to assess consequences and adaptation measures analysis applying WEAP model.

Water Resources

Impact on water resources. In view of expected warming and preservation of the current precipitation

rates, the speed of glaciation decrease in the Aral Sea Basin is expected to be from 0.2% to 1% per year.

Assessment of Climate Change impact on the flow in the formation zone is conducted for two Climate Scenarios – A2 and B2. In prospect till 2030, the current rates of the flow with high natural variability are expected to remain the same. The Amudarya River Basin and small water currents are more vulnerable to Climate Change. It is expected that the water flow will potentially decrease by 2-5% in the Syrdarya River Basin and by 10-15% in the Amudarya River Basin by 2050 (Scenario A2).

During the years of acute water scarcity (assessment for extremely warm and dry years), vegetation flow in the Syrdarya and Amudarya Rivers Basins might decrease by 25-50%.

Water Consumption in the Irrigation Zone. Increase of evaporation coupled with warming will lead to water loss in the irrigation zones. It is expected that irrigation norms will increase in average by 5% by 2030, 7-10% by 2050, and 12-16% by 2080 in Uzbekistan (assessment conducted using CROPWAT and ISAREG models). Expected decrease of river water resources will lead to worsening of the water scarcity situation, which will be especially acute during low-flow years.

Overall Water Deficit. Integrated system WEAP was used to assess overall deficit of water resources. The following criterion is taken into consideration in assessment calculations of water demand according to scenarios B2 and A2: variations of flow from formation zone, increase in irrigation norms, population size, change in the agricultural crops structure and non-irrigation water consumption. According to assessment, overall water deficit in Uzbekistan made up 2 km^3 in 2005 and will increase up to 7 km^3 by 2030 and up to 11-13 km^3 by 2050.

Consequences and Adaptation Measures. The situation with water supply in Uzbekistan might worsen due to expected reduction of existing water resources with the most acute consequences occurring in the Aral Sea area. Scarcity of water resources, especially in the years of extreme water deficit, requires review of water use principles and applying water deficit mitigation measures.

The main adaptation measures that are most necessary include development of regional principles and rational solutions that meet interests of all transboundary rivers' users, implementation of the integrated water resource management system, establishment of the system of early drought prevention, strengthening legal basis in water use, water saving, improvement of irrigation-drainage system infrastructure, improvement of irrigation techniques and shaping careful attitude towards water.

Agriculture

Agriculture productivity. Change of agro-climatic conditions will not significantly impact agriculture productivity in Uzbekistan in the nearest two decades. Changes in thermo- and moisture supply will become major factors of productivity by 2050-2080.

Climate Change impact assessment was conducted for cotton, winter wheat, rice, alfalfa, and vegetables. Crops losses were estimated in relation to productivity of modern breeds with optimal irrigation regime and with water deficit by the scenarios with the use of irrigation model ISAREG.

Just due to evaporation, the loss in cotton crops could achieve from 4% by 2030 to 10% by 2050. With this, maximum loss rate in extreme years could achieve 14%.

The main crop losses in the future will be determined by water security of irrigated farming. By 2050, cotton crop losses could achieve 11-13% in the Syrdarya River Basin and 13-23% in the Amudarya River Basin only due to Climate Change (increased evaporation and reduced flow). Decrease in grains and vegetables productivity is also possible.

Pastures and Cattle Breeding. Calculations show that increase in temperature and insignificant increase in precipitation by 2030-2050 (land degradation was not taken into account) will not impact the productivity of natural pastures. Preservation of high load from sources of salt and dust (dried-up part of the Aral Sea), low watering and increase in livestock number will lead to pastures degradation, decrease of their productivity and pasturing conditions.

Assessment of Climate Change Impact on Karakul Sheep. With climate warming, the thermal loads will grow. For instance, by September 2030 the thermal loads will increase by 5-11%. Increase of thermal loads will negatively impact reproductive capacities of animals.

Climate Change and Food Security in Uzbekistan. Complex demographic situation, decrease in land productivity and scarcity of water resources could lead to adverse impact on agriculture due to Climate Change, thus, threatening food security of the country. A number of adverse factors could lead to agricultural products deficit of 10-15% by 2050 in comparison with the current period.

For food security purposes, it is proposed to increase the amount of areas for growing rice, vegetables, watermelons, melons, potatoes and fodder while preserving of cotton volume sufficient for stabilization of annual export and import currency balance of the country. Increased efficiency of agriculture is also possible through introduction of the modern science and technology achievements, environmental protection of land and water resources, and further improvement of economic relations.

There is need for measures that will assist adapting to Climate Change: improving ameliorative condition of lands, increasing efficiency of irrigation systems, improving irrigation technologies, introduction of

drought-resistant and productive plant species, and improving land and water resources management.

Hazardous Phenomena and Risk Management

Global warming will further lead to increased repetition of hazardous hydrometeorological phenomena.

Droughts. Due to potential decrease of flow in the zone of formation and increase in water consumption, the risk of droughts will increase in many sectors, especially in the lower reaches of the rivers.

Mudflows and floods. It is expected that the increase in the amount of mudflows will achieve 19-24% in comparison with the current situation by 2030-2050 and 12-13% by 2080. There is a potential of increase in duration of periods with high mudflow risk.

Outburst risk lakes. Warming in the mountainous zone will lead to increase of altitudinal limit of lakes; the probability of lake outbursts will increase. Generally, there is a probability of increase of mountain lakes outburst risks.

Avalanches. In average, according to scenarios, the avalanche risk in Uzbekistan will decrease approximately by 1.2-1.3 times less by 2030-2050 and over 2 times less by 2080. Probability of destructions will insignificantly decrease (2-14% by 2050 in comparison with the current period).

Hazardous Weather Phenomena. Average dates of extreme *frosts* on the territory of Uzbekistan shift towards winter season. However, due to the natural high climate variability, there is a risk of late spring and early fall frosts. Increase of daily precipitation expected according to Climate Scenarios might lead to increased risk of negative consequences caused by *heavy precipitation and hails*. According to the existing Climate Scenarios, the increase in number of days with atmospheric drought should be expected in prospective.

The Climate Risk Management

Early information is the basis for weather and climate risk management. The main measures of risk reduction include development of observation and research networks, introduction of the new forecast and active control technologies and establishment of the early warning and information dissemination systems.

Role of Insurance. The insurance market of the country is intensively developed. In some years, the amount of payments under agricultural insurance was significantly higher than the amount of insurance premium. This confirms the high level of risk of agricultural production in Uzbekistan and propriety of insurance.

Climate Change Consequences on Health

Direct Consequences of Climate Change are obvious in Uzbekistan due to cases of death and injuries occurring during natural disasters. Estimates show increase of mudflows risks, high risk of avalanches are expected up until 2050.

Thermal and Cardio-vascular Diseases. Thermal discomfort is observed during all summer months practically on the whole territory of the country. According to the Climate Scenarios, it is expected that the level of humidity will increase along with maximum and minimum temperature amplitude and a significant increase in duration of thermal waves is expected on the country territory increasing the risk of thermal diseases.

It is found out that May and September will become uncomfortable in the future. By May 2030, the area of territories where man could experience extreme thermal loads may increase by 18%.

Malaria Spread Risk might increase due to the climate factors, especially in Surkhandarya, Tashkent and Syrdarya provinces and the Ferghana Valley.

Feral Herd Infections. According to the Climate Scenarios, it is expected that duration of hot and dry period will increase and winter months will become warmer. This will impact the dynamics of number of carriers and bearers of feral herd infections.

Acute Intestinal Infections. The assessment demonstrated that potential risk of acute intestinal infections will increase by 8-10% by 2050 and 15-18% by 2080 due to increase in temperature.

Biodiversity and Ecosystems

Biodiversity in Uzbekistan is threatened due to high anthropogenic load. Climate Change intensifies desertification process and decreases water resources, which leads to extreme vulnerability of riparian forests and ***water ecosystems***. The biodiversity of the Aral Sea has catastrophically reduced. Fishing in Uzbekistan decreased by 4.5 times even in comparison with 1980s. This takes place at the time of the climate aridization, especially in the years of extreme water scarcity that could be considered an analogy of the future.

For the ***Steppe Fauna Complex*** the following tendencies have been identified: falling-off of the Southern habitat border towards North and expanding of habitat of the Southern-Asian heat-loving species towards North.

More dry and hot conditions will lead to decrease of desert ***forests*** productivity and reduction of juniper habitat in the mountainous zone. Reduction of forests and other vegetation besides the loss of habitat decreases absorption of carbon dioxide.

Economy Sectors

Warming will lead to decrease in energy consumption for heating purposes by 12-16% by

2030. Duration of hot period will increase by 16-20% and this will lead to increased energy consumption for ventilation and air conditioning, increased natural loss of oil products and additional surcharge in the fuel consumption rates during the hot periods in the transport sector.

In construction sector, increase in summer temperatures will lead to necessity of developing new projects of residential, agricultural and industrial buildings adjusted to very hot and dry climate conditions as well as production and import of new construction materials.

Priority Strategies and Adaptation Measures

In ***agriculture and water resources*** sectors, vitally important adaptation needs are reflected in the strategy on 'Water Saving and Rational Water Use in Irrigated Land Tenure', although the measures included in the strategy require high investments, especially improvement of irrigation and drainage infrastructure and introduction of such irrigation technologies as trickle irrigation, impulse irrigation and intrasoil irrigation.

Prevention and mitigation of negative consequences of the drought is also an important strategy that includes such measures as defining transboundary water use concept during the drought, timely forecast of the drought, development and implementation of targeted programmes on damage mitigation; development of the monitoring and prevention system and development and implementation of the population social protection measures.

Regional interaction and international community support are required for improvement of the hydro-meteorological monitoring of snow and ice resources of the Aral Sea Basin.

The adaptation measures identified in the *water resources* sector, where the best adaptation strategy is in preserving and increasing of fish resources, can not be implemented without a regional interaction.

The largest potential in the ***population health*** sector includes disease prevention, increasing of public awareness, provision of good quality water to population, improvement of water purifying technologies, maintenance of thermal comfort in the premises, reduction of urban heat islands and introduction of early warning system about the upcoming hot period.

Mitigation Measures for Negative Consequences of floods, mudflows and lake outbursts include ensuring protection measures during construction in dangerous zones, conducting avalanches, mudflows and lakes monitoring, improvement of forecasts and warning systems and special technical constructions in the most dangerous areas.

For the ***forests and forestry*** sector the following strategies are identified: improvement of the forestry management system including legislative initiatives and institutional changes, increasing efficiency of timber work and increasing scientific and personnel capacity of the sector.

The current issues of Uzbekistan are closely tied with Climate Change, biodiversity reduction and desertification. This defines general priorities and measures of negative consequences' mitigation. This requires integrated efforts and coordinated actions.

Research and Systematic Observations

Systematic Observations. 78 meteorological and 130 hydrological observation points are active in Uzbekistan. Hydro-meteorological data collection and processing are conducted by the Regional Centre in Tashkent. Information exchange is in place with hydrometeorological centers of the region and part of the data is provided to international hydrometeorologic centers through CLIMAT system. Hydrometeorological Centre of Uzbekistan receives METEORAT satellite data. There are such requirements for observation system development as a technical upgrade of observations processes, establishment of additional hydrology points on the transboundary rivers, improvement of specialized stations' work and rehabilitation of the aerologic network. There is also a need for automated stations.

Scientific ***research*** is conducted in the framework of the State scientific-technical programmes, funded from the state budget. These programmes potentially support research on mitigation and adaptation measures, monitoring of the regional climate and forecast methods development. Research related to Climate Change consequences assessment has been mainly conducted in the framework of the UNFCCC implementation which allowed for involving a very wide range of scientists in the process. Major constraints for conducting scientific research include shortage of funds and specialists who possess knowledge on modern methods and tools of analysis as well as knowledge in specific, non-traditional areas of knowledge. Lack of data on socio-economic sectors could also be mentioned as one of the challenges.

Adaptation, Mitigation and National Development Plans

National development and environmental programmes include activities that meet adaptation requirements in such sectors as water resources and agriculture, population health, ecosystems and others. However, these programmes are uncoordinated and have one common challenge – lack of funds for their implementation.

Actions addressing GHG emissions decrease taken in the framework of sectoral programmes (the Energy Sector, oil and gas, transport, forestry and other sectors) are not efficient enough due to financial, organizational and other type of barriers.

National development plans could be supported by resources and mechanisms stipulated for mitigation and adaptation measures in the framework of the UNFCCC and by international financial institutions. However, this requires additional capacity building on the national level.

There is a need for development of National strategy/plan of action on the climate that would include both – adaptation to Climate Change and its mitigation. This would help create the required capacity and unify efforts taken by the country to achieve the common goal – mitigation of Climate Change and its consequences.

Technology Transfer

Technological Need for Environmentally Friendly Technologies. High specific emissions occur due to use of outdated technologies, worn-out equipment and irrational use of fuel and energy resources. Achieving energy efficiency is impossible without introduction of environmentally friendly technologies. Given that the leading role of the fossil fuel and technologies based on fuel burning will remain the same, it's deemed most efficient for Uzbekistan to introduce environmentally friendly technologies in the Energy Sector, chemical industry, and household solid waste areas as well as in transport and forestry.

High country capacity in the area of renewable energy sources is a good precondition for environmentally friendly technologies transfer, but their implementation is limited due to the high cost.

Creating Enabling Environment for Technology Development and Transfer. The energy saving policy is implemented aimed at creating legal base that favors energy efficiency and renewable sources of energy in the country. The Law 'On Rational Use of Energy' regulates stimulating pricing policy aimed at effective technologies and energy saving fund subsidies.

Technology Transfer Mechanisms. The mechanisms of cooperation are in place that allow for direct attraction of international investments and creation of ventures providing access to new technologies. Uzbekistan utilizes the Clean Development Mechanism that allows national economy attracting investments and modern environmentally friendly technologies. Tax benefits are introduced to encourage foreign partners to directly invest into Clean Development Mechanism projects.

Capacity Building for Technology Development and Transfer. Over 10 demonstration projects that included a strong training component have been implemented with support from UNDP, GEF, CIDA and ADB. However, the lack of qualified personnel remains a priority issue.

Barriers and Gaps include lack of financial resources, deficient development of the local market, insufficient legal base, low awareness of potential consumers on modern resource saving technologies, the current policy oriented on use of traditional types of energy, insufficient amount of research in the area of mitigation and lacking technical and expert capacity.

Education and Public Awareness

Efforts related to ***Education, Personnel Capacity Building and Public Awareness on Climate Change*** are coordinated by the Uzhydromet. Specialized and general publications and websites are developed and environmental media campaigns are conducted in cooperation with mass media. Training on experience exchange, information and training materials development and dissemination and demonstration projects have been conducted in the framework of bilateral and multilateral programmes and projects with support from international organizations.

Environmental Education in Uzbekistan is coordinated by the Ministry of Education and Environmental Protection Agency. Although the environmental study is included into the higher education curriculum, Climate Change issues are practically not addressed.

NGO and Environmental Education. About 200 NGOs are actively working in the area of informal environmental education in the country (conducting environmental activities, forums, trainings and developing publications), however, Climate Change issues are not sufficiently addressed.

Intensive development of the ***information-communication technologies*** in the last few years create preconditions for increasing public awareness, however, there are such constraints as insufficient amount of computers and communication means among population, especially in rural areas.

Public awareness should be raised in a systematic manner with involvement of qualified personnel rather than have a form of separate campaigns conducted every once in a while.

Constraints, Gaps and Needs in Other Areas

National circumstances. There are difficulties in receiving accurate data on socio-economic indicators that could be compared on the international level.
There is a need in improvement of the statistical reporting forms and use of international standards of assessment methodologies.

Inventory. The main need of the capacity development include assessment of biomass use as fuel, study of age related and other characteristics of livestock, establishment of the statistical accounting system for HFC and improved monitoring of used land.

Policy and Mitigation Measures. There are limitations in data collection and analysis for emissions reduction and mitigation scenarios capacity assessment. Recommended models were not applied due to the lack of data.

The needs of capacity development include additional training on the Clean Development Mechanism projects, improvement of legislation on standards and norms in the mitigation areas, subsidizing and support of the energy saving projects and renewable sources of energy, and financial encouragement of mitigation measures. There is a necessity for new assessment of technological needs and analysis of the mitigation measures' economic efficiency for updating the Strategy and Plan of Actions.

Vulnerability Assessment and Adaptation

Climate Scenarios. There is a need to apply more densely mapped models, improve «downscaling» methods. It is necessary to review various time horizons and space scales of the scenarios as well as scenario limitations and forecast capacity.

Socio-economic scenarios. There is a need for capacity building in the area of the scenario development for the countries with transition economy and development of the model approach based on the international experience.

Water Resources. There is a need in the assessment of the mountainous zones' glaciation, improvement of model methods of assessment for each river basin, and intensification of research on applying such models as WEAP with higher detailed elaboration of the territory. There is also a need in assessment of the efficiency of rational water use measures in irrigated farming and environmental consequences of Climate Change (water quality, underground water level and quality of drinking water sources).

Agriculture. More differentiated data on crops productivity, land degradation and new grades is required for better assessment. There is a need for application of model methods and tools, irrigation models, models such as APSIM, DSSAT and others to assess the current and future productivity of crops and pasture plants.

Absence of sufficient data about livestock amount and loads on pastures did not allow for assessment of cattle farming vulnerability in due manner.

In general, there is a need for economic assessment of vulnerability and adaptation measures in agriculture and other sectors.

Population Health. The needs in capacity development in the health sector include revealing the most climate-sensitive diseases, risk groups and vulnerable territories, study of interrelation of environment, climate, and health and support in development and implementation of adaptation measures.

Biodiversity and Ecosystems. There is a need in conducting studies of ecosystems that are sensitive to Climate Change, monitoring and research of Climate Change impact on species habitat and identification of species that are under most threat. The main barriers include absence of methodology and information, insufficient expert capacity and low level of funding of research in the sector.

Hazardous Phenomena. There is a need for continued study of drought impact and adaptation measures, assessment of socio-economic consequences with the territorial differentiation, and development of the risk reduction programmes. Identification of future dangerous zones is required for risk reduction related to droughts, floods, mudflows, and avalanches as well as development of forecasting and warning systems. Interaction of the National Hydrometeorological Services with insurance companies should be strengthened and optimal insurance mechanisms should be introduced taking the existing international experience into account.

Overall Needs of Capacity Development

Development and implementation of mitigation and adaptation measures are the major priority issues in the area of Climate Change in Uzbekistan. Overall challenges existing in this area include lack of organization, technical and financial resources, qualified personnel and insufficient legal base.

Attracting additional funds and investments for practical implementation of Climate Change mitigation and adaptation measures becomes a priority task, however, it requires corresponding capacity building in all areas and development of the National strategies/plans of action on Climate Change.

Introduction

Resolving the issue of global warming requires international coordination and cooperation. The driving force and the legal basis for international efforts on climate system protection is the United Nations Framework Convention on Climate Change (UNFCCC). The ultimate goal of this outstanding international agreement is stabilization of greenhouse gases concentration in the atmosphere at the level that prevents hazardous anthropogenic interference in the climate system. This level should be achieved within the timeframe allowing for natural adaptation of ecosystems to Climate Change while not putting food production and further sustainable economic development of the countries at risk.

Uzbekistan joined the Convention in 1993 and ratified the Kyoto Protocol in 1999, thus, accepting certain commitments.

Despite the difficulties related to transition period, Uzbekistan undertakes efforts to fulfill its commitments under the UNFCCC actively taking part in the work of the elected bodies of the Convention, international and regional projects on Climate Change and undertakes measures for national capacity development.

The project entitled "Uzbekistan – Climate Change Study of the Country" was completed in 1999 with the goal to prepare the Initial Communication of the Republic of Uzbekistan under the UNFCCC.

The Communication presented on the 5th Conference of Parties in Bonn in 1999 included GHG inventory data for 1990-1994, materials for emission trends assessment, general description of available or stipulated mitigation measures, the country Climate Change vulnerability assessment and general characteristics of the adaptation measures.

The project entitled "Uzbekistan – Climate Change Study of the Country, Phase 2" was completed in 2001. This project allowed identifying technological needs of various economic sectors, and conducting preliminary assessment of potential GHG emissions reduction projects. The necessary scientific-methodology activities for vulnerability assessment of main environmental systems and economic sectors were conducted providing overview of possible Climate Change adaptation measures and a National report on systematic observation networks was prepared.

Climate Change related research and assessment were expanded in the framework of the Second National Communication preparation. Implementation of the project allowed for:

- Improvement of database and decrease the uncertainty of national GHG inventory;
- Assessment of mitigation potential in various economic sectors for promotion of environmentally friendly technologies, practices, and processes that facilitate sustainable development and GHG emissions reduction;
- Assessment of vulnerability and adaptation capabilities in various socio-economic sectors;
- Identification of priority strategies and adaptation measures allowing to lessen the negative consequences of Climate Change in the country, including impact of extreme climate phenomena;
- Assessment of potential risks related to changes of the regional climate and needs for development of early warning systems;
- Assessment of conformity of systematic observations with the Global Climate Change Observation System requirements and the climate monitoring principles, revealing of the needs for capacity building and update of the National report on systematic observation networks; and
- Making a greater contribution in improving public awareness and knowledge on Climate Change in the country.

Such documents as 'Towards National Strategy for Climate Change Adaptation' and 'Information Climate Manual for Agricultural Planning in Climate Change Conditions' that contains maps and tables of agro-climatic indicators corresponding to Climate Scenarios were also developed in the framework of the project.

Priority strategies and Climate Change mitigation and adaptation measures were selected for each sector in close cooperation with the stakeholders, which will allow for their integration in national development programmes and plans.

1. National Circumstances

Table 1.1 The main socio-economic indicators of the Republic of Uzbekistan

Territory	**448.900 km^2, 55th largest country, the share – 0.33%**
Population	26.663 million by January 2007, average density – 59.4 persons/km^2 .
Administrative entities	Republic of Karakalpakstan, 12 provinces, 159 rural districts, 119 large and medium size cities, 114 settlements of urban type, 1.472 villages
National currency	Soum (1 USD = 1235 soum by the end of 2006)
Gross Domestic Product (GDP)	20759.3 billion soum (in 2006)
	GDP production structure (in 2006): services – 39.5%, agriculture – 24.1%, industry – 22.1%, construction – 5.1%, net taxes – 9.2%
GDP per capita	781 thousand soum (in 2006)
Industry	Total output 14640.3 billion soum (by the end of 2006)
Leading industries	Fuel and energy (27.0%), light industry (14.6%), non-ferrous metallurgy (18.5%), food production (8.9%), machine-building industry (13.8%), construction materials (4.2%) (by the end of 2006)
Agricultural production	Total output – 7.314 billion soum (by the end of 2006) including: plant cultivation output – 4.165 billion soum (56.9%); livestock production – 3.149 billion soum (43.1%)
Main agricultural sectors	Cotton, wheat, vegetables, fruits, grapes, melons and gourds, production of row silk, astrakhan, meat, eggs and milk
Minerals	Total reserves include more than 100 types of mineral raw materials – $3.5 trillion including gold (4th place worldwide), molybdenum (8th place), uranium (10th place), copper (11th place), natural gas (14th place) as well as energy carriers, non-ferrous metals, mining-chemical raw materials and construction materials
Transport	Extension of rail roads – 4.13 thousand km, roads with solid paving – 81.6 thousand km. Turnover of goods – 73.4 billion ton-km, passenger turnover – 50.0 billion. passenger-km (by the end of 2006)
Foreign trade	Foreign trade turnover (by the end of 2006) – $10785.7 million. including export – $6389.8 million and export -$4395.9 million
Leading export items and their share in the export	Cotton (17.2%), energy carriers (13.1%), services (12.1%), non-ferrous and ferrous metals (12.9%), machines and equipment (10.1%), chemical production (5.6%), foodstuff (7.9%) (in 2006)
Leading import items	Machines and equipment (40.3%), chemical output (15.0%), services (9.1%), non-ferrous and ferrous metals (10.4%), energy carriers (4.3%), foodstuff (8.1%) (in 2006)
Position in the world economy	2nd position in astrakhan production, 2nd – in cotton export, 5th – in uranium production, 6th – in cotton picking, 9th – in gold mining, 11th – natural gas production, 13th – in cotton yarn production
Source	*«Uzbekistan in figures -2006» Statistical Review, State Statistics Committee of the Republic of Uzbekistan). - Tashkent, 2007.*

Table 1.2 Economy in figures

Indicator	Unit of measurement	1990	1995	2000	2005	2006
Population	million people	20.5	22.9	24.8	26.3	26.6
Population growth	% of the previous year	…	1.9	1.3	1.2	1.3
Urban population	% of the total number	40.8	38.4	37.3	36.1	35.9
Rural population	% of the total number	59.2	61.6	62.7	63.9	64.1
Population employed in economy	% of the total number	…	36.9	36.2	55.2	55.9
Life expectancy	years	69.3	70.8	71	71.5	71.5
Literacy level	% of the adult population	98.7	98.9	99	99.3	99.3
Provision of settlements with natural gas	%	46.2*	73.9	76.1	80	81
Provision of settlements with drinking water	%	70.0*	71.5	80.4	81.8	82.6
GDP (current prices)	Billion soum	...	302.8	3255.6	15210.4	20759.3
GDP per capita	Thousand soum	…	13.3	131.5	579.2	781
GDP in PPP per capita	US $	3250	1973	2422**	3227**	2835**
Industry and construction as percentage of GDP	%	36.8	24.2	20.2	25.6	27.2
Agriculture as percentage of GDP	%	37.2	28.1	30.1	25.1	24.1
Services as percentage of GDP	%	26.3	34.4	37	38.3	39.5
Net taxes as percentage of GDP	%	-0.3	13.1	12.5	11	9.2
Private sector as percentage of GDP	%	4*	58.4	72.6	75.8	77.8
State sector as percentage of GDP	%	96	41.6	27.4	25.2	22.2
GDP growth rate	% of the previous year	-5*	-0.9	3.8	7.0	7.3
Industrial production growth rate	% of the previous year	1.5*	0.1	5.9	7.2	10.8
Agricultural production growth rate	% of the previous year	-1.1*	2.2	3.1	5.4	6.2
Growth rate of investments in fixed capital	% of the previous year	...	4	1	5.7	9.3
Growth rate of chargeable services to population	% of the previous year	-42.6*	-27	15.7	16.3	20.1
Trade growth rate (retail trade turnover)	% of the previous year	...	-4.3	7.6	5.1	14.7
Construction growth rate (putting into exploitation of total dwelling spaces)	% of the previous year	...	-7	3	-2.1	7.6
Transport growth rate (passenger turnover)	% of the previous year	...	-19.5	5.2	15.4	8.3
Growth rate of foreign trade turnover	% of the previous year	...	-3.8	-2.1	9.6	13.5
Inflation level by index of consumer prices	% of the previous year	...	....	24.9**	6.3**	8.7**

Note: * - 1991 data of the Center for Socio-Economic Research of the Republic of Uzbekistan
** - Human Development Report: Uzbekistan – Tashkent: UNDP, 2007/2008.

1.1 Geographic Situation and Climate

Location. Uzbekistan is situated in Central Asia between the 37° and 45° North latitude, and the 56° and 73° East longitude. Its total area is 448.9 thousand square kilometers. Uzbekistan borders with Kazakhstan to the North and West, with Turkmenistan and Afghanistan – to the South, and with Tajikistan and Kyrgyzstan – to the East. Plains occupy 78% of the country's territory, mountains and mountainous valleys – 21.2%. The largest part of Uzbekistan is the Fergana Valley with the greatest density of population.

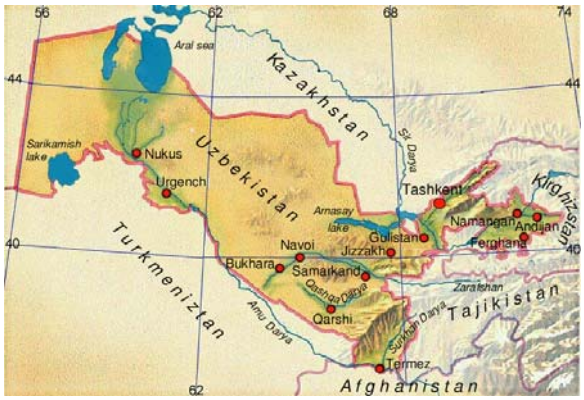


Figure 1.1 *Geographical location of the Republic of Uzbekistan*

Vast plains are occupied with deserts and semi-deserts. The Kyzylkum Desert, the largest sand desert, stretches out from the Zeravshan River Valley to the Aral Sea. In the East and South-East, the valleys gradually transform into ridges of the Tien-Shan and Gissar-Allay mountain systems with highly divided relief (Figure 1.1).

Uzbekistan belongs to the Aral Sea Basin, the main water arteries of which are the Amudarya and the Syrdarya rivers. In the Amu Darya delta there are many channels, small lakes, "tugai" (riparian) forests, saline and boggy lands.

Intensive and irrational water resources use in the region for agricultural needs have resulted in considerable shrinking of the Aral Sea and desiccating of a great number of the lakes in the Amydarya delta. In some territories of Uzbekistan in the natural depressions large irrigation-discharge lakes emerged, the largest of which are Sarykamysh and Arnasay.

Climate. Uzbekistan is situated in the Northern band between subtropical and temperate zones. High solar radiation coupled with geographic location form continental climate, which is characterized with seasonal and day-to-night fluctuations in the air temperatures, long, dry and hot summers, humid springs and irregular winters.

During the warm part of the year, intensive transformation of air masses occurs above the vast deserts (the Kyzylkum and Karakum) resulting in formation of summer thermal depressions. In the central part of the desert during this period extreme air temperatures reach 45-49°C (Figure 1.2).

Penetration of radiation heat in winter time is noticeably decreased. Cooled and sometimes snow-covered desert surfaces cannot affect entering cold air masses and they easily penetrate the very Southern territories of the country. Cold penetrations are accompanied with winds and heavy precipitation. The entering arctic air masses reduce temperature down to very low values. In the Southern regions absolute minimum temperatures can drop down to - 25°C (Figure 1.2).

The South-West Periphery of Siberia anti-cyclone is associated with long periods with low air temperature when air masses from Siberia penetrate the plains of Uzbekistan. However, a number of cold penetrations have noticeably decreased over the last two decades.

In general, the Uzbekistan's territory is situated in the arid part of Asia. In the plains, precipitation is minimal (within the range of 80-200 mm) and occurs during the cold period of the year. The Aral Sea does not affect the quantity of precipitation very much, only contributing to the slight increase in the coastal area.

Variability of precipitation is great, especially in the warm period of the year. According to the index of climate variability [CVI=(P90-P10)/P50], extremely high variability of precipitation (CVI>2) is observed in the warm half of the year.

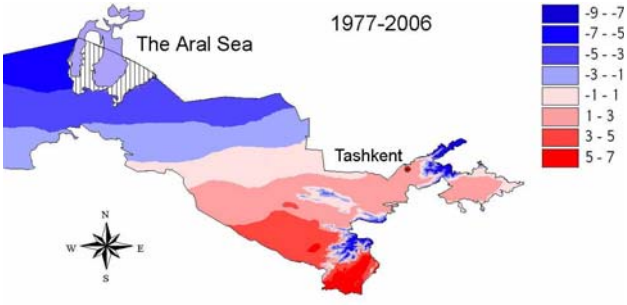
In the foothills, precipitation can be as much as 300-400 mm per year, and about 600-800mm per year on the West and South-West slopes of mountain ridges, which are subject to air masses. Here precipitation can occur all year-round. Climate variability of precipitation in the foothills and mountainous areas is moderate (CVI<1).

Spatial variability and values of the main climate characteristics in Uzbekistan are shown on the maps (Figure 1.2).

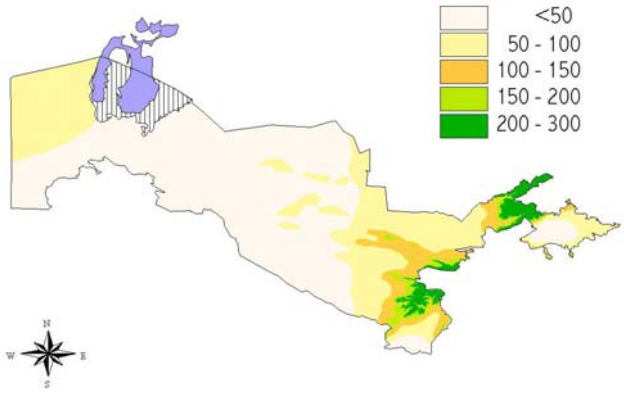
Recorded absolute maximum of air temperature (°C)

Recorded absolute minimum of air temperature (°C)

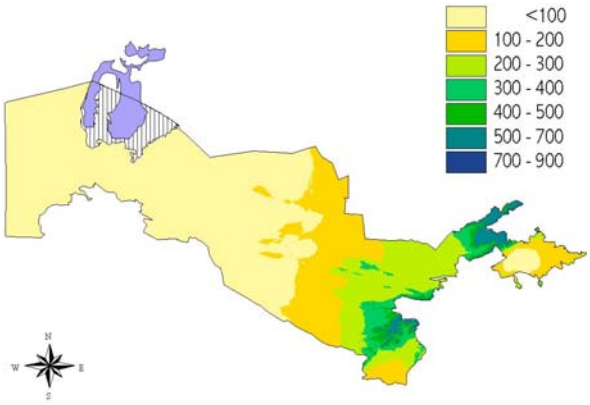
Average summer air temperatures (°C)
(June, July, August)



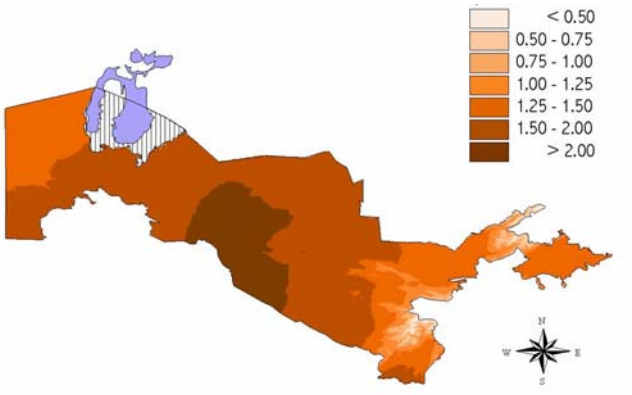
Average winter air temperatures (°C)
(December, January, February)



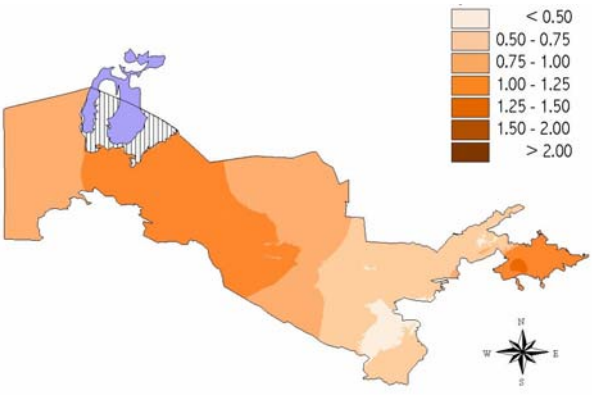
Distribution of median (P_{50}, мм) of precipitation total for the warm half of the year



Distribution of median (P_{50}, мм) of precipitation total for the cold half of the year



Distribution of the climate variability index (*CVI*) of precipitation totals for the warm half of the year



Distribution of the of the climate variability index (*CVI*) of precipitation totals for the cold half of the year

Figure 1.2 *The main climate characteristics of Uzbekistan*

1.2. Water Resources

Surface Waters. Average long-term volume of the Amudarya and Syrdarya Rivers runoff makes up 112.3 km^3, with 73.5 km^3 formed in the Amudarya River Basin and 38.8 km^3 – in the Syrdarya River Basin. The Central Asian countries jointly use surface waters of the Aral Sea Basin. Water resources directly formed on the Uzbekistan territory come from the Amudarya River Basin (6%) and the Syrdarya River Basin (16%). However, only 8% of the total runoff is formed on the Uzbekistan's territory.

In accordance with the international agreements and depending on year water content, Uzbekistan is allocated from 44 km^3 (2001) to 59 km^3 (2005) of water per year. The Figure 1.3 presents the values of annual river runoff of various probabilities of the Amudarya and Syrdarya Rivers.

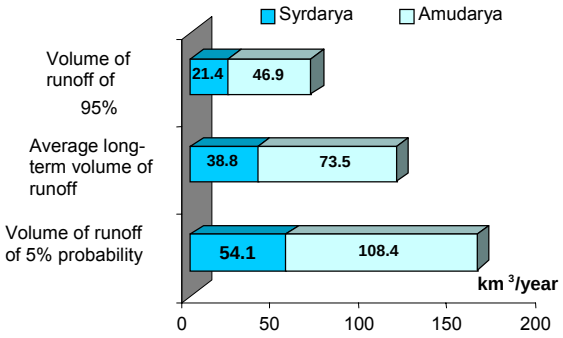


Figure 1.3 *Annual river runoff of different probability of the Amudarya and Syrdarya Rivers*

The natural runoff regime of the rivers in the Amudarya and Syrdarya basins is greatly distorted by the reservoirs, water withdrawal for irrigation and the discharge of drainage water. All of these have broken up their hydrological and hydro-chemical regimes.

Most part of the Aral Sea Basin suffers severe anthropogenic impact when low water withdrawal can reach 60-100%. *The compensation potential of the basin has been exhausted and the dimensions of irretrievable water consumption indicate a high vulnerability of water resources of the whole Central Asian region.*

Surface water quality in the mountainous zone of the runoff formation remains high, with mineralization from 89 to 400 mg/l. Specific polluting substances, such as heavy metals, phenol, mineral oils (natural hydrocarbons) are found within the background values.

The runoff consumption area, in particular, the downstream area and estuaries, are characterized by high mineralization (from 1.070 to 250 mg/l), while on the territory affected by industrial and municipal sewage the values of nitrite nitrogen, organic substances and heavy metals are several times as much as admissible norms/standards allow.

Uzbekistan is the main water resources consumer in the region, as its agricultural production almost entirely depends on irrigation for which about 90% of the water withdrawal from the surface sources is used (Figure1.4). Due to poor conditions of the irrigation network and ineffective water resources management, a great amount of water is lost through evaporation and filtration. The losses in the irrigation network are estimated 40% (Figure1.4)

Despite the fact that less amount of the water resources is used in the other sectors and for domestic purposes (10%), there is low level of effectiveness and high water demand (Figure 1.4).

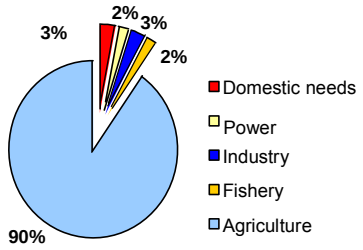


Figure 1.4 *Surface water use*

Underground waters. Atmospheric precipitation, filtration from riverbeds, canals, lakes and irrigated area are the source of underground water formation. Fresh water resources are mainly located in the Fergana Valley (34.5%), Tashkent province (25.7%) and Samarkand province (18%). It was stated that in the Republic of Uzbekistan the fresh and slight saline underground waters amounted to 23578.39 thousand m^3/day in 2005. Use of these reserves is shown in the Figure 1.5.

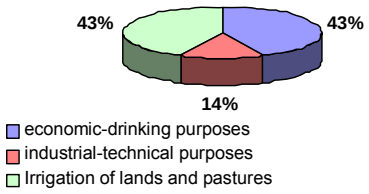


Figure 1.5 *Use of underground water for different purposes*

The Aral Sea is situated on the territory of two states – Uzbekistan and Kazakhstan. The sea condition always depended on the runoff volume of the transboundary rivers Amudarya and Syrdarya crossing the territory of five Central Asian countries.

Prior to the desiccation (before 1960), the Aral Sea was the forth largest lake worldwide (its area was 66.1 thousand km^2; the water level fluctuated around 53 m) with water inflow of 60 km^3 per year. At present time, due to intensive water withdrawal from the Amudarya and Syrdarya for population needs, water inflow decreased down to 4-5 km^3.

By 2006, the sea level dropped down by 30 m and water volume was twice reduced (Figure 1.6). This has resulted in the drying up of the Aral Sea and emerging of the largest "creeping" ecological crisis.

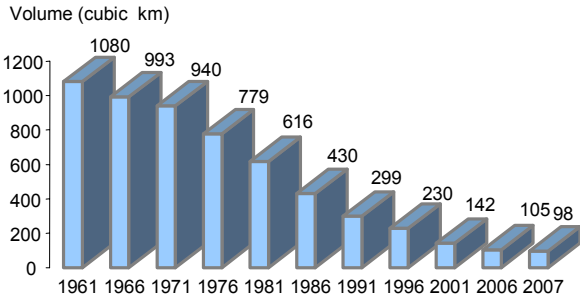


Figure 1.6 *Change in the Aral Sea volume during the period of 1961-2007*

1.3 Ecosystems and Territories under High Anthropogenic Pressure

1.3.1. Biodiversity

Biological diversity Uzbekistan is home for 27,000 species of flora and fauna. Flora is represented by 11,000 species of which 4,500 are higher plants, fauna – by 103 species of mammals, 441 species of birds, 63 species of reptiles, 3 amphibious species, as well as 84 species of fish and 11,000 species of arthropods.

Such big predators as the turan tiger and cheetah are documented to be extinct. Hyena, caracal, Asian leopard, onager and argali are in danger of extinction. Extremely complicated situation exists with 'saigak' (saiga antelope) population, which is about to become extinct in Karakalpakstan. It happens mostly due to unprecedented slaughter combined with the desiccation and degradation of its natural habitat.

In Uzbekistan biodiversity quality is assessed as *high and very high* only on the 6.8% of the territory (permanently protected territories, natural woods and shrubs), as moderate – on the 50.5% of the territory (non-irrigated hayfields and pastures) and as low and very low – on the 16% of the territory.

The total protected area accounts for 4.6% of the country's territory. Out of that about 40% consists of 9 reserves and 2 national parks with natural habitat.

On the most of the natural pastures extensive cattle-breeding has changed the natural habitat and the ecosystems have been degraded to some extent. The whole territory under arable farming hosts low biodiversity stemming from almost full destruction of the natural habitat.

The climate warming and aridization accompanied by anthropogenic pressure intensify the processes of fragmentation and loss of biodiversity of all ecosystems.

1.3.2. Natural Ecosystems

In Uzbekistan the main ecosystems are the desert ecosystems of the plains; ecosystems in the foothill semi-deserts and steppes; river and coastal ecosystems; wetlands and delta zone ecosystems and mountainous ecosystems.

Human activity most heavily affects the foothill territories and river flood-plains where habitat of wildlife ecosystems sustaining ecological balance are catastrophically decreased and replaced by anthropogenic landscapes.

The hydrological regime of the aquatic and semi-aquatic ecosystems has drastically changed; as the lower reaches and basin outlets water becomes saline.

The Aral Sea Problems. At present time, the Aral Sea is divided into three parts: the Northern Sea (Small Aral), the West part (Big Aral) and the East part, which is the most shallow and saline (Figure 1.7). The dried sea bottom area is more than 33 thousand km^2, the coast line has retreated by 150 km from the once operating sea port Muynak.

Natural wetlands are situated in the Amudarya delta occupying the territory of about 700 thousand hectares. As water inflow to the delta declined shifting the coastline of the Aral Sea, numerous natural freshwater lakes disappeared, tugai areas decreased by half, and the reed areas decreased to a sixth of their former area.

The desiccation and salinization of the Aral Sea have caused vertical water stratification to appear and led to pollution of lower layers of water by hydrogen sulphide that have never been witnessed before. These processes have resulted in loss of biodiversity of all biocenosis, death of ichthyo-fauna, and deceleration of fishing and the fish-processing industry; although at one time the Aral Sea was a large supplier of seafood.

The Aral Sea desiccation has resulted in many negative consequences on the South Aral Sea territory. More than 200 species of flora and fauna have disappeared; the area of the delta lakes and reed swamps in the lower reaches and around the sea itself has decreased. The pastures productivity has been cut in half and vegetation loss has reduced flood-plain productivity to one tenth as compared to earlier times.

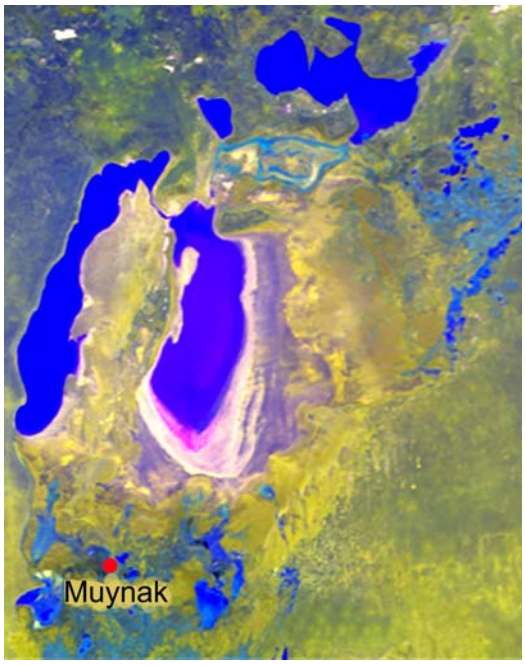


Figure 1.7 *Satellite image of the Aral Sea made on 4.10.2007 (NOAA-18).*

The salt desert – Aralkum has been formed on the bare sea bottom, wherefrom annually more than 100 thousand tones of salt and fine-dispersive dust with sand particles are transferred with winds onto the contiguous territories. The South part of the Aral Sea region, within a radius of 75-100 km experiences the most severe impact of the salt and dust transfer; the amount of dry deposition here varies in average from 500 to 2.702 kg/hectare per year. In these depositions the components of marine salts prevail (chlorides, magnesium, sodium, sulfates). At the distance of 550-700 km from the Aral Sea coast line the amount of dry depositions reported to be 300-450 kg/hectare.

Intensive salt and dust transfer leads to increase in salt content in arable lands and pastures. In addition, the pastures in the Aral Sea region are exposed to anthropogenic loads (overgrazing), resulting in degradation of the desert ecosystems (decrease in vegetation cover area, formation of drifting sands).

Figure 1.8 *Dried Aral Sea bottom*

1.3.3. Forests and Forestry

Forest resources (about 8 million hectares) include lands meant for forest growing and forest free lands, which should undergo reclamation before growing forests on them.

Forest lands include areas under forest (about 5% of the country's territory), light forests, burned-out forests and logged lands.

Non-forest lands include ploughed fields, hayfields, pastures, marshes and sands.

In accordance with orographic, soil and climate conditions forests are divided into mountainous, valley and flood-plain forests and desert ones.

Desert forests occupy the most part of the total forest lands (78%). The main species in this area are saxaul, saltwort and 'kandym'.

Coniferous species occupy 11% and nut trees around 3% of the mountainous forests. Main mountainous forest species are junipers (Figure 1.9), pistachio-trees, almond-tree and walnut. Along rivers, in wetlands there are tugai, occupying 5% of the forest lands, where turanga, loeaster, tamarisk and others also grow.

The forests in Uzbekistan are under increasing anthropogenic pressure: the forest lands are subject to fragmentation and the area under the groves is diminishing. The distance from the groves to settlements is increasing.

Due to the complete river runoff regulation, natural tugai reproduction is broken, their species set is changing and the area under them is being reduced. Tugai are being destroyed or severely degraded. On the irrigated and arable lands such useful plantations as field protection belts are disappearing.

Forest productivity in Uzbekistan is very low. Wood stock per 1 hectare on average amounts to $6m^3$, coniferous species to 29 m^3 and saxaul to around 3 m^3.

Figure 1.9 *Juniper forests*

However, Uzbekistan has a capacity for increase in greenhouse gases sinks through the creation of industrial plantations of fast-growing arboreal species on irrigated lands and growing of field protection forests. There is enough area in the forest resources for creation of such industrial plantations.

Lack of allocation of water for forestry irrigation is a constraint for such activity. Forests for field protection are possible to grow on the lands meant for agricultural activity. The special state program is required to develop this field.

1.4 Socio-Economic Conditions

1.4.1. State Structure

In accordance with the Article 1 of the Constitution of the Republic of Uzbekistan, the main law of the country that was adopted in December 8, 1992, Uzbekistan is independent democratic state.

The head of the state is the President of the Republic of Uzbekistan, the government bodies are the Oliy Majlis (Parliament), the Cabinet of Ministers and the judicial bodies. The supreme state representative body is the Oliy Majlis of the Republic of Uzbekistan that exercises legislative power and consists of two chambers. Cabinet of Ministers – Government of the Republic of Uzbekistan is the executive power body. Courts are judicial authority in the Republic.

The government system is built up according to functional-sectoral and territorial principals and includes 14 ministries, 9 committees, 11 agencies and departments as well as local governmental bodies – province, city and district 'khokimiyats' (local municipalities). Administrative division of Uzbekistan is presented in the table 1.1.

The ministries, the state committees and the departments address social and economic development problems through their territorial branches.

1.4.2. Population

One of the most important peculiarities defining a specific social-economic development of Uzbekistan is *demographic situation*. Uzbekistan is among the countries with a high rate of birth and natural population growth. Over the last decade, the population of the Republic was increasing at a rate of 1.2% per year. This tendency makes it necessary to pay more attention to dynamics of economic growth and addressing the employment problems.

Uzbekistan is the most populous of all the Central Asian countries, the 3rd one among the CIS countries with the population accounting to 0.4% of the worldwide population.

Uzbekistan had a population of 26.7 million by the end of 2006, with 64% living in rural areas and only 36% in urban areas (Figure 1.10).

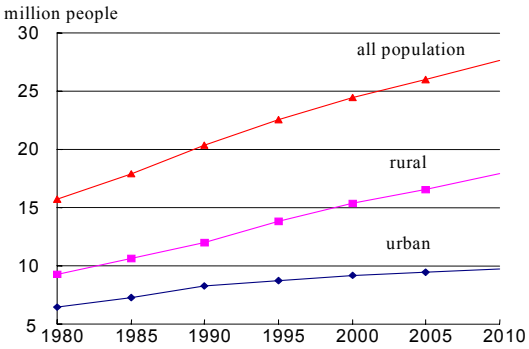


Figure 1.10 *Dynamics of population*

Under higher rates of rural population growth in the nearest future, the overpopulation problems will make formation of labor market in the rural areas even more difficult, taking into account existing shortage of land and water resources.

Average population density in the Republic of Uzbekistan is 59.4 inhabitants per km^2. Population density is the highest in the Fergana Valley (400 inhabitants per km^2).

The peculiarity of the demographic situation in Uzbekistan is the prevalence of children, teenagers and pensioners who are especially of need of the state protection. Their percentage was 41.1% in 2006. These are the most vulnerable population strata.

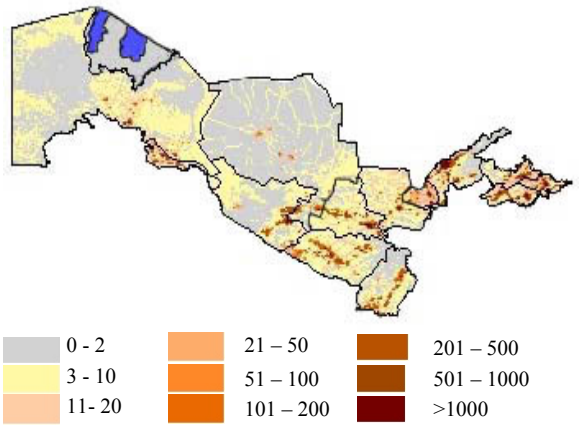


Figure 1.11 *Population density (inhabitant/km^2)*

Working age people amounted to 55.9% or 14.8 million people of the total population in 2006, with 10.5 million employed in economy.

Labor migration has a positive influence on economic growth including population income. Money transferred to the country is estimated to be 10% of GDP (according to the National Report on Human Development 2007/2008).

The level of poverty in the Republic decreased during 2001-2005 but still remains high (25.8% of the total population). This decrease occurred mainly among urban population while the decrease is insignificant in the rural area.

Increasing employment and improving of the population's well-being are the main economic development priorities of Uzbekistan. The government of Uzbekistan approved the strategy on improving population well-being, the goal of which is to reduce low income population by 20% by 2010 and by 14% by 2015.

The measures taken to create new jobs have resulted in the reduction of unemployed people by 5% in 2007. Wages, pensions, scholarships and allowances have become 1,5 times higher in 2007. Real income of the population has increased by more than 27% in 2007.

Besides demographic situation, population income and labor market, the factors influencing living standards are public and environmental health. Over the last decade, the national social programs in education and public health have been implemented in the country.

Education enjoys a significant proportion of governmental expenditures in Uzbekistan. During the period of 1996-2006 expenditures for education amounted to 6.5-7.5% of GDP. Compulsory 9 year schooling is in place. The system of 3 year upper secondary education in colleges has been introduced; the system higher education has been improved (bachelor's degree and master's degree). The literacy level is more than 99% in Uzbekistan.

Public Health. Mortality reduction and high birth rate contribute to the population growth. For the last decade, the common mortality has fallen by more than 20% (from 6.4 per 1,000 inhabitants in 1995 to 5.3 in 2006). The infant mortality rate has considerably fallen (from 26.0 per 1,000 inhabitants in 1995 to 14,5 in 2006), nevertheless, it remains high in comparison with the level in the developed countries. Life expectancy rate in 72.5 years in 2006.

At present, the public health system includes 1.165 patient care establishments, amount of hospital beds is 54.9 and of physicians 29.9 per 10.000 people.

Health expenditures amount to 3.7% of the GDP. This is not high taking into consideration the existing issues.

Nutrition structure of the population does not correspond to medical standards; there is deficit of microelements due to their insufficient amount in environment (deficit of iron, iodine and vitamin A).

Environmental problems (surface water pollution, soil degradation, desiccation of the Aral Sea) deteriorate sanitary-hygienic and socio-economic situation, especially in the lower reaches of the Amudarya River where discharges of the collector-drainage waters impair water quality resulting in a drinking water deficit. Salt and dust transfer from the dried bottom of the Aral Sea contributes to the atmospheric air pollution.

Over the last two decades, aggravation of ecological and socio-economic situation in the Aral Sea region has led to increase in prevalence of iron deficiency anemia, tuberculosis; pathology of endocrine system (thyroid gland, diabetes, etc.), liver and kidneys, and reproductive system became more frequent. The number of allergic diseases increased in Khorezm province in 2003-2006. TB rate in Karakalpakstan is twice as higher than in average throughout the rest of Uzbekistan and anemia among children is very frequent. The situation with acute intestinal diseases is also harsh in Karakalpakstan.

In order to overcome the above-mentioned problems, a number of programmes are being implemented in Uzbekistan, in particular, the Programme on population's health protection and prevention measures for 2004-2008. The Law on Quality and Security of Food Stuffs has been adopted by the country.

The programme on implementing the second stage of the health-care sector reform, which is aimed at increasing the quality of medical care and expanding the number of the sector's beneficiaries through increasing the number of medical points and combating acute infectious and virus diseases, is being implemented since 2007.

1.4.3. Economic Structure

Uzbekistan is a country with the economy in transition. Before the disintegration of the Soviet Union, the economy of Uzbekistan was heavily dependent on the USSR's centre playing the role of raw materials source and the major market. After the collapse, economic relations with Russia and former republics of the Union were affected leading to increased inflation rate, depression of the industrial development and deficit of goods and services. Economic indicators show a significant recession during this period of time.

Taking into account the economic situation and low life level in Uzbekistan in the beginning of 1990s, Uzbekistan could not utilize the "shock therapy" method during the market transition.

The Government of Uzbekistan has worked out its own way of development for the country, in which the transition from one system to another should be stage-by-stage and evolutionary.

The socially focused market economy or so-called "Uzbek" model of economic development has been selected as the economic basis of the state sovereignty of the country, which in the greatest measure that corresponds to the present stage of social development and specific conditions of the Republic.

The realization of this economic model has allowed not only to stop downswing, but also to reach positive dynamics of the basic macroeconomic processes, to provide an annual increase of GDP and

the industrial output, to stabilize situation in the internal consumer market, to reach grain and energy independence, to create a new market infrastructure for agriculture.

Today the economic growth in Uzbekistan is provided at the expense of implementation of market reforms and attraction of foreign investments, deep structural transformations in economy, modernization and updating of manufacture, creation of the new export-focused branches and companies, the accelerated development of small-scale business and private enterprise in manufacture, farming and services, perfection of monetary-credit and tax-budgetary policy.

As a result, since 2000, GDP per head at purchasing-power parity (PPP) began increasing (Figure 1.12). The increase of this indicator has been provided at the expense of higher growth of real GDP in comparison with the population growth (7.3% and 1.3% in 2006, accordingly).

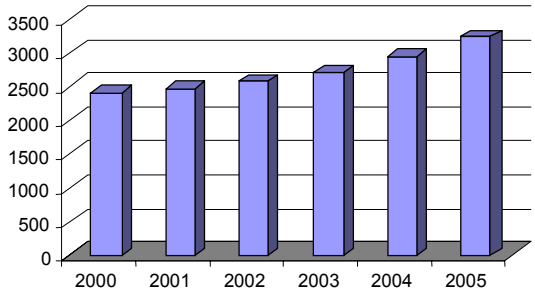


Figure 1.12 *Dynamics of growth of GDP per head, purchasing-power parity $ (source: Human Development Report 2007/2008, UNDP)*

The industry, building, communications and services grow at advance paces, investments into the fixed capital are increasing, and the rate of inflation is decreasing. Especially appreciable growth of real GDP (2.1 times more) has been provided during the period of 2000-2006 (Table 1.3).

Table 1.3 The basic macroeconomic indicators of the economy development of Uzbekistan, %

Years	2000	2002	2004	2006
GDP (executed)	103.5	104.0	107.7	107.3
Key economic sectors (industry, agriculture, building, transport and communication	102.9	104.7	107.2	109.9
Industrial production	105.9	108.3	109.4	110.8
Investments into fixed capital	100.9	103.8	105.2	109.3
Inflation (as to the previous year)	128.2	121.6	103.7	103.4

For the last 15 years, there were some transformations in the infrastructure of economy of Uzbekistan – the share of services in GDP has considerably increased. By 2006, the industry share has reached 22.1%, the services ratio has made up 39.5%, agriculture – 24.1%, taxes – 92%, building ratio – 5.1% (Figure 1.13) of GDP.

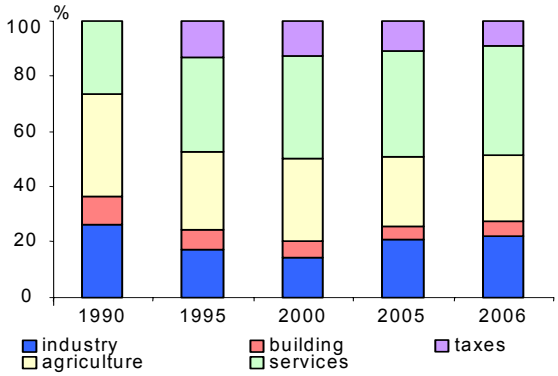


Figure 1.13 *GDP structure in the key branches of economy during 1990-2006, %*

In spite of the growth of industry share in GDP since 2000, total GHG emissions in Uzbekistan in 2005 have been lowered by 9.3% in comparison with 1990. The following factors promoted such reduction of emissions:

- increase of the share of service sector and decrease of power overhead connected with it;
- investment stimulation in technical modernization of manufacture that has affected decrease of power consumption in the industry;
- increase of the share of natural gas as the fuel in all sectors of the national economy.

This was reflected on the fuel consumption per head which has lowered by 22.2 % (Figure 1.14).

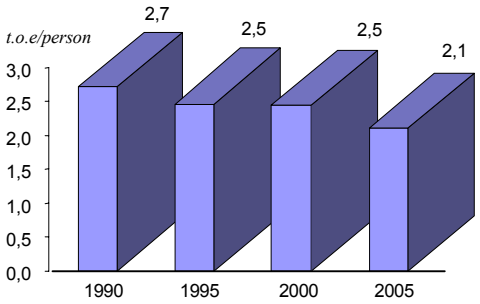


Figure 1.14 *Dynamics of change of fuel consumption per head, t.o.e/person*

As a result, total GHG emissions per head were reduced by 14.7% for the specified period and in 2005 have made up 7.6 t of CO_2-equivalent per head (Figure 1.15).

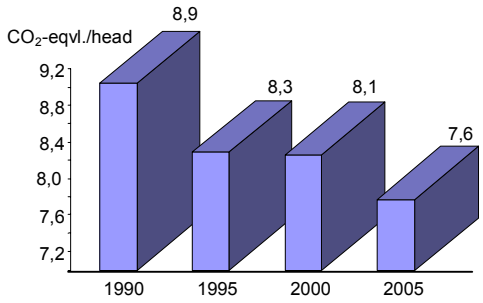


Figure 1.15 *Changes of GHG emissions per head, m CO_2-equivalent /head*

Development of industrial production and information-communication technologies promoted the growth of the foreign trade turnover of the goods and services with many countries of the world.

In 2006, export made up 57.2% of total amount of foreign trade turnover, import – 42.8%. Uzbekistan exports lint, energy carriers, nonferrous and ferrous metals, machines and equipment, chemical production, foodstuffs and services. Machines and equipment make up more than 40% of import to Uzbekistan.

1.4.4. Economic Development Priorities

The ***economic priorities till 2020 are*** defined as: modernization, technical and technological updating of manufacture in strategically important industries (fuel and energy and metallurgy through processing of new reserves of raw mineral resources and application of modern effective energy saving technologies for extraction and processing); development of chemical and light industry, industry of building materials, etc.

Transport and communication infrastructure will get large development as the major factor of the steady, balanced and complex development of all branches and spheres of the national economy.

The list of the branch programs, the realization of which will promote further GHG emissions reduction and decrease of environmental pressure in Uzbekistan is presented in Table 1.4.

Table 1.4 The List of Basic Targeted Government Programs Implemented in Uzbekistan

	Title of the Targeted Program	Realization period
1.	Development of services	2006-2010
2.	Development of highways	2007-2010
3.	Localization of manufacture on the basis of local resources	2006-2008
4.	Development of the coal industry	2002-2010
5.	Development of agricultural mechanical engineering	2006-2010
6.	Development of oil and gas sector	2006-2010
7.	Development of the industry of construction materials	2005-2010
8.	Modernization and technical re-equipment of enterprises of the textile industry	2006-2008
9.	Modernization and reconstruction of enterprises of cotton-processing industry	2007-2011
10.	Increase of livestock in individual, dehkon (peasant) and farming households	2006-2010
11.	Modernization and technical re-equipment of wine-producing enterprises	2007-2010
12.	Development of information and communication technologies sector	2005-2010
13.	Providing rural settlements with potable water and natural gas	2003-2009

1.5. Economic Sectors

1.5.1. Agriculture

About 80% of the foodstuffs necessary for the population of the country are produced by the agrarian sector in Uzbekistan, and agriculture is one of the main sources of GHG of non-power origin (protoxides of nitrogen and methane).

In the structure of gross output of agriculture in Uzbekistan *crop production* share makes 56.9%, *cattle breeding* – 43.1% (2006).

Since 2000, agriculture reforms have been implemented in the country. Private (dehkon) farming, which is more effective in market conditions, has become the main form of agriculture management in the country. The share of non-governmental sector has reached 99.7% with more than 215 thousand private farms in place managing about 85% of all agricultural lands. The share of farming in cotton industry has made almost 99% and grain growing – 82%.

By 2006, vegetable and fruit growing has increased by 2 times, wheat – by 66%, corn – by 20%, rice – by 14%.

Cotton is the main strategic agricultural crop. Uzbekistan is the world's second

largest cotton exporter. In 2006, the raw cotton crop was more than 3.6 million tons, which is 20% more than it was in 2000.

The number of cattle, sheep and goats, and poultry has increased by 35%, 29% and 81%, accordingly (Table 1.5).

Table 1.5. Cattle and poultry livestock, thousand heads

Production type	1996	2000	2007
Cattle, including	5203.5	5281.8	7044.6
cows	2286.4	2310.0	2982.5
pigs	207.9	83.0	93.1
sheep and goats	9322.3	8863.6	12016.2
poultry	13369.6	14521.6	24188.4
horses	150.0	148.4	162.4

The production of principal kinds of cattle-breeding stuffs has being raised in a stable manner, namely, meat by 42%, milk by 43%, eggs by 2 times, wool by 29%. The level of meeting population's needs in meat, milk and margarine products and other major foodstuffs is satisfactory today.

All these have led to the growth of methane emission by 33.1% and to the decrease of nitrous oxide emissions by 26.4%. The growth of methane emission during the period of 1990-2005 is determined by the increase of livestock. The decrease of N_2O emissions is connected with the reduction of use of mineral fertilizers in agriculture.

The agricultural sector of the Republic faces the variety of problems and threats caused, first of all, by already existing high anthropogenic pressure on environment, by rigid deficiency of land and water resources for development.

Features and problems of agrarian sector

Land resources. In agriculture of Uzbekistan more than 50% of available land is used: irrigated and dry arable land, pastures (Figure 1.16). The lands of forest resources are partially used for the agricultural purposes.

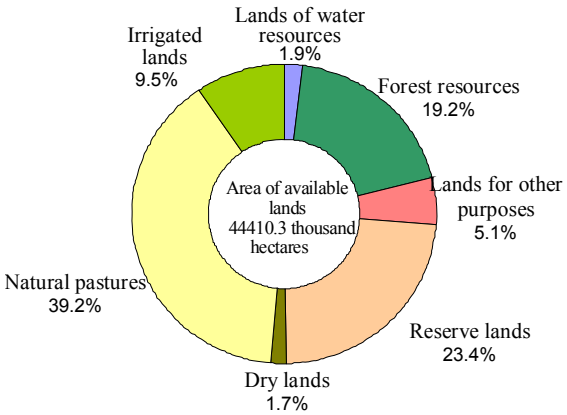


Figure 1.16 *Use of available lands in Uzbekistan as of 1st of January, 2006*

Pastures. By the beginning of 2006, natural pastures occupied 21207.3 thousand hectares of land in Uzbekistan. The pastures are subdivided into desert-plain (67.6% of the area of all pastures), plain-hill (26.9%) and submountain-mountain (5.5%) according to natural conditions.

The processes of pasture degradation, caused by anthropogenic desertification and aridization of the climate, are observed in the Republic. There is a fragmentation of ecosystems of the natural pastures and decreasing in their biological efficiency.

For the last decade, the efficiency of the pastures has decreased on the average by 23%. The greatest decrease in the efficiency is registered in the Republic of Karakalpakstan (27%).

The degradation of the pastures was caused by increasing pressure due to increase of cattle livestock for the last 10 years (Table 1.5). ***Irrigated lands*** – basis of agriculture in Uzbekistan. Uzbekistan possesses the largest area of the irrigated lands among all Central Asian countries.

Stabilization of irrigated lands occurred due to exhaustion of accessible water resources in the country. The areas of the irrigated lands per head were considerably reduced (Figure 1.17). Currently, 0.16 hectares of the irrigated lands per head are required with about 0.13 hectares of that being irrigated arable lands.

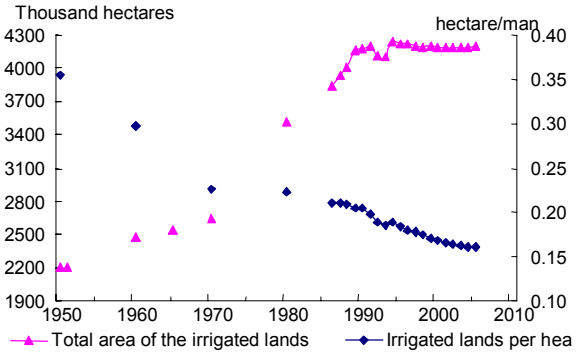


Figure 1.17 *Dynamics of total area of the irrigated lands and indicator per head (hectare/person)*

The off take for irrigation from superficial sources in shallow years reaches 100% that is an indicator *of unstable water use* in agriculture.

Soil. The medium-loam (4% of the irrigated lands), heavy-loam, clay (25%), light-loam (2%), sabulous and sandy (4%) soils prevail in the Republic. Basically, it is dark and typical sierozems. Dry crops settle in sierozem and mountain cinnamonic zones.

The soils of Uzbekistan are characterized by low level of fertility. Humus content is low, usually not more than 1-2%. The tendency of decrease of humus content has been observed for the last few years.

Degradation of the irrigated lands. The natural features of Uzbekistan (absence of natural drainage flow, low atmospheric precipitation and high

vaporability) lead to salinization of soils, wind and water erosion. In general, about 15% of the irrigated lands and 8% of water are subjected to wind erosion throughout the country.

The problem of land salinization is critical almost in the whole territory of Uzbekistan. The lands in the areas located downstream of the rivers are more subjected to salinization. While less than 10% of the lands are subjected to strong salinization in the upper reaches of the Amudarya and Syrdarya, 95% of the lands are considered substantially saline in the lower reaches of the Amudarya (the Republic of Karakalpakstan). The productivity of the basic agricultural crops in Karakalpakstan *has decreased by 20-30% compared to 1980s*.

Use of saline lands, the flushing mode of irrigation, which demands more water, work and means, is being applied.

For the last decade, there was a reduction of planted areas of various crops in Uzbekistan that is caused by changing of structure of crops, deficiency of water resources and the degradation of the lands, resulted, mainly, by growing rate of salinization.

A number of interconnected factors strengthen degradation of the lands and makes negative impact on agricultural production including irrational water use, physical ageing of irrigation and drainage systems, ineffective method of irrigation, absence of crop rotation and low humus content.

The important factor destabilizing agriculture in Uzbekistan is scarcity of water resources. Geographic and demographic features of Uzbekistan lead to increased negative impact connected with the increase of water scarcity and degradation of the lands.

The processes of the Climate Change strengthen the vulnerability to such natural disasters as droughts, and impose a threat upon food security.

In this case, the land reclamation improvement and increase of fertility of the irrigated lands are ***priority directions of development of agriculture*** in Uzbekistan.

This problem will be resolved through implementation of the *Government program of reclamation improvement of the irrigated lands for 2008-2012*, specifying the actions on building, reconstruction and repair of land reclamation objects and upgrading reclamation equipment. In 2008-2012, the problem is posed to carry out building and reconstruction of the main, inter-regional and inter-economic collectors and reclamation chinks, restore drainage networks, provide subcontract and water management organizations with modern equipment on the basis of leasing.

Realization of this Government will become a considerable contribution in the activities on the Climate Change adaptation in Uzbekistan.

1.5.2. Energy Sector

In power sector carbon dioxide, carbonic oxide, nitrogen oxide (NOx), water and other substances of direct and indirect GH action are formed at fuel burning.

The power sector makes the major contribution in total GHG emissions in the country. The analysis of the reasons explaining the considerable divergence between growth of GDP and decrease of GHG emissions during 1990-2005, has shown that there were structural changes in GDP: the share of less power-intensive branches, such as services and trade has increased; the energy-saving technologies were actively applied almost in all branches; the share of natural gas as fuel in life and manufacture has increased.

Gross consumption of fuel and energy resources for the last 15 years had the steady tendency to reduction. In comparison with 1990, the fuel consumption in the power sector by 2005 has decreased by 15,6 %, in the industry – by 4.7%, in transport – by 21.7% and in agriculture – by 7.3% (Figure 1.18).

The structure of fuel use by the basic directions of consumption has not essentially changed; the resources are used for generation of thermal and electric energy, and also as technological fuel in the industry. However, in the structure of fuel consumption the population share has considerably increased by 30.8 % in 2005 in comparison with 1990 that is connected with population growth, increase in number of individual cars, and also available housing expansion.

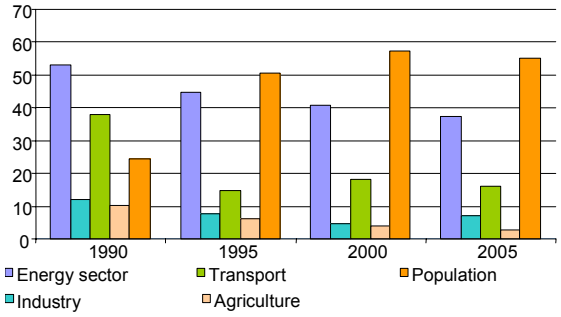
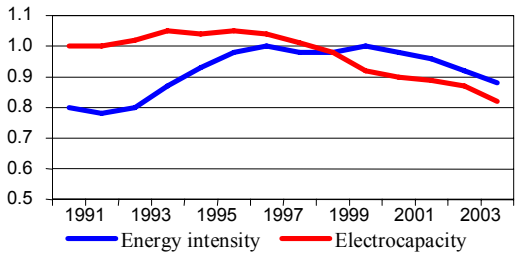


Figure 1.18 *Dynamics of internal consumption fuel-and-power resources by sectors, %*

Nevertheless, the main issue of development of energy sector in the country is high power consumption of GDP. The analysis of dynamics of the basic economic indicators and volumes of consumption of fuel resources during 1990-2005 has allowed identifying two stages characterizing different tendencies of change of power consumption of GDP and accordingly GHG emissions in Uzbekistan.

At the first stage during the period of 1990-1996, consumption of power resources growth rates exceeded rates of increase of GDP, even though recession was observed during this period. As a result, the power consumption of economy has increased by 24.6% (Figure 1.19). The low prices for the basic power resources considerably subsidized by the Government during this period did not stimulate consumers to an effective utilization of energy carriers and energy saving.

At the second stage since 1996, despite the tendency of growth of industrial production, energy efficiency of economy began to improve due to liberalization of the prices in energy system and energy saving politics implemented by the state. The price policy of real payments for the consumed energy was supplemented with the process of providing consumers with meters for consumption record of natural gas and hot water started by the Government. The tendency of reduction of power consumption of GDP by 14 % and electro capacity of GDP by 20 % (Figure 1.19) was outlined as a result. Naturally, there was a reduction of GHG emissions by 15 % in the energy sector, connected with fuel burning during this period. It has been caused, mainly, by decrease in consumption of fuel resources and, somewhat, change of structure of burnt fuel (increase of use of natural gas).



Energy intensity of GDP– kg o. e./dollar by PPP
Electric capacity of GDP– KW h/dollar by PPP

Figure 1.19 *Efficiency of use of power resources in Uzbekistan, kg o.e./dollars*

Despite outlined decrease, power consumption of GDP of Uzbekistan continues to remain very high. High power input of the national economy is resulted by the increase of specific expenses of fuel directly for production and services as there is a domination of power-intensive branches of raw and extracting sector in energy consumption structure. The share of power-intensive branches in the structure of consumption of primary power resources makes more than 53%. Especially high specific expenses of the electric power (more than 2 times higher) are in housing sector because of low efficiency and large losses in power supply systems. The gas consumption level in housing sector is 3-4 times higher than the same indicator of the developed countries.

Branch Program on Energy Supply is developed for providing sustainable development of economy in Uzbekistan for the period till 2010. The realization of organizational and technological measures on fuel and energy saving and carrying out of purposeful energy saving policy within the program will allow lowering essential power consumption of GDP by 33-35%. The potential of organizational and technological energy saving is estimated not less than 8-10 million t.o.e. Raw and processing industries have about 30% of this potential for saving, more than 45% in the sphere of housing and 25 % in other branches and economy sectors. Program realization on Energy saving will promote the reduction of GHG emissions in the energy sector.

Natural gas is dominating energy source in the structure of fuel and energy resources. Natural gas makes up about 85% in manufacture of primary energy. Its production has increased by 36.1% during 1990-2005. Predicted stocks of natural gas is 60-85 billion м^3 per year. The share of Uzbekistan in world production of natural gas is 2.3-2.5%.

The basic consumer of natural gas is housing economy. The population share in consumption of natural gas has increased up to 41 % in 2005 due to implementation of the Government program on gas supply, including rural population.

"Uzbekenergo" State Joint Stock Company – the largest manufacturer of electric and thermal energy is among largest gas consumers. Its share in the structure of consumption of natural gas makes up about 35%.

Expenses of natural gas on technological needs of the power enterprises and loss of natural gas at transportation and distribution remain rather high now. These losses are connected both with technologically outdated pipeline system, and with high power consumption of manufacture of energy sector. As a result, along with the increase of volumes of extraction, transportation and processing of natural gas during 1990-2005, the growth in its leakage was observed. The share of gas emissions due to leakage makes up 99%.

Transportation and transit of natural gas to consumers through the system of the main gas pipeline are carried out by "Uztransgas" Joint Stock Company, which provides services at more than 13 000 km of gas pipeline and includes 24 compressor stations. In general, 248 gas-transfer units function in the system. The total volume of transported gas has made up 89.1 billion м^3 in 2005, 39.3 billion м^3 of which is transit of Turkmen gas, the turnover of goods of pipeline transportation has made up 38 billion t-km in 2006. Natural gas is exported to Russia, Kazakhstan, Kyrgyzstan and Tajikistan. It is expected that with introduction new natural gas fields, the increase of hydrocarbon stocks will make up 521.1 million t.e.f in prospect till 2010. By 2014, it is planned to raise volume of gas export.

According to the Program on Energy Saving till 2010, annual consumption of natural gas in the country will be 32 billion м^3 by 2010.

Implementation of measures on energy saving in gas branch will allow lowering consumption of natural gas for own needs in extraction, processing and reducing leakage during transportation of natural gas to 4.7 billion м^3 per year and by that, to reduce considerably GHG emissions in the energy system.

In connection with the increase of extraction of natural gas, the volumes of coal mining were reduced approximately by 50 % since 1992 till 2000. Today, the coal share in power balance makes up 3.9%. Though by 2006 the coal mining has again started to increase to 3.1 million tons, these volumes are much lower, than those of the last years (Figure 1.20).

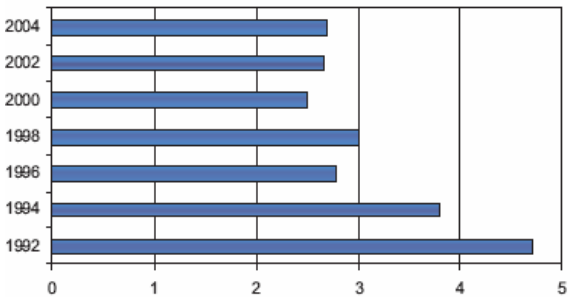


Figure 1.20 *Coal production during 1992-2004, million tons*

Uzbekistan has the established resources of coal in number of 1.9 billion tons, about 70 % of all coal resources makes brown coal or lignite. The coal mining is conducted on three deposits: Angren where about 80% of all coal is extracted, Shargunsky and Baysunsky. All extracted coal is consumed in the country. The basic consumer of coal fuel is the power sector the share of which is about 90% of the general coal consumption and 100% of gas of underground gasification of coal. "Uzbekugol" Open Joint Stock Company is the exclusive manufacturer of coal in the country.

In 2002, the Program of development of the coal industry for 2002-2010 was accepted, which provides for an increase in coal mining of up to 9.4 million tons by 2010, as well as a decrease of its share in generation of the electric power down to 15%. The increase of coal share in the structure of fuel use will promote increase in GHG emissions, however, at application of modern environmentally friendly technologies, the growth of GHG emissions of coal burning can be reduced considerably.

Uzbekistan has considerable resources ***of liquid hydrocarbons***. By 2006, the volumes of extraction of liquid hydrocarbons have reached 5.5 million tons, thus crude oil averaged only more than 60 % of the extraction. Crude supply is enough for 20-23 years. Oil is processed at two large oil refining factories (ORF) of "Uzbekneftegaz" National Holding Company: Fergana ORF (8.7 million tons per year) and Bukhara ORF (2.5 million tons per year). Natural gas is processed at Mubarek OGRF (25 billion м^3 per year).

In 2004, the "Strategic Program of oil and gas exploration for 2005-2020" was accepted, which will allow providing increase of oil stocks up to 70 million tons and gas condensate to about 66 million tons.

Application of modern environmentally friendly technologies in oil-extracting branch is supposed to promote the reduction of GHG emissions and the decrease of negative impact on environment.

The power industry of Uzbekistan includes complex of more than 53 power enterprises united in the framework of "Uzbekenergo" State Joint Stock Company, they carry out the centralized power supply for national economy and the population, and also thermal energy supply to industrial and household consumers of the Republic.

The main source of GHG in power industry is process of fuel burning for the purpose of generation of thermal and electric energy. For electric power and heat generation natural gas – 90.8%, residual oil – 5.3% and coal – 3.9% are used.

The power enterprises of the branch produce in average more than 48 billion kW/h of electric power and more than 10 million Gc of thermal energy each year.

The basis of power system of Uzbekistan is thermal power stations (TPS) of general capacity of 10.6 million in kW. The share of TPS makes up 85.2% (Figure 1.21).

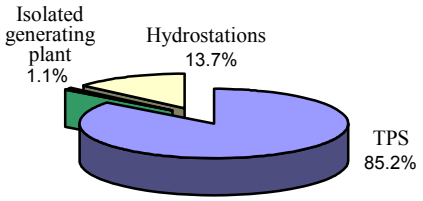


Figure 1.2. *Structure of the established capacities of power plants in Uzbekistan*

There are five TPS with the established power units of capacity of 150-800 MW in Uzbekistan. Over 85% of the electric power are produced at large thermal power stations – Talimardzhan (800 MW), Syrdarya (3000 MW), Novo-Angren (2100 MW) and Tashkent TPS (1860 MW). There are two large stations working on coal burning. 12.7% of the electric power are generated at hydrostations. The hydrostations share in the structure of the established capacities makes up 13.7% (Figure 1.21). The largest hydrostations are Charvak (620 MW), Hodzhikent and Gazalkent. The established capacity of power stations of Uzbekistan exceeds 12,4 million kW and makes about 50% of generating capacities of all Electric power system of Central Asia.

The transfer and distribution of the electric power to Republic consumers is carried out through transmission lines with pressure of 0.4-500 kW, the general length of which exceeds more than 235

thousand km. The basic consumers of the Republic are connected to the zone of the centralized power supply.

The basic volume of the supplied electric power falls to the share of the industrial enterprises (41.9%), agricultural consumers (30.8%) and population (14.3%) (Figure 1.22). The energy consumption per head per year makes 1940 kW/H in the Republic.

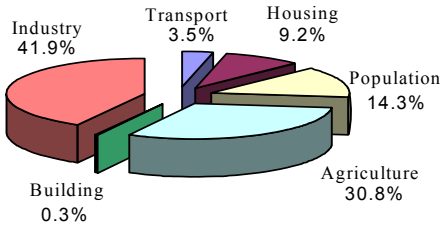


Figure 1.22 *Power consumption structure by branches in 2006*

Despite the power resources of Uzbekistan, there is a number of issues, which directly and indirectly influence the power independence of the country and growth of GHG emissions in the future.

More than 30% of the established capacities have become outdated and have low efficiency, because of that, there are considerable losses of energy taking place, both at its development, and transportation, transfer and distribution to consumers. Considerable losses cause growth of GHG emissions.

For the purpose of reduction of energy losses, the branch Program of development of electric power industry for the period till 2010 is being implemented. The basic measures are directed at reconstruction and modernization of operating capacities with application of modern technologies. It will lead to increase in generating the electric power up to the level of 61-62 billion kW/h per year and to more effective utilization of fuel. Realization of these steps will promote the Climate Change mitigation.

Providing population and enterprises *with heating and hot water supply* in Uzbekistan is carried out, mainly, from the centralized sources and, in small amount, from the independent sources of the industrial enterprises, local boiler-houses. More than 7.5 thousand boiler-houses of various capacity function in the Republic, where there are almost 25 thousand coppers of various types and designs, among them the quantity of small boiler-houses of the capacity of 3-100 Gkal/h is 1186. The centralized heat supply is developed in all cities.

About 5 million t.o.e. of fuel is annually spent for heat generating in Uzbekistan which makes about 10% of total fuel consumption. The main kind of fuel is natural gas. There is a small amount of the boiler-houses working on coal and some remote rural areas use wood fuel for heating.

The main problem of centralized heat supply system in Uzbekistan is its low efficiency: more than 30% of household heat supply system have exhausted own resource which leads to a considerable heat loss. The designed efficiency of large boilers is 90-92%, however, their actual efficiency is 50-75%, and the designed efficiency of small boiler-houses is about 60-75%. Such indicators predispose increased GHG emissions by the thermal boiler-houses.

Considering the inefficiency of the present centralized system of housing heat supply, the Government of Uzbekistan is considering the issue of decentralization of heating sector through introduction of small and independent thermal installations. However, currently heat supplying enterprises have no funds for re-equipment as actual heat and hot water fees paid by consumers do not cover the expenses required for modernization of the system.

Besides, the prices for thermal energy and hot water paid by population are subsidized by the Government which does not stimulate heat and resource saving. As a result, GHG emissions of power sector have grown by 40% in 2005 in comparison with 1990 in housing sector, and by 64% in commercial sector respectively.

1.5.3. Industry

GHGs are produced by the industry as a byproduct of certain technological production cycles. The industries generating GHG of technological origin are metallurgy, and metal processing (rolling mill and pipe manufacture, metal casting, production and repair of refrigerators), petrochemical industry (production of ammonia, nitric acid, caprolactam) and the industry of building materials (cement manufacture, lime, glass). GHG are formed both, as a result of fuel burning in technological furnaces for high-temperature heat generation, and in the process of chemical and thermal transformation of raw materials. All above leads to generation of CO_2, CO, N_2O, NOx.

During 1990-2006 the structure of the industry in Uzbekistan hasn't considerably changed. The energy sector makes up the largest share of industry (electric power industry and fuel industry) – 27.0% with industrial production and metallurgy making up 20.8 %, light industry accounting 14.6%, and mechanical engineering amounting 13.8% (Figure 1.23) in 2006.

Since 2000 Uzbekistan has experienced a growth of industrial production due to realization of industrial Investment program which actively involves foreign investments for reconstruction of existing capacities and building of new industrial enterprises. A decline of

industrial production in the 1990's caused a decrease in GHG emission of industrial processes. With the improvement of economic situation in the country which facilitated industry development, some growth of industrial GHG emissions is expected. The share of CO_2 in the emissions of the industrial sector makes more than 70%, the share of N_2O is about 30%. CH_4 and HFC emissions are insignificant and make less than 1%.

The industry of Uzbekistan includes a large machine-building complex, metallurgical industrial complex for manufacture of ferrous and nonferrous metal, modern enterprises for manufacture of gold, silver and a palladium, aviation manufacture factory, new factories for manufacture of cars and buses, large chemical enterprises for manufacture of mineral fertilizers, cement works, diversified industrial complex of light industry (cotton cleaning, cotton and silk industries), medium and small enterprises for fruit-and-vegetable processing and manufacture of food production. However, their main problems, ageing of the basic production assets, technological lag in foreign markets, and lack of investments for modernization still remain in place which in turn brings the additional contribution to growth of GHG emissions from industrial activity.

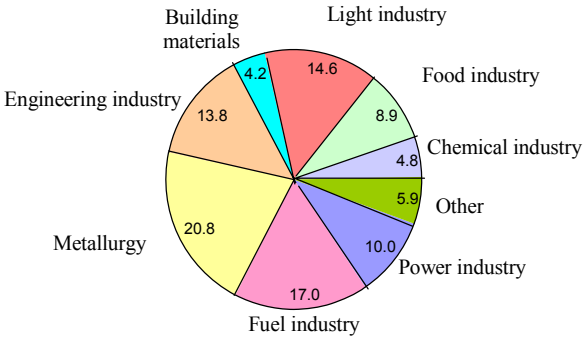


Figure 1.23 *Industrial production structure in 2006, %*

1.5.4. Transportation

Transport is the next significant source of GHG after thermal and electric power sector. Functioning of transport complex is accompanied by generation of CO_2, CO, CH_4, N_2O, and NOx emissions.

The transport sector of Uzbekistan includes automobile, railway and air transport. The main kind of transport is ***automobile*** which amounted 84,9% of the volume of passenger and cargo transportation in 2006 (Figure 1.24).

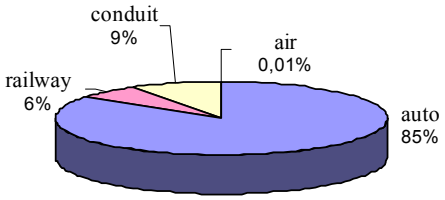


Figure 1.24 *Structure of passenger and cargo transportation by kinds of transport in 2006, %*

The increase of passenger and cargo turnover in automobile transport in Uzbekistan was promoted by active development of an extensive transport network in 1990-2005. In 2006 the network of highways with solid covering has made 51.6 thousand km, railway roads – 5.7 thousand km.

The network of highways in Uzbekistan takes a leading place by the indicator of development among the CIS countries and now provides current requirement for transportations of cargoes and passengers in the country.

For the last 15 years automobilization of the population is observed as a result of which private automobile passenger transportation amounts more than 70%, the passenger turnover of private transportations is 78.3%. The automobile transport in Uzbekistan consumes 79.1% of liquid hydrocarbon raw materials (gasoline).

The majority of existing motor transport does not meet modern requirements for resource saving and international environmental standards because of technological gap, and it is a significant source of atmospheric air pollution and GHG emissions in Uzbekistan.

The quantity and the structure of passenger and cargo transportation in *railway transport* have not changed for the period considered. The share of oil cargoes (24.6% of total volume) and building cargoes (23.5%) prevails in the structure of railroad cargo transportation. In 2006 12.7% of total amount of exported cargoes were transported by rail, 5.7% of which went overseas.

Air transport in Uzbekistan carries out internal and international transportations of cargoes and passengers, with more than 24 thousand flights to 20 countries of the world annually carried out. In 2006 1 mln. passengers were transported by air, the passenger turnover made 4,7 billion in passenger-km. Uzbekistan is a member of the international organizations of civil aircraft ICAO and IATA. There are 10 airports in Uzbekistan, with half of them accepting international flights.

1.5.5. Tourism

Uzbekistan has rich tourist potential and is famous for its several sightseeing and historical places, such as Samarkand, Bukhara, Shakhrisabz, and Khiva, several of those sights are included into the UNESCO list of the World heritage.

Currently, the tourism industry of the Republic of Uzbekistan is in the phase of development of a modern international tourism infrastructure: the new system of state regulation of tourist activity is created; private sector including travel insurance companies and agencies, hotel and restaurant businesses, transport structures, environmental tourism is actively developing.

In 1992 "Uzbektourism" National Company was created as the state body in tourism, it coordinates and provides for development of a uniform state policy in tourism industry of the Republic of Uzbekistan. In 1998 Association of Private Tourist Organizations of Uzbekistan was established and now it represents over 400 private travel companies in the country. In 1999 the law «About tourism» had been adopted by the Uzbek Government with the aim of legal regulation of relations in tourism industry and the development of the tourist services market.

According to the forecasts of the Ministry for Foreign Affairs of the Republic of Uzbekistan, entrance tourism is supposed to increase by more than 3.5 times by 2010. The volume of entrance tourism will reach one million tourists. Thereupon, it is necessary to estimate vulnerability of tourism sector to Climate Change in the future.

Registan Square in Samarkand

West Tian Shan mountain

1.6. Waste

The waste products formed on the territory of Uzbekistan are subdivided into three groups: solid industrial waste, solid household waste, deposits of sewage.

The basic sources of GHG emissions of waste products are the burial and burning of solid wastes, and also sewage cleaning.

In Uzbekistan, the burial of solid waste is carried out at the waste disposal sites. Burning of solid household waste (SHW) is not performed in Uzbekistan as there are no waste recycling plants. Sewage cleaning is made at treatment facilities by biological method in aerobic conditions, with mainly ethane and insignificant share of nitrogen oxide being emitted in the process.

The most essential contribution to GHG emission is made by burial of waste on the SHW disposal sites (methane (CH_4) emission) and to a lesser degree the waste products of human activity (N_2O emission).

In connection with the country population growth during 1990-2005 a stable growth of emissions is observed (by 87%) from both, dumps of solid household waste and household sewage. Along with this, the negative influence of industrial drains on environment has decreased because of industrial recess/

More than 100 million tons of solid *industrial waste*s are annually formed in Uzbekistan of which:

- more than 30% are dangerous waste, over 14% of which are toxic;
- 1.5-2% is waste referred to as secondary material resources (scrap of metals, ashes, shrot etc.);
- about 68% mining industry waist (overburden rocks, rock debris ores, etc.).

Non-utilized waste of industrial production places at 43 industrial enterprises of Uzbekistan which have large-capacity storages of industrial wastes. They occupy about 6.7 thousand hectares. 92% of these objects are located on the territory of Tashkent,

Fergana, Samarkand, and Navoi regions, where large producers of industrial wastes are concentrated, such as power plants, nonferrous and ferrous metallurgy, chemical manufacture, and building industry. Since 2000, the volumes of toxic waste have increased from 14.4 million tons to 40.2 million tons by 2007 along with the amount of industrial objects (Table 1.6).

Table 1.6. Change of volume of toxic waste formed at the enterprises of Uzbekistan during 2000-2007

Years	2000	2002	2004	2006	2007
TOTAL Formed in toxic waste plants, mil. t	14.4	31.3	35.7	38.5	40.2

Currently, an insignificant part of industrial wastes is utilized in soil loosening, filling of drainage collectors and strengthening of dams as well as in road building, slag stone production, breeze blocks, for manufacture of organic and mineral fertilizers, building materials and constructions etc. The insignificant extent of industrial waste utilization is caused by a low content of useful components in waste products, lack of processing capacities and absence of modern technologies.

Recycling of sewage deposits is not made in Uzbekistan because of high level of their toxicity.

Annually about 30 million м^3 of *solid household waste (SHW)* is formed in Uzbekistan**.** In total there are 175 SHW dumps in the Republic which occupy 1.14 thousand hectares of the territory. Large areas of FHW are located near densely populated cities in Samarkand, Djizak, Tashkent regions.

Difficult conditions for recycling and neutralization of solid household waste have developed in large cities of the Republic and densely populated areas of Fergana valley.

In the capital of Uzbekistan, Tashkent alone, a large industrial centre and an well populated city (more than 2.6 million people), up to 20 thousand tons of industrial wastes and about 1.5 million tons of household waste is annually generated and taken out to the city disposal site of 52 hectares.

As a whole, recycling of solid household waste is not present in Uzbekistan which promotes growth of GHG emissions of waste products taking into account the steady population growth.

1.7. Legal and Institutional Base for Environmental Protection and the UNFCCC Implementation

1.7.1. Legal Framework

Much attention is paid to the issues of environment protection in Uzbekistan. The legislation in the given area includes more than one hundred laws and governmental orders. The major directions of environmental policy of the state are:

- Formation and development of the corresponding legislation;
- Development of environment protection and social and economic development programs;
- Macroeconomic regulation of resource and power saving, application of environmentally safe equipment and technologies;
- Deepening institutional reforms with the aim of creation of environmental market structures;
- Increase of responsibility of enterprises and organizations, irrespectively of kind of ownership, for financial and material support of environmental safety of their activities;
- Information providing, improvement of ecological education.
- The constitution of Uzbekistan includes special articles on protection of the environment; rational use and protection of land, the earth interior, faunae and flora, and natural resources.
- The mechanisms and tools of state regulation in the field of environment protection, principles of transition to paid nature management and legal base for realization UNFCCC are reflected in the Legislation.

Current legislation of Uzbekistan includes one of the major provisions of Article 4 of UNFCCC - regulation on development and periodic update of the National Inventory of anthropogenic emissions from sources and absorption by absorbers of all green house gases. The Law about «Protection of atmospheric air» (Article 26) contains direct instructions for providing State account for «...kinds and quantity of polluting substances, biological organisms, GHGs and ozone destroying substances emitted into atmospheric air».

All legal documents, including the system of the state monitoring of environment, create the basis for UNFCCC implementation in Uzbekistan. In general, analysis of the legislative base of Uzbekistan in the field of environment protection demonstrates that the adopted laws support UNFCCC objectives. However, legal acts are sometimes insufficiently worked out and have a declarative character which complicates their implementation. There are no necessary procedures that would correspond to the specific obligations requirements present under UNFCCC.

Table1.7. The nature protection legislation including questions of UNFCCC

Law and Date of Adoption	Contents
About environment protection 9.12.1992	The main law, regulating ecological relations, defines the core ecological and legal principles of rational use of natural resources and environment protection. ***Resolutions of Cabinet of Ministers (sublaw acts):*** Resolution № 469 as of 20.10.1999 «About the program of actions on environment protection in the Republic of Uzbekistan for 1999-2005 » Resolution № 111 as of 3.04.2002 "About approval of Regulation on state monitoring of environment in the Republic of Uzbekistan» Resolution № 16 as of 13.01.2003 " About approval of Regulation on state monitoring of environment in the Republic of Uzbekistan for 2003-2005»
About protection of atmospheric air 27.12.1996	Legal regulation of activity of the state bodies, enterprises, establishments, organizations of public associations and citizens in the field of protection of atmospheric air ***Resolutions of Cabinet of Ministers:*** Resolution № 199 as of 1.05.2003. «About improvement of payment system for pollution of natural environment and placement of waste in the Republic of Uzbekistan » Resolution №389 as of 09.10.2000 "About questions of implementation of the Program of actions for environment protection in the Republic of Uzbekistan for 1999-2005» and Resolution № 183 as of 14.04.2004"About improvement of hydrometeorological service» which regulates the monitoring of implementation of National strategy of decrease of GHG emission and inventory order
About rational use of energy 25.04.1997	Provision of effective utilization, storage and processing of various kinds of fuel in economy sectors, legal basis of manufacture and use of alternative kinds of fuel, nonconventional and renewed energy sources, formation of the general legal bases providing preservation of national power resources
About ecological examination 25.05.2000	Standard-legal base of maintenance of ecological safety ***The Cabinet decision*** № 491 as of 31.12.2001"About consoliding of Regulation of the state ecological examination in the Republic of Uzbekistan»
About forestry 15.04.1999	Regulates use and protection of forests, contains general provisions as relates to functions, ownership of forests, and forestry funds as well as regulates the use and restoration of forest resources ***The Cabinet decision*** № 160 as of 30.03.2001"About the delegation of attorney on creation of forests, their protection and safety, development of the hunting economy" reserved business and national parks, and also the organization of environmental tourism to the competence of Central administrative board of forestry
About especially protected natural territories 7.05.1993	Legal, environmental, economic, organizational bases of creation, management and protection of the unique natural complexes which are national riches and public property in interests of the present and future generations.
About protection and flora use 26.12.1997	Regulates relations in the field of protection and use of natural flora
About protection and fauna use 26.12.1997	Regulates relations in the field of protection, use and reproduction of fauna
About water and water use 6.05.1993	Regulates water relations, rational use of water for the needs of population and national economy, and also protects the rights of enterprises, establishments, organizations, farms, and citizens in the field of water relations
About the state sanitary inspection 3.07.1992	Regulates public relations, establishes sanitary requirements for various economic activities, forbids the activity breaking sanitary norms
About waste products 5.04.2002	Regulates waste management issues for the purpose of prevention of harmful influence of waste on life and health of citizens, environment, reduction of waste and stimulation of their rational use in economic activities
About the state cadastres 15.12.2000	Regulates the order of development and maintaining various cadastres, including land, water cadastres etc.
About safety of hydraulic structures 20.08.1999	Regulation of activities in maintenance of safety at designing, building, operation, reconstruction, preservation and liquidation of hydraulic structures

1.7.2. Institutional Structure

After signing UNFCCC the Government of Uzbekistan has formed the National commission on problems of Climate Change, headed by the Assistant of Prime minister of the Republic of Uzbekistan. The commission structure includes representatives of the ministries and departments engaged in management of the environment and responsible for realization of the ecological policy in the Republic. Improving the control system, the Cabinet of Ministers published the decision about reorganization of some of the national commissions. This decision liquidated the National commission on problems of Climate Change and the Center of Hydrometeorology Service under the Cabinet of the Republic of Uzbekistan (Uzhydromet) was assigned "…duties of fulfillment of obligations of the Republic of Uzbekistan under the UNFCCC".

The Secretariat on Convention realization was created In Uzhydromet as a constantly operating coordinating body for performance of national obligations, General Director of Uzhydromet is the National coordinator on UNFCCC in Uzbekistan. The Secretariat is guided by the Constitution of the Republic of Uzbekistan, laws, and decrees of the President, decisions and orders of the Cabinet of Ministers.

Practically all structures of Uzhydromet are involved in the work on UNFCCC realization and other global environmental conventions. According to the decision of the Cabinet of Ministers of the Republic of Uzbekistan «About improvement of hydrometeorology service» № 183 as of 14.04.2004 the functions of Uzhydromet aimed at the UNFCCC implementation are:

- providing authorities of the Republic in state and economic management, enterprises, establishments, and citizens with information about actual and expected changes of hydro-meteorological conditions and climate, the level of pollution of environment, and emergency information about occurrence of the hazardous as well as natural hydro-meteorological phenomena;
- monitoring of the Climate Change and provision of forecasts, as well as contribution to estimation of its impact and to measures and variants of strategies of reaction to Climate Change;
- fulfillment of corresponding international obligations, including obligations under WMO, UNFCCC (including regular inventory of GHG), the United Nations Conventions to Combat Desertification and Drought, facilitating the national interests by participation in the International programs.

The Information Centre on Climate Change and the library on the given subjects were created in Uzhydromet. The major part of the library includes materials of Conferences of the Parties and Subsidiary UNFCCC organs, final materials of sessions, National Communications of the Parties to the Convention, Assessment reports of the Inter-Governmental Panel on Climate Change (IPCC), methodological and technical guidelines, and publications concerning the Climate Change.

During the implementation of projects on developing of National Communications and training programs, teams of national experts (Figure 1.25) were created of employees of the leading ministries, departments, industrial enterprises and companies, scientific-research institutes, research-and-production centers, and NGOs.

Inventory of GHG is carried out in Uzhydromet. The main source of primary data is the State Statistics Committee, the state entity on national economy data gathering. Sources of data on emission factors, about features of production, structure and tendencies of development of manufacture are as follows:

- The State Committee on Wildlife Management;
- The Ministry of Agriculture and Water Resources;
- "Uzbekenergo" State Joint Stock Company;
- "Uzbekneftegaz" National Holding Company;
- "Uzstroymaterialy" National Joint Stock Company;
- "Uzbeksanoat" State Joint Stock Company;
- "Uzcommunhizmat" Uzbek Agency.

The information about the activity in the framework of the UNFCCC is presented at request to Governmental bodies and interested organizations.

Reports on participation of the delegation of Uzbekistan in Conferences of the Parties and sessions of Subsidiary Organs of the Convention are annually represented to the Cabinet of Ministers and the Ministry of Foreign Affairs of the Republic of Uzbekistan.

The Programme № 525 "About measures on realization of investment projects in the framework of the Interdepartmental Council on CDM of the Kyoto Protocol" as of 6.12.2006 and the Ministry of Economics was appointed as the National Body of the Republic of Uzbekistan on CDM.

The main function of the National Body on CDM is to assist realization of the CDM projects in Uzbekistan and their approval at national level for official representation of projects in Executive Council on CDM at UNFCCC Secretariat. The decision № 9 of the Cabinet of the Republic of Uzbekistan as of 10.01.2007 consolidates

the order of preparation and realization of investment projects within CDM.

Created institutional structure for the UNFCCC implementation in Uzbekistan has been functioning for several years and facilitates coordination among the ministries and departments. It is necessary to preserve and further develop the existing ways of interaction and cooperation in meeting the UNFCCC commitments.

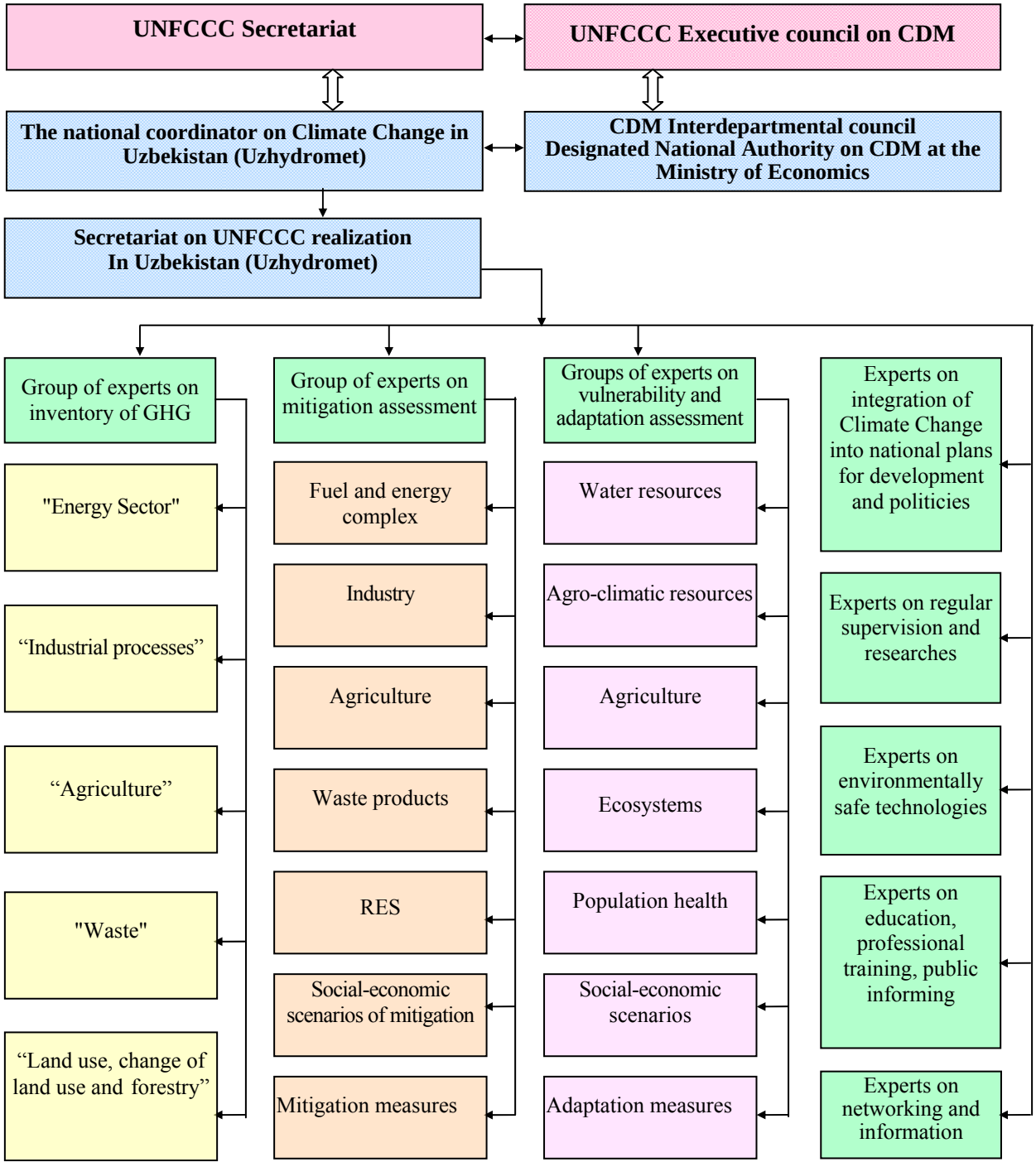


Figure 1.25 *Organizational structure of UNFCCC related activities in Uzbekistan*

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2. Inventory of Greenhouse Gas (GHG) Emissions

GHG Inventory in Uzbekistan is carried out by the Hydrometeorology Centre under the Cabinet of Ministers of the Republic of Uzbekistan (Uzhydromet) that is a responsible authority for implementation of the country's obligations under the UN Framework Convention on Climate Change, in accordance with the Resolution № 183 of 14.04.2004 of the Cabinet of Ministers of the Republic of Uzbekistan. National group on inventories is established on the basis of one of the Uzhydromet's branches – Air, surface water and soil pollution monitoring service (PMS), which was entrusted with master role to conduct inventories. The whole information on greenhouse gases is being collected, compiled and stored at the PMS of Uzhydromet. Experts from various institutions, organizations and industrial companies are involved into fulfillment of certain tasks to provide data on activity, emissions' ratios and other characteristics as well as run calculations and documentation. State Committee on Statistics, major national companies, research institutions and other organizations stipulated in the Interaction Figure 2.1 act as sources of the activity data.

First national inventory included temporary distance from 1990 to 1997 and was conducted within preparation of the National Communication of the Republic of Uzbekistan on UNFCCC. The year of 1990 (core) and the year of 1994 are presented in detail.

The Second National Communication (second inventory) embraces earlier analyzed as well as revised estimates of anthropogenic emissions and greenhouse gas absorptions which are not controlled by the Montreal Protocol, for the period of 1990-2005 years as well as earlier omitted sources of emissions. National coefficients responding to a considerable degree the national standards and designed to decrease uncertainty were developed in certain categories of the sources.

Annual volumes of GHG activity and emissions calculated based on the sector methods for the last 4-10 years at the certain organizations were used for estimates. As a result of recalculations of the emissions' estimates using national coefficients and more precise data on activity, total emission of GHG in comparison with the one calculated in the First National Communication has increased for different years by 12-30% (Table 2.1). Some estimates for 2004-2005 years may be specified.

Estimation of emissions / absorptions were conducted in accordance with the Revised 1966 IPCC Guidelines for Greenhouse Gas Inventories and Reporting on Climate Change User Manual for the Guidelines on National Communications from non-Annex 1 Parties, 2004.

Analysis of key sources was done in accordance with the Good Practice and Uncertainty Management in National Greenhouse Gas Inventories IPCC, 2003.

Main key sources for years 2000 and 2005 are methane emissions from oil and gas systems, gas combustion in household sector and gas combustion in energy and heat production, amounting to 67-69% of total national emission. More detailed analysis of the main sources is outlined in the National Reporting on Greenhouse Gases Inventories.

Table 2.1 Main reasons of overall emissions change

Sector	Category	Reason of recalculation	Remarks
Fuel Combustion	Internal aviation	Refined data on activity	Decrease of total emission by 0,3-0,8 million tons in CO_2
	International aviation bunker	Refined data on activity	Increase of emission by 0,3-0,8 million tons in CO_2
	CH_4 и N_2O emissions from fuel combustion	Earlier omitted source	Minor increase of total emission by 0,2-0,5 million tons in CO_2-eq. for different years
Energy Leakages	Gas recovery, transportation	National factors	Useful increase by 4-18 million tons in CO_2-eq. for different years
	Gas conversion (cleaning from sulphides)	Earlier omitted source by inventory National coefficient	Increase of overall emissions by 15-18 million tons in CO_2-eq. for different years
Industrial Processes	Ammonia production	National coefficient	Insignificant reduction of overall emissions by 0,3-0,5 million tons in CO_2
	Nitric acid production	National coefficient Refined data on activity	Increase of overall emissions on average by 1,4 million tons in CO_2-eq.
	Potential emissions HFC	Earlier omitted source by inventory	Insignificant increase of overall emission

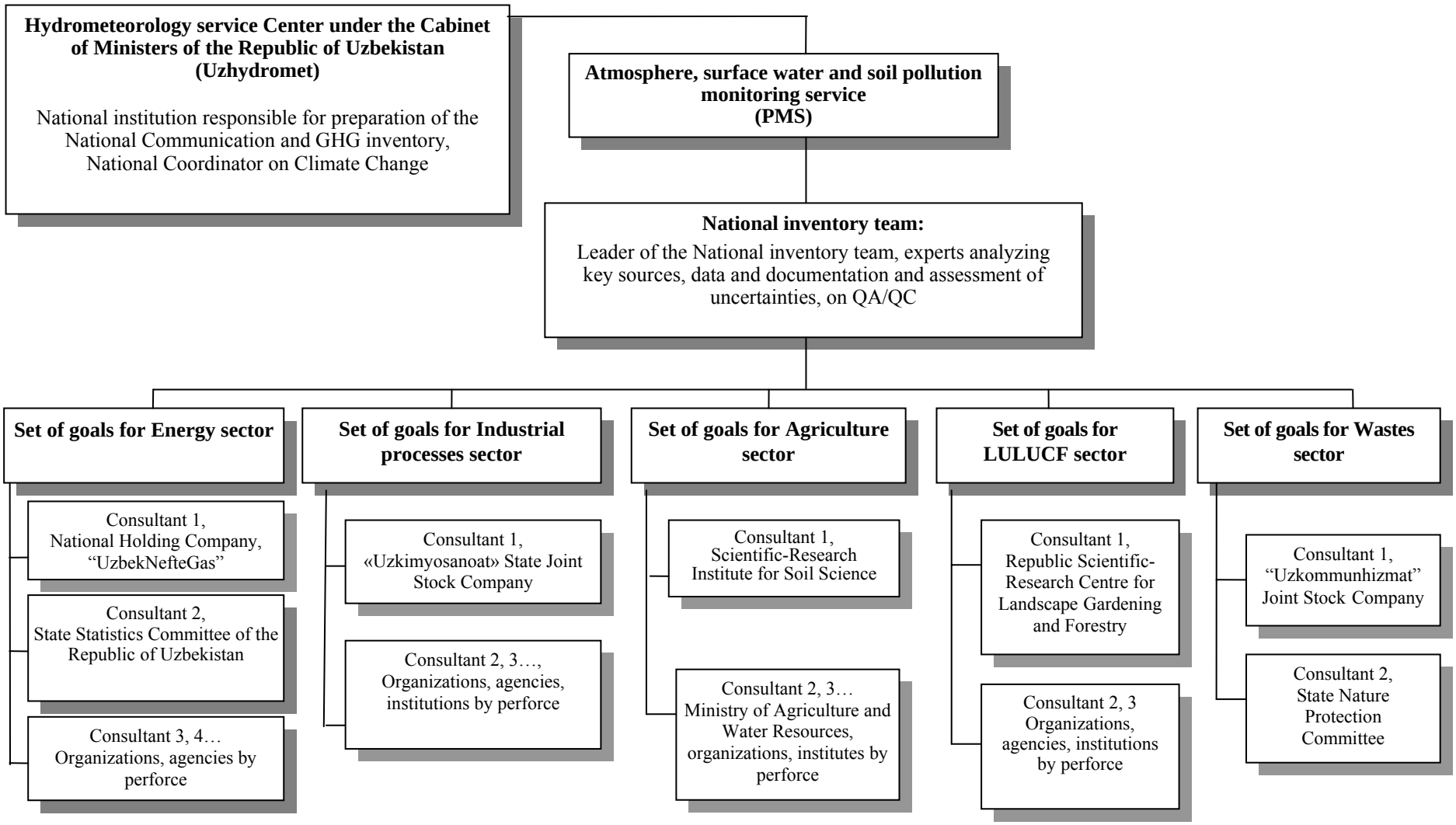


Figure 2.1 *Organizational structure of the National system of GHG inventory*

2.1. General GHG Emissions

Total emissions of greenhouse gases in Uzbekistan without land use and forestry reached 201.2 million tons in CO_2-eq. in 2000. Carbon dioxide is the main greenhouse gas the proportion of which accounted for 54% of aggregate emissions in 2000. Between 1990 and 2005, the proportion of carbon dioxide declined while the proportion of methane increased. The proportion of nitrous oxide accounts for 5-7% of overall emissions (Figure 2.2). Potential emissions of hydro fluorocarbon assessed only for the period of 2000-2005 years. They are extremely insignificant and amounted to 6.34 Gg in CO_2-eq. in 2000.

Aggregate emissions of greenhouse gases, without taking into account land use and forestry, totaled 199.8 million tons in CO_2-eq. in 2005. Thus increase of total emissions in comparison with the baseline year (1990 – 182.9 million tons in CO_2-eq.) accounted for 10% in 2000 and 9.3% in 2005. Reduction of the emissions rise rate is linked to change of the structure of economy: decline of the power-consuming sectors proportion and introduction of power-saving programs in nonproductive sphere.

As it is revealed on Figure 2.2 no abrupt fluctuations of total GHG emissions are observed within the reviewed period since 1990. The greatest reduction occurred in 1998 (3.9%). The base year level was significantly increased in 1993 году (13%), which stems from abnormal increase of methane fugitive emissions from gas systems due to high volumes of transit gas. In the last years (2000-2005) growth of emissions ranged between 10 and 13.5% (2002).

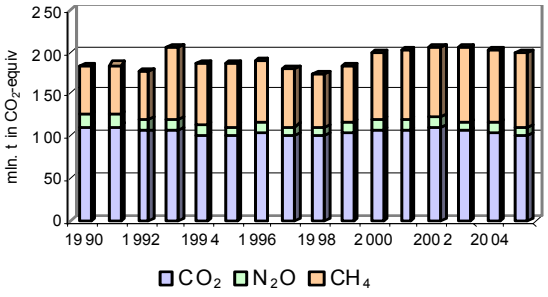


Figure 2.2 *Greenhouse gas emissions*

In 2000 ("Land-Use Change and forestry" sector) sinks totaled 1018 Gg in CO_2, or 0.5% of aggregate emissions (Figure 2.3).

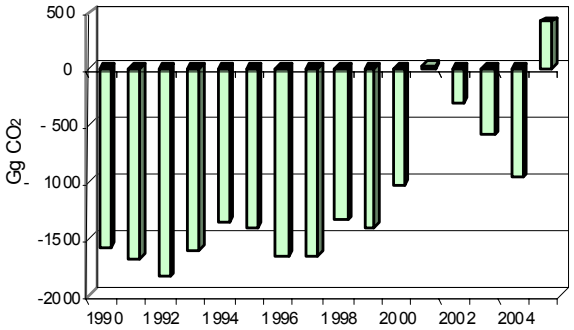


Figure 2.3 *Greenhouse gas removals*

Emissions by category and gases are provided in detail in Appendix A (1990, 1994, 2000 and 2005 years).

Emissions in CO_2-eq. per capita (Figure 2.4) accounted for 8.1 tons in CO_2-eq. in 2000 which is decline by 8,8% in comparison with 1990 (8.9 tons in CO_2-eq./per capita). In 2005 – 7.6 tons in CO_2-eq. per capita, decline from the level of the year of 1990 by 14.7 %.

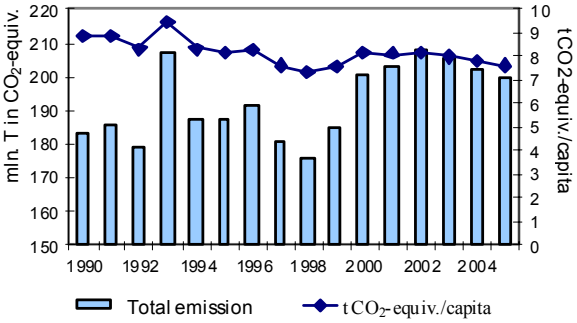


Figure 2.4 *GHG emissions per capita*

Reduction of this factor is linked to increase of gas proportion in the structure of the used fuel and increase of nonproductive spheres.

2.2. Trends of Emissions by types of Gases in 1990-2005

Changes in the volumes of total emissions, separate gases and gas structures are linked to overall economic situation in the country. In 2000 CO_2 emission accounted for 108.6 million tons, excluding sector of «Land-Use Change and forestry», international bunker and emissions from biomass combustion. Observed reduction of emissions and proportion of carbon dioxide is linked first of all to decrease of production volumes in 90s and, in the last five yeas – to change of the Republic's economy structure, i.e. increase of the share of nonproductive sectors (Table 2.2). Increase of the volume of total emissions during the last five years is linked to growth of methane emissions in gas sector due to growth of volumes of gas recovery and transportation. Increase of methane emissions in agricultural sector stems from increase of livestock. In the "Waste" sector emissions also increase with the growth of population. In 2000 году methane emissions accounted for 81.7 million tons in CO2-eq.

Nitrous oxide emission declined due to reduced use of nitrogen fertilizers. In 2000 N_2O emissions

accounted for 10.8 million tons in CO_2-eq. (Figure 2.5).

Table 2.2 The shares of gases (%) in aggregate emissions in 1990, 1994, 2000 and 2005 years

Gas	1990	1994	2000	2005
CO_2	62	54	54	50
CH_4	31	39	41	45
N_2O	7	7	5	5

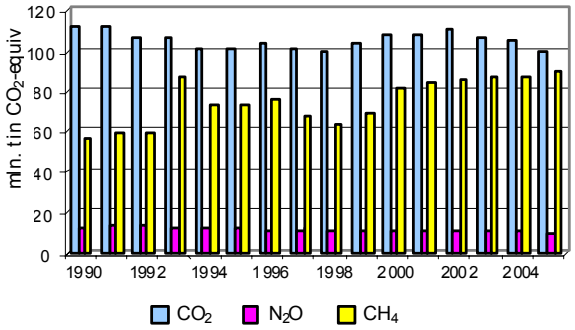


Figure 2.5 *Trends of the main GHG emissions*

2.3. Trends of Emissions by Sectors in 1990-2005

Energy sector is a dominant sector in aggregate volume of GHG emissions. In 2000 emissions from energy sector was estimated at 175.5 million tons in CO_2-eq., which accounts for 87% of total emissions (increase by 3% in comparison with the year of 1990) (Figure 2.6, 2.7). Emissions from agriculture sector are valued at 16.1 million tons in CO_2-eq. Its share declined insignificantly. The share of industrial processes decreased significantly from 4 to 2% due to decline of production volumes. Emissions from the present sector accounted for 5.0 million tons in CO_2-eq. in the year of 2000. Emissions in the "Waste" sector accounted for 4.5 million tons in CO_2-eq. in 2000. The share of this sector remained unchanged since 1990.

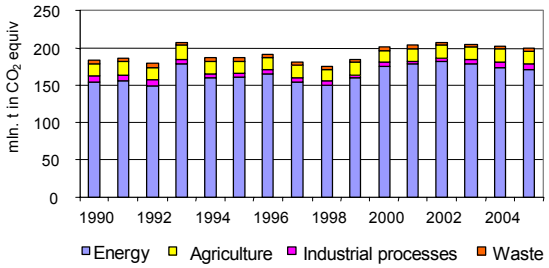


Figure 2.6 *Trends of GHG emissions by sectors*

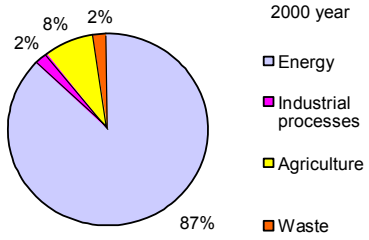


Figure 2.7 *Composition of emissions by sectors*

2.4. Emissions of Gases with Indirect Greenhouse Effect and Sulfur Dioxide

CO is the most significant gases of this group, emissions of which accounted for more than 1 million tons in 2000, while emissions of the other gases ranged between 250-300 thousand tons (Figure 2.8). Decline of emissions is observed for all gases (Figure 2.9). To a greater extent this is linked to increase of the share of natural gas as the fuel in all the economy spheres of the country.

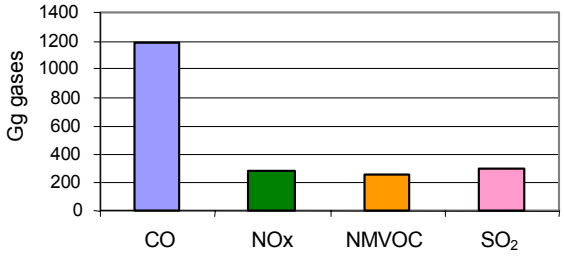


Figure 2.8 *GHG Emissions with Indirect Effects in 2000*

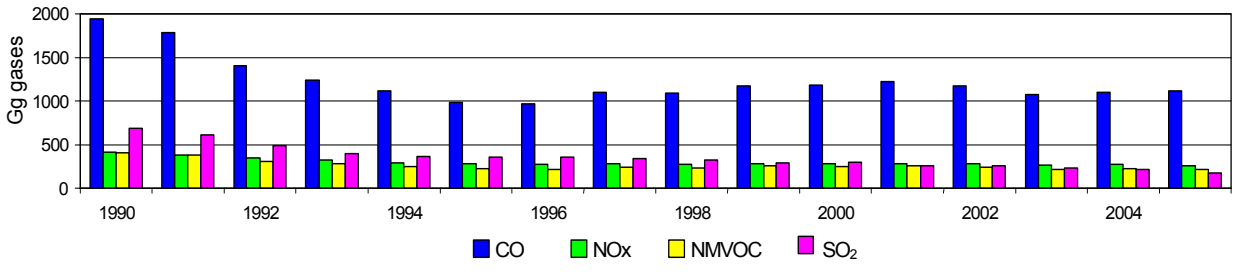


Figure 2.9 *Trends of gas emissions with indirect greenhouse effect*

2.5. Review of Greenhouse Gases Emissions by Sectors

2.5.1. Energy

Reduction of greenhouse gas emissions related to fuel combustion as well as increase of methane leakage takes place in energy sector (Table 2.3). In 2000 the share of gases from fuel combustion accounts for 60%, while share of methane leakage – 40%. Between 1990 and 2005 the share of emissions from combustion declined from 70% to 55%, and the share of methane leakages increased respectively. This is related to increase of volumes of natural gas recovery, transportation and conversion.

Table 2.3 Greenhouse gas emissions in "Energy" sector, Gg in CO_2-eq.

Category	1990	1994	2000	2005
Fuel combustion, sectoral approach, CO_2	107009	96894	105016	95648
Fuel combustion, base approach, CO_2	110495	97909	106060	96076
Fuel combustion, CH_4	385	196	146	137
Fuel combustion, N_2O	177	109	110	91
Leakages, CH_4	46141	62090	70245	76463

Fuel combustion in the greenhouse gas emission leads to reduction of emission volumes and share from production sectors as well as rise of emission volumes and increase of the share of household and commercial sectors (Table 2.4, Figure 2.10). This is attributed to the overall decline of the production volumes and structural changes in economy – increase of the share of nonproductive sectors and implementation of the state program on population gasification. The share of methane emissions in leakages, related to gas, accounts for 99%.

CO_2 emissions from fuel combustion were calculated using both approaches, sectoral (105.0 million t) ad base (106.1 million t) for the year of 2000. The difference amounts to 1%.

The main sources for estimation of the level of emissions in the "Energy" sector in 2000 were: leakages from oil and gas systems – 35% of aggregate emissions; gas combustion in household sector – 16%; gas combustion at production of energy and heating – 16%; gas combustion in commercial sector – 3.5%, and some other categories input of which into the overall emissions ranges between 0.7 and 2.9% and totals at 15%.

Table 2.4 GHG emissions from fuel combustion, Gg in CO_2-eq.

Sub-sector	1990	1994	2000	2005
Energy industries	55205	45020	44359	36750
Manufacturing industries and construction	10199	6075	4996	5341
Transport	16574	8765	11179	9632
Commercial sector	6871	10416	9053	10720
Residential sector	12504	22713	32777	31067
Agriculture	5715	3874	2704	2032
Other	503	337	206	334

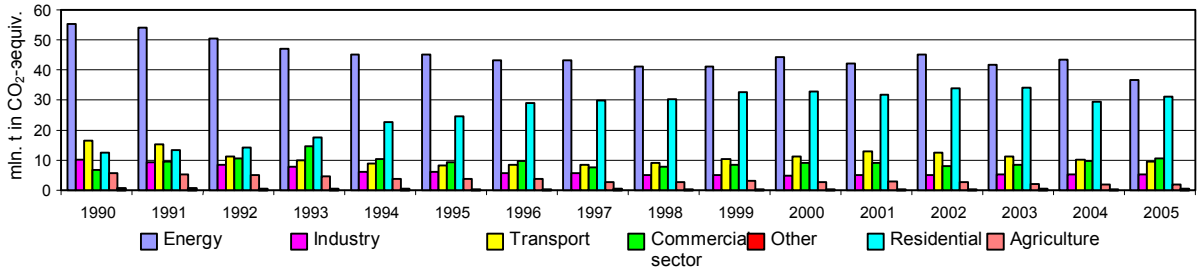


Figure 2.10 *Trends of emissions from fuel combustion by sectors*

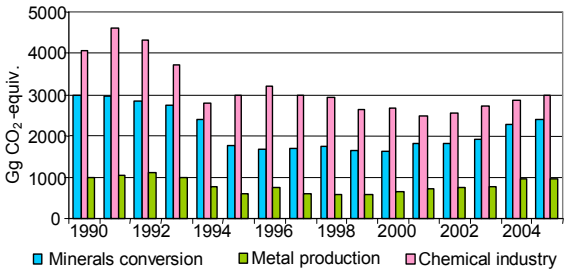
2.5.2. Industrial Processes

Aggregate greenhouse gas emissions under "Industrial processes" sector as well as emissions under separate categories declined due to reduction of the production volumes in the 1990-ties.

Certain rise of emissions in all the categories outlined since 2000 due to improvement of the economical situation in the country (Table. 2.5, Figure 2.11). CO_2 proportion in the emission under this sector accounts for more than 70%, N_2O proportion – about 30%. CH_4 and HFCs emissions are slight and account for less than 1%.

Table 2.5 GHG emissions in the «Industrial processes» sector, Gg in CO_2-eq.

Category	1990	1994	2000	2005
Conversion/processing and use of minerals, CO_2	2997	2402	1627	2396
Chemical industry, CO_2	2282	1297	1298	1403
Chemical industry, N_2O	1782	1475	1374	1581
Chemical industry, CH_4	-	-	0	3
Metals production, CO_2	998	774	665	972
Consumption of fluorine-containing gases	-	-	6	12



Puc. 2.11 *Trends of GHG emissions in the «Industrial processes» sector*

The main source of emissions in the sector in year 2000 is cement production (0.7% of total emission). For estimation of the emission trends, emissions induced by ammonia production (0.7% of total emissions) are added to them.

2.5.3. Agriculture

Increase of CH_4 emission and decline of N_2O emission is observed in the "Agriculture" sector. Growth of methane emissions is linked to increase of livestock and sheep (Table 2.6, Figure 2.12). Decline of N_2O emissions occurs due to decreased utilization of the mineral fertilizers. The share of CH_4 emissions in the present sector accounted for 45.5% in 2000, N_2O emissions – 54.5% respectively. The share of methane was increasing between 1990 and 2005, while the N_2O share was decreasing.

Only two categories, emissions from agricultural soils (4.2% of total emission) and enteric fermentation (3.3%), were the main sources in the sector in 2000 in assessment of the level of emissions.

Table 2.6 GHG emissions in the «Agriculture» sector, Gg in CO_2-eq.

Category	1990	1994	2000	2005
Enteric fermentation, CH_4	5833	6706	6592	7902
Manure management, CH_4	420	483	480	567
Manure management, N_2O	287	261	229	276
Rice cultivation, CH_4	262	288	188	100
Burning of agricultural residues, CH_4	23	44	87	133
Combustion of agricultural surplus, N_2O	9	16	32	49
N_2O emissions from agricultural soils – direct	5155	4754	4113	3324
N_2O emissions from agricultural soils – indirect	3531	3307	2909	2290
N_2O emissions from agricultural soils – pasture	1535	1642	1517	1801

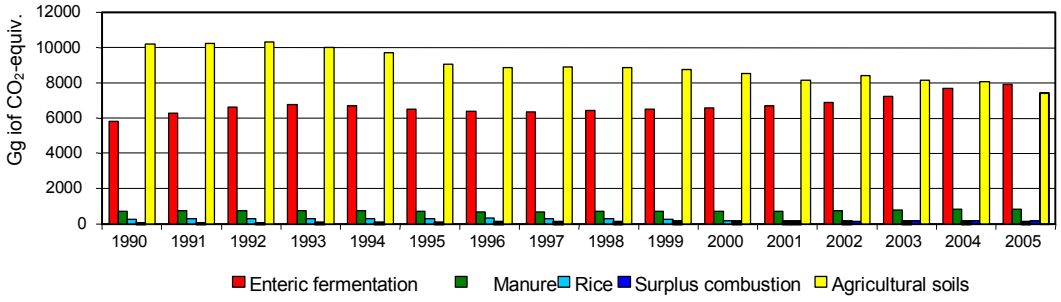


Figure 2.12 *Trends of emissions in «Agriculture» sector*

2.5.4. Changes in Land Tenure and Forestry

Forest-covered area of Uzbekistan does not exceed 5% of the country territory. CO_2 absorption occurs at accumulation of biomass in the forests, whereas CO_2 absorption or emission occurs as a result of change in land tenure. In the forestry, assessment of absorptions is conducted once in 5 years according to the periodicity of the State Inventory of forest resources. Equivalent values are accepted for the following four years. The indicators of the 1998 State Inventory of forest resources were utilized for assessment of absorptions in this category in 2000.

Table 2.7 Emissions and absorptions in the «Change in land tenure and forestry» sector in Gg CO_2

Category	1990	1994	2000	2005
Forestry	- 421	-399	- 751	- 562
Land-Use Change	- 1145	-953	- 267	+ 980
Net-values	- 1566	-1352	- 1018	+ 417

Both, absorptions and emissions (Table. 2.7, Figure 2.13) were estimated for the 'Change of land tenure' category for the reviewed period. Peaks of emissions from change in land tenure are linked to sharp decline of cultivated swamp land under rice crops.

CO_2 absorption accounts for not more than 1.5% of the overall CO_2 amount and not more than 1% of the total amount of emissions. Key categories in the present sector were not evaluated.

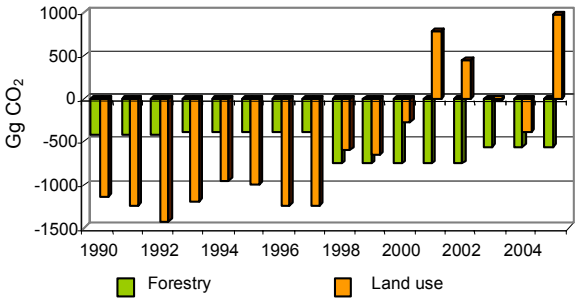


Figure 2.13 *Trends of emissions/removals in the «Land-Use Change and forestry» sector*

2.5.5. Waste

Stable growth of emissions from solid waste landfills as well as wastewater is observed in the "Wastes" sector due to increase of the country population (Figure 2.14). Emissions from the industrial wastewater started declining in the 1990s due to reduction of production volume. Gradual growth of emissions has started since 2001 (Table 2.8). The structure of the greenhouse gases through years varies insignificantly (Figure 2.15).

Dumps of the solid household wastes (1.8% of total emission) represent the only key source for assessment of emission levels in the sector.

Table 2.8 GHG emissions in the «Waste» sector, Gg in Gg CO_2-eq.

Category	1990	1994	2000	2005
Solid waste disposal sites, CH_4	3343	3492	3705	3814
Industrial wastewater, CH_4	60	44	33	40
Domestic wastewater, CH_4	233	243	265	275
Domestic wastewater, N_2O	438	477	528	560

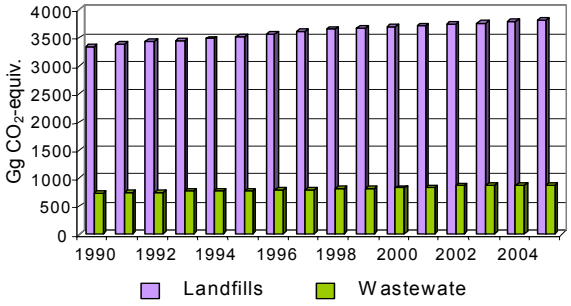


Figure 2.14 *Trends of GHG emissions in the «Waste» sector*

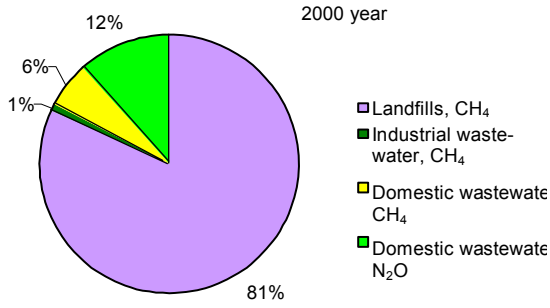


Figure 2.15 *Composition of GHG emissions in the «Waste» sector*

2.6. Uncertainty in Emission Assessments

In the current inventory there was an attempt to estimate a common uncertainty for every category wherever it was possible to use national uncertainty figures and values on default specified in the 2003 IPCC Good Practice Guidelines. Uncertainty is estimated only for CO_2 emissions from fuel combustion and CO_2 and N_2O emissions in "Industrial Processes" Sector.

Sum of emissions, for which the uncertainty was assessed, accounts for 109 million tons in CO_2-eq., i.e. 54.2% of aggregate emissions in 2000. Uncertainty in emission units accounts for 11.8 million tons in CO_2-eq. (or 10.9% of the estimated amount of emissions). The dispersion of estimated emissions values is as follows: minimum – 97.2 in CO_2-eq. and maximum – 120.9 CO_2-eq..

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3 Policy and Measures for GHG Emissions Reduction

3.1. National Mitigation Strategy

Uzbekistan, to the extent possible, is carrying out the practical activity to mitigate of Climate Change consequences and achieve the goals of the Convention and The Kyoto Protocol.

The Law of the Republic of Uzbekistan "On atmospheric air protection" (1996) is the legislative base for implementation of measures of mitigation of Climate Change aftermath; the law orders enterprises, institutions and organizations to conduct activities focused on GHG emissions reduction, introduction of the energy efficient technologies, saving of energy resources and application of environmentally safe power sources (Article 24).

These activities are carried out in the framework of fulfilling a wider social objective – preservation of environment, achieving sustainable economic and human development via elaboration and implementation of national sector and region based programs and individual projects of socioeconomic development.

When carrying out mitigation activity the ministries, agencies, and enterprises of the Republic are governed by the environmental policy principles specified in the National strategy on sustainable development, namely:

- Support of ecosystem integrity through efficient natural resource management;
- Mitigation of the growing economy impact on the natural environment;
- Environment protection as an essential component of development process;
- Social and economic coordination for the life quality improvement;
- International cooperation with consideration of the global ecological interdependency.

These principles are the foundation for development and implementation of the measures focused on:

- Reduction of emissions of substances contaminating atmosphere, including the greenhouse gas;
- Improvement of assessment methods of contaminants emissions to the atmosphere, including GHG;
- Improvement of the system of environment quality standards with consideration of the international requirements and obligations of the Republic of Uzbekistan by international conventions and treaties.

The strategic directions of Climate Change mitigation are determined by key provisions of the National Strategy on GHG Emissions Reduction approved by the decree of the Cabinet of Ministers of the Republic of Uzbekistan of 09.10.2000 № 389.

The National strategy provides for the use of such measures as implementation of relevant ***tariff policy in energy sector, furnish measuring devices for fuel and energy consumers, adoption of national standards*** on GHG emission, ***promotion of energy saving policy*** among the population, ***regular inventories*** of GHG emission and sink, ***allocation of quotas on CO_2 and methane emissions*** among the national economy branches, ***establishment of the market infrastructure*** allowing for transfer of reduced emission volumes on the basis of particular projects implementation to ensure most efficient GHG emission reduction.

The Strategy defines the aims for development and implementation of the complex of *technical measures* focused on reduction of GHG emission by 2010 to 16.4 – 33.5 million tons in the energy sector.

Uzhydromet and Ministry of Economy of the Republic of Uzbekistan provide implementation and monitoring of the National strategy of GHG emission reduction.

Public administration and economic management bodies, local authorities are to follow the strategic directives approved by the Government of the Republic of Uzbekistan and, to the extent of their capacity, develop and implement certain activities and projects on Climate Change mitigation.

3.2. Capacity for GHG Emissions Reduction

The estimate of GHG emission carried out in 2005 in Uzbekistan showed that emission was 199.8 million ton of GHG in CO_2 equivalent, with more than half of emissions attributed to carbon dioxide. Unlike many other countries of the world, Uzbekistan has significant share of methane emissions – 44.7%, чwhich is associated with a developed gas industry. The share of the nitrous oxide emission is 5%, and HFC is less than 0.01% (Figure 3.1).

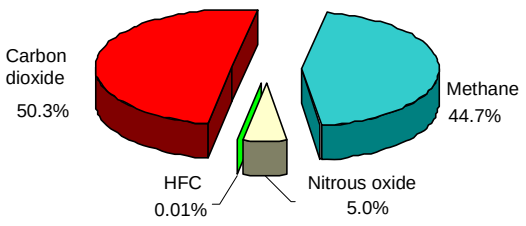

Figure 3.1 *Structure of the greenhouse gas types (2005)*

Energy sector generating 86.2% of the total emission volume and agriculture (8.2%) are the main GHG emission sources. The share of other economic sectors is small: being only 3.2% for the industrial processes, and 2.4% for waste (Figure 3.2).

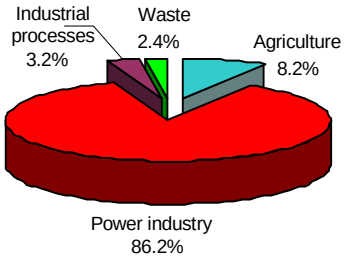

Figure 3.2 *GHG sources structure (2005)*

Stationary and movable equipment and processes based on fuel combustion are the primary sources of the carbon dioxide emissions. They account 55.7% of the total GHG emission volume in the energy sector.

Processes associated with extraction, processing, transportation and distribution of natural gas and oil are the main sources of methane leakage and account for 44.3% of GHG emissions in the energy sector (Figure. 3.3).

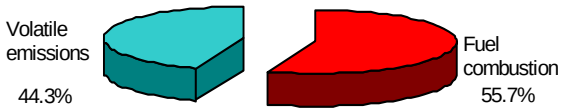

Figure 3.3 *GHG emission structure in the energy sector (2005)*

Significant share of the energy sources in the total GHG emission allows for a considerable potential for GHG emission reduction in the sector. It is true, in particular, for oil and gas industry, fuel and energy conversion sector, and municipal (domestic) service spheres where the share in total GHG emission amounts to more than 80%.

Studies in the framework of the project "Technical assistance to the Republic of Uzbekistan in the energy need assessment" conducted by the Asian Development Bank (ADB) in 2004 demonstrated that the total energy saving potential was estimated at 23 million t.e.f. a year, and its full-scale realization would provide for GHG emission reduction by more than 40 million ton in CO_2-equivalent annually. For instance, introduction of combined heat and electric power production alone can save approximately 3 million t.e.f. a year, and upgrade of power plants may provide annual saving of 2 410 million m^3 of natural gas (2 million t.e.f.).

This data prove the estimates made during the development of First National Communication of the Republic of Uzbekistan under the UNFCCC and agree with the recent estimates of the Ministry of Economy of Uzbekistan – around 18-20 million t.o.e. per year which corresponds to 35-40% or current energy consumption in the country.

Availability of such significant energy saving potential confirms that introduction of energy saving technologies in economic sectors is most desirable in terms of national sufficiency in energy resources, and will ultimately promote Climate Change mitigation.

Analysis of the energy sector status conducted by foreign and national experts demonstrated possibility of implementation of various energy saving measures in certain branches of the sector.

In ***electric Energy Sector,*** the most significant technological measures are as follows: construction of new energy efficient plants along with reconstruction of already existing ones, this includes steam-to-gas and gas-turbine power plants, reconstruction of heat and power plants, utilization of waste heat and low-grade energy resources on the plants; introduction of ACS. Reduction of energy losses during generation, transportation and distribution is one of the key problems in the Energy Sector.

In ***gas industry,*** a significant potential for energy saving is in increase of efficiency of gas compressor units (GCU) amounting about 23%, while overseas it is 33-36%. Upgrading of gas distribution network, use of modern units and utilization of excessive pressure during transportation and distribution will enable reducing the fuel consumption to 80-100 t.e.f. per kW/h.

In ***oil industry,*** significant saving reserves lay in oil-well gas and oil transportation and storage losses, reduction of fuel consumption for heating of oil and water-oil emulsion, and improvement of the jack pumps efficiency.

Power intensity of the ***oil-refinery*** can be reduced via upgrading and introduction of new processing plants, application of efficient catalysts, use of disposal plants, oil refinery solid waste gasification, and losses elimination. Procurement of the heat recovery hardware will enable to increase efficiency by 10-15%.

In ***coal-mining industry*** the largest energy saving activities are as follows: hardware upgrading, industry re-equipment, coal mining byproducts and waste utilization, reduction of fuel and energy losses at coal and waste-rock transportation, coal gasification on the mining site and arrangement of the appropriate operation of the coal-mining equipment.

In ***housing and communal*** *sector* the primary energy saving activities are as follows:

- Provision of all consumers, including population, with fuel and energy measuring devices; improvement of the centralized heating supply system;

- Upgrade and replacement of inefficient boiler houses;
- Transfer of the heat supply systems to the closed principle;
- Thermo isolation of heating pipe-networks and buildings;
- Replacement of worn out pipes in the heat supply system;
- Provision of consumers with the systems of solar energy based hot water supply;
- Gasification of the urban coal boiler houses;
- Introduction of technologies of source water treatment for water boilers with the capacity of up to 10 Gcal/h;
- Introduction of the frequency vary-drive on all housing and communal services energy sites.

In ***chemical industry*** the following is required: upgrading of processes, especially energy consuming ones, introduction of the combined-cycle plants on CHPs and boiler-houses of the industry, carrying out the structural reforms in development the output of organic chemistry, plastic mass, synthetic resin, chemical man-made fiber, application of which reduces demand in the energy consuming metal production, utilization of domestic power sources (hot gas and heat energy, assisting the chemical production).

In ***ferrous and non-ferrous metallurgy*** energy saving can be achieved by improvement of the production technology, furnace upgrading, improvement of the quality and assortment of the roll stock, utilization the heat of spent gasов of engineering processes, electric power generation via utilization of the pressure drops, application of the advanced heat insulators in furnaces.

Significant energy reserves lie in upgrading of the open-flame thermal and heating furnaces ***in the mechanical engineering and the other industrial branches,*** in installations upgrading, procurement of the recuperators, advanced automated burning facilities, automated control systems for the combustion processes and thermal processing.

Significant energy saving can be achieved when ***improvement of the efficiency of electric drive*** through application of electric motors with electric vary-drive and change the structure of ***illuminating lamps*** provided for increase of gas-discharge tubes share in the lighting load.

In ***construction materials industry*** it is possible to increase the goods output on the basis waste from the coal-cleaning, CHP ashes and slag waste. It is necessary to apply the cutting-edge fuel warm-up and combustion technologies, utilize the secondary heat energy resources and waste gas.

In ***agriculture*** the energy saving is associated with upgrading of the depreciated pumping units, electric technical hardware in irrigation systems and vertical drainage systems, improvement of the vehicular pool structure via increase of their application efficiency, expansion of the lightweight machines and individual utilization mechanisms application.

In ***transportation sector*** the energy saving potential lays in improvement of transportation and motor pool structure arrangement, significant increase of the share of vehicles with diesel drive, multiple growth of gas utilization as an engine fuel, construction of roads with the hard deposition, improvement of the pool structure and vehicles in the railway and aircraft transportation.

Activities on involvement of ***renewable energy sources*** in the energy balance of Uzbekistan may provide a certain contribution in GHG emission reduction.

3.3. National and Sectoral Mitigation Programmes

The targets of the National strategy on GHG emission reduction are achieved through development and gradual implementation of number of national, sector and region based development programs and particular investment projects.

The programs on arrangement of instrumental recording of energy and resource consumption were developed, implemented or are at their implementation phase in the Republic as one of the key directions of mitigation defined by the National strategy:

- "Program on providing of gasified apartments (buildings) with gas metering devices"; according to this program, natural gas counters were installed in approximately 3.9 million apartments;
- "Program on providing of residential houses with the heat power metering devices at the entrance points designed for 2005-2006", implementation of this program enabled heat energy metering at the entrances of over 26 thousand of residential houses connected to the district heating system;
- "Program of installation hot water metering devices in the multi-apartment housing of the Republic of Uzbekistan for 2007-2008", according to this program hot water meters will be installed in 627 thousand apartments.

Completion of these programs will enable providing metering of energy and resource consumption at all stages of energy flow from its generation to consumption, and create conditions for limitation of GHG emissions in economic sectors.

Oil and gas industry of Uzbekistan is the largest GHG source – with 1/3 share of total emissions in the Republic, and the number of programs on the

greenhouse gas emission reduction have been implemented or are ongoing in the very this industry.

The "Program of providing the rural settlements with the natural gas" completed in 2005 is one of the largest national programs largely contributing in Climate Change mitigation; its implementation enabled the population of over 10600 rural settlements receiving the network natural gas, and the citizens of almost 1200 remote difficult of access rural settlements receiving condensed gas or the other modern type of fuel. It made it possible to significantly reduce deforestation and coal firing by the rural population.

The energy saving Program anticipating energy resource saving for 2007-2012 has been developed and is under implementation in the industry; it anticipates the following saving:

- Natural gas – 3 620.9 million m^3;
- Condensate – 279.6 thousand tons;
- Condensed gas – 1 637 thousand tons;
- Heat energy – 2 175.8 thousand Gcal;
- Electric power – 147 million kW/h.

In general, the energy saving Program in the oil and gas sector will enable reducing the energy resource consumption to 7 677 thousand t.s.f. for the period 2007-2012, facilitating GHG emission reduction of 13 435 thousand ton in CO_2-equivalent.

Moreover, the program anticipates for this period utilization of the natural gas in amount of 18.6 billion m^3 via ongoing project "Utilization of the oil-well gases produced in Kokdumalak field".

Over 84 billion US dollars from Uzbekneftegaz companies own funds are allocated for the energy saving program implementation along with involvement of over 358 million US dollars of direct foreign investments and loans.

In the electric power engineering the heat power plants are the largest GHG emission sources; they have huge energy saving potential being realized according to the 'Program of development and reconstruction of generating capacities in the Republic of Uzbekistan' and the 'Program of energy saving for 2010'. Improvement of the efficiency of fuel and energy resource utilization in the industry and significant reduction of anthropogenic load of energy production on environment are the priority strategic objectives of these programs.

The number of large energy saving projects with total cost of 724.2 million US dollars have been scheduled in these programs framework; the projects implementation will enable reducing the volumes of organic fuel combustion on the power plants almost by 890 thousand t.o.e. a year (Table 3.1).

A significant reduction of specific consumption of the equivalent fuel for electric power supply by heat power plants of Uzbekenergo SJSC forecasted from 387.7 g/kW/h in 2004 to 344.33 g/kW/h in prospective till 2020. This will enable reducing fuel consumption in natural gas conversion to more than 2.5 billion m^3 a year.

Table 3.1 Energy saving projects of Uzbekenergo SJSC

Power plant	Project	Saving thousand t.o.e year	Investments $ million
Tashkent TES	Construction of CCP 370 MW	260.6	221.0
Mubarek HPP	Construction of CCP 106 MW	90.0	103.2
Tashkent HPP	Construction of GHP 75 MW	54.0	86.1
Navoi HPP	Construction of CCP 346 MW	240.0	232.0
Talimardjan TES	Construction of the power generating unit 800 MW	170.0	36.5
Syrdarya TES	Rehabilitation of 2 units 300 MW	75.0	45.4
	TOTAL:	**889.6**	**724.2**

Uzbekenergo SJSC Program on furnishing of high efficiency devices and systems for electric power metering to energy sector enterprises, multi-apartment and individual residential buildings to be completed in 2008 also facilitates improvement of energy efficiency and GHG emission reduction.

In general, implementation of energy saving measures in energy sector will enable increase of electric power generating output to 20% to 2010 with retention of the fuel consumption on existing level, and saving the energy resource consumption in 813.8 thousand t.s.f., which will reduce GHG emissions on 1 424.2 thousand ton in CO_2-equivalent.

In industry of Uzbekistan enterprises of all energy consuming branches have also developed and are implementing the energy saving programs for the

period to 2011, focused on upgrading, rehabilitation and technical re-equipping facilitating GHG emission reduction. In particular:

- According to the Program of upgrading and rehabilitation of enterprises of the *cotton ginnery industry* for 2007-2011 the modern hardware will be introduced and efficiency of production capacity will be increased in 41 enterprises of the industry;
- The Program of upgrading the *construction branch*, technical and technological re-equipment of enterprises of Uzstroymaterialy JSC by 2011 identified the target parameters on improvement of the efficiency of the energy resource consumption; according to them, reduction of specific consumption of the energy resources will amount 83.5% against 2006 indicators decreasing the energy resource consumption in 201.8 thousand t.s.f. without consideration of increase of the production output and introduction of new capacities;
- The Program of upgrading and technical re-equipment of the *fat-and-oil industry* enterprises for period by 2011 has also identified that the energy resource consumption in the industry for 1 million sum of commercial output by 2011 has not to exceed 0.57 t.s.f. against 0.77 t.s.f. in 2006, i.e. to be reduced to 26%, facilitating the energy saving of 58.5 thousand t.s.f. and reduction of GHG emissions in 102. 4 thousand ton in CO_2-equivalent by 2011;
- The Program of upgrading, technical and technological re-equipment of *metallurgical industry* for the period by 2011, according to this program in Uzmetkombinat JSPC in 2011 specific consumption of the electric power per production of one unit of commercial output will be decreased to 18.7%, and the natural gas consumption – to over 30%, compared to 2006. Uzmetkombinat JSPC is planning the saving of around 23.5 million m^3 of natural gas and over 39.6 million kW/h of electric power for the period 2007-2012, i.e., 61.1 thousand t.s.f., and, correspondingly, to considerable reduce GHG emissions – to 106.9 thousand ton in CO_2-equivalent. The system of the energy saving activities carried out in Almalyk and Navoi mining and smelting enterprises will allow the saving of, correspondingly, 225.2 thousand t.s.f. and 109.1 thousand t.s.f. for the period 2006-2010 of the fuel and energy resources, enabling GHG emission reduction to 394.1 thousand ton in CO_2-equivalent and 190.9 thousand ton in CO_2-equivalent, correspondingly;
- The Program of upgrading, technical and technological re-equipment of the *chemical industry* enterprises for the period период 2007-2011 will significantly improve the energy efficiency of the industry in term of the key parameters: specific consumption of the natural gas per production of one unit in the industry will achieve 82.9%, electric power – 86.3% by 2011 against the 2006 level. For the period 2006-2010 482.2 million. m^3 of natural gas are planned to be saved along with 343.3 thousand kW/h of electric and 53.1 thousand Gcal of the heat energy or 710.4 t.s.f., which will facilitate reduction of GHG emissions to 1 243.2 thousand ton in CO_2-equivalent. Moreover, in order to reduce GHG emissions in Uzbekistan, in 2006 Uzkimyosanoat SJSC and Mitsubishi Corporation Company (Japan) concluded the Agreement on the joint development of the project on reduction the nitrous oxide (N_2O) emissions. This project anticipates the activities on the units rehabilitation and the hardware replacement with the advanced processes in 4 chemical enterprises, which will allow reducing the nitrous oxide emissions to 80% of existing level.

Housing and communal sector is one of the key GHG sources in the Republic. The sectoral integrated program on introduction of the energy saving technologies has been developed and is ongoing for emission reduction, improvement of the energy efficiency in the communal sector; according to this program the following activities are under implementation:

- "Program of the stepwise replacement the outdated and inefficient boiler units in off-budget organizations and enterprises for the period 2005-2007" which anticipates replacement of 3 370 boilers in 1 095 boiler-houses in the various regions of the Republic;
- "Program of replacement the outdated and inefficient boiler units with the advanced resource saving boiler units in the budget organizations and enterprises for the period 2007-2008", enabling increase of energy efficiency of 2399 boiler units in the boiler-houses providing the heat supply to the multi-storied buildings (over 2 stores) with induced circulation of the heat carrier;
- "Program of replacement the outdated and inefficient boiler units with domestic boiler with the natural circulation in the budget organizations and enterprises for the period 2007-2008"; according to this program, 7 713 boiler units will be replaced in the boiler-houses providing the heat supply to one-storey, two-storied, separately located buildings where the heating system may operate without induced circulation of the heat carrier;
- "Program of rehabilitation of depreciated heat networks at the own funds expense of the hat supply enterprises in the breakdown of regions of the Republic for the period 2006-2009"; according to this program 514.7 km of the heat networks will be replaced in the Republic.

These programs implementation will allow reducing the specific energy resource consumption for the heat

power generation by 25-30% and decrease the heat losses in the heat networks amounting up to 28% to the standard rates.

In the public services the number of certain priority investment projects with the total cost of 61.1 million US dollars has been scheduled by 2010, which will facilitate improvement of the energy efficiency of this branch (Table 3.2).

Table 3.2 Priority projects in the public service field

№	Project title	Implementation period (years)	Investments $ million
1.	Rehabilitation of the heat supply systems in Tashkent city	2005-2007	40.0
2.	Rehabilitation of the heat supply systems in Chirchik town via transfer to the closed heat supply system	2006-2008	6.0
3.	Localization of the "Centre" and Dustlik-1" boiler-houses in Namangan town	2006-2009	4.6
4.	Rehabilitation of the heat supply systems in Fergana town	2007-2010	11.0

In transportation sector the measures on improvement of the efficiency of the energy resource utilization provide high contribution in Climate Change mitigation. In particular, ongoing "Measures on development the network of automatic gas-filling compressor and gas-filling stations as well as the stepwise motor vehicles transfer to condensed and compressed natural gas". According to these measures and documents approved by the Government, 4.7% of vehicles of the legal and 11% of vehicles of physical entities of the total vehicles in the Republic operating with the spark-ignition engines are supposed to be transferred to compressed natural gas and condensed gas during the period of 2007 2012. These plans implementation will enable bringing the annual consumption of condensed gas by the vehicles to 638 thousand ton by 2012, and compressed natural gas – to 919.4 million m^3, causing reduction of GHG emissions at least to 350 thousand ton in CO_2-equivalent against the existing level.

Efficiency of the energy resource consumption by vehicles is also directly associated with the efficiency of traffic routes and road condition. Ongoing "Program of construction and rehabilitation of the general use motor roads of international importance for the period 2007-2010" and "Program of rehabilitation of the general use motor roads of the national importance for the period 2007-2010", in the framework of which 679 km of roads will be constructed or rehabilitated are supposed to contribute in GHG emission reduction.

The measures on renewal of the vehicular pool, improvement of the quality of the motor fuel, application of alternative fuels as well as the activities to control toxicity and opacity of exhaust gas are contributing to Climate Change mitigation in transport sector.

3.4. Energy Sector Pricing Policy

Implementation of the relevant ***tariff policy in the energy sector*** was identified by the National strategy of GHG emission reduction as an important impact drive focused on motivation of enterprises and organization in mitigation projects implementation**.**

The state pricing policy in the Energy Sector is carried out based on the actual socioeconomic conditions of Uzbekistan and oriented towards a gradual introduction of market pricing principles as well as strategic and socially significant kinds of energy resources.

Currently, in the result of this policy implementation of the following procedure of the energy resource sale has been established and is operating in Uzbekistan:

- Natural gas, electric and heat power are sold at the state controlled prices;
- Motor petroleum, diesel fuel, residual fuel oil, aviation kerosene and coal are sold at controlled and exchange prices;
- The rest of the energy resources – at transaction prices.

Change of the structure of controlled tariffs, gradual reduction of the cross-sectional subsidizing of certain consumer categories and bringing domestic controlled prices and tariffs for fuel and energy to the mean global prices for these resources are the important aspects of the state pricing policy in Energy Sector, facilitating improvement of efficiency of energy consumption by industry and by population.

Table 3.3 provides the dynamics of the state-controlled prices for the electric and heat power for various consumer categories, demonstrating that for the period of 2000-2007 the tariffs dramatically grew and their structure changed.

This structure and dynamics of the tariffs for energy is determined with many factors, including the price growth on the primary energy resources – oil, natural gas, coal and their processing products.

Table 3.3 Dynamics of prices for the electric and heat power for the various consumer categories

Category #	Tariff sections and consumer groups	Units	August 2000	October 2004	November 2007
	Electric power				
I	Industrial and equal consumers with capacity 750 kvA and over:				
	• Payment per 1 kW of the peak load	Sum a year	9800	47200	72800
	• Payment per 1 kW of consumed energy	Sum per 1 kW/h	4.4	22.15	34.55
II	Industrial and equal consumers with capacity up to 750 kvA	Sum per 1 kW/h	7.5	27.2	43.70
III	Production agricultural consumers, including pumping station, funded from the budget	-"-	4.8	26.1	43.70
IV	Electrified railway and public transport (electric motive power)	-"-	7.0	27.2	43.70
V	Non-industrial consumers, budget organizations, urban street lighting	-"-	5.8	27.2	43.70
VI	Commercial organizations, cafes, restaurants and services	-"-	20.0	34.0	44.90
VII	Population, settlement	-"-	4.7	25.0	43.70
	Population of residential buildings provided with electric ovens	-"-	2.35	12.5	21.85
VIII	Electric power used for the heating, hot water supply and cooling (air conditioning)		20.0	34.0	43.70
IX	Advertisement and illumination	-"-	70.0	110.0	110.00
X	Economic needs of the power system	-"-	4.4	25.0	43.70
	Heat power				
I	All consumers except for the bulk ones (resellers, greenhouse farms) hot water and steam of all parameters	Sum per 1 Gcal	2 240	11 450	17 300
II	Bulk consumers-resellers and greenhouse farms, hot water and steam of all parameters	-"-	1 865	9 750	14 800
III	Economic needs of the power system	-"-	1 625	8 500	13 020

Price dynamics for fuel resources used in electric power generation provided in the Table 3.4, shows their cost growth as well.

The parallel measures are taken on reduction the population funding – prices on the natural gas for population grew more than in 2.2 during the recent 3 years; in January 2005 the price of 1 000 m^3 of gas was equal to 9 214 sum, and in November 2007 – 20 540 sum.

Dramatically increased the state-uncontrolled prices on the energy resources. At early November 2007 exchange base prices were as follows: residual fuel – 102.0 thousand sum/t; diesel fuel – 671.7 thousand sum/t and petroleum AI-92 – 918.6 thousand sum/t, exceeding 2000 level.

Table 3.4 Dynamics of prices on the fuel resources for the Energy Sector

Date	Natural gas (sum/th. m^3)	Residual fuel (sum/t)	Coal (sum/t)
2003, November	20 900	36 076	18 504
2005, April	39 150	55 900	19 190
2007, November	51000	96000	25576

3.5. Legislative Initiatives in Support of Mitigation

Activity on legislative ensuring of the measures for on improvement of the energy efficiency of economy, involvement of renewable energy sources in the power balance of the country and reforming the energy-related industries promote increase of Uzbekistan contribution in Climate Change mitigation.

When analyzing the process of enforcement of the Law "On rational utilization of energy" in specialized committee of the Legislative Chamber of Oliy Majlis, parliamentarians acknowledged the following ways of economic motivation of energy saving and technological upgrading: introduction of the cutting-edge energy saving technologies and hardware, improvement of the system of energy consumption

metering, introduction of renewable energy sources, including unconventional ones.

For the market reform deepening and further economy liberalization development and adoption of number of laws is planned, to be focused on:

- Development of market mechanisms of the power industries control;
- Establishment of market environment in energy sector;
- Establishment of efficient mechanisms of the cost reduction if the power industries;
- Encouragement the energy saving in all economic fields;
- Stepwise elimination of the cross-section funding of the various energy consumer groups;
- Increase of liability for the damage to environment in the result of the fuel and energy resource development.

The draft law was developed "On the Energy Sector"; the following draft laws are planned to be developed: "On state control over the tariffs on electric and heat power", "On the basis of the tariff control in the communal system", "On the power engineering", "On technical control over the energy systems", as well as the draft laws regulating relations in the field of the oil and gas recovery, transportation and refinery. The amendments are planned to be made in existing Law of the Republic of Uzbekistan "On the rational energy utilization". The draft law was developed "On unconventional and renewable energy sources" for establishment of favourable normative base and acceleration development of renewable Energy Sector.

3.6. Use of Clean Development Mechanism under The Kyoto Protocol

The market infrastructure on transfer of the reduced GHG emissions anticipated by the National strategy on GHG emission reduction was established in the Republic of Uzbekistan on the basis of the certain mitigation projects implementation with application of capacities of the flexible mechanisms of The Kyoto Protocol.

In late 2006, a special **Inter-agency Council** was established by the Decree of the President of the Republic of Uzbekistan for investment projects implementation in the framework of the Clean Development Mechanism (CDM) under The Kyoto Protocol to the UNFCCC in the Republic of Uzbekistan. This Council:

- Identifies priority fields of CDM application;
- Approves the rules and procedures for the CDM projects selection and approval at the national level;
- Approves the CDM projects at the national level based on results of expertise by authorized bodies;
- Approves the draft agreements on the purchase of emission reductions among CDM projects stakeholders.

Ministry for Economy of the Republic of Uzbekistan was assigned as the **National CDM body** to carry out:

- Development and selection the projects for implementation in CDM framework, formation of the relevant project database;
- Coordination of activity or authorized ministries and agencies on the project expertise for their conformity with the terms and procedures specified by the Article 12 of the Kyoto Protocol, international treaties and legislation of the Republic of Uzbekistan, as well as international and national criteria of sustainable development;
- Submission of investment projects proposed for CDM implementation to Inter-agency Council for approval;
- Submission of investment projects to Executive CDM Council under the UNFCCC Secretariat after their approval by Inter-agency Council;
- Monitoring of implementation of the investment projects in CDM framework.

The Government approved a special Statute on procedure of development and implementation of the investment CDM projects under The Kyoto Protocol. According to this Statute, the projects proposed for implementation have to meet the following ***National criteria of sustainable development***:

- economic:

- Reduction of energy and raw stock consumption per one output unit;
- Improvement of the production efficiency or natural resource utilization via introduction of cutting-edge technologies;
- Facilitation the private market sector development in the Republic of Uzbekistan.

- environmental:

- Promotion of environment conservation and degradation prevention;
- Minimization of the natural raw stock consumption and production waste;
- Introduction of technologies oriented on the raw stock recycling and/or utilization of renewable natural resources;
- Mitigation of negative impact on environment.

- social:

- Promotion of employment growth and increase of actual revenue of population;
- Health-improvement of the personnel involved in the project implementation and population living in the project implementation location;
- Raising the population awareness on the issues of the natural resource management.

By early 2008 the ministries, agencies, companies and individual enterprises developed over **60** CDM project proposals with the total volume of annual GHG emission reduction over **14.6** million ton in CO_2-equivalent, covering the key categories of GHG sources: Energy Sector, industrial processes and waste management (Table 3.5).

Table 3.5 CDM project proposals

Category of GHG sources	PIN	Annual reduction of GHG emission (th. t. CO_2-eq.)
ENERGY SECTOR - total	45	14 551
including energy efficiency	22	2 982
Renewable energy sources	12	462
Methane leakage	11	9 479
INDUSTRIAL PROCESSES	9	1 469
WASTE MANAGEMENT	9	158
TOTAL	**63**	**14 641.4**

For attraction investments for CDM projects the Government has established various privileges, in particular, customs fees and profit tax privileges, conditions are created for accelerated development and approval of the project documentation and the other encouraging measures are carried out.

The list of CDM project proposals in the breakdown of ministries, agencies and companies with the actions taken for attraction the domestic and foreign investments in amount of over **1.8** billion US dollars for their implementation, is provided in the Table 3.6.

Ten CDM projects included in submitted list in the chemical, oil and gas, electric power industries and waste sector are ready for implementation with involvement of the foreign companies and carbonic funds. Three project proposals on small Energy Sector are considered by the Asian Development Bank for their further implementation (Table 3.7). The National CDM Body in Uzbekistan has approved 55 project proposals, and the project initiators are searching for domestic and foreign investors.

Apart from creation of additional effect on emission reduction, CDM projects are significant mean for involvement of the foreign financial resources in Uzbekistan economy. CDM mechanism provides the good perspectives for the projects which can not be implemented under the current conditions due to their low cost-efficiency, high risks and the other obstacles. CDM mechanism is of specific importance in Uzbekistan for implementation of the projects on energy efficiency and utilization of renewable energy sources.

Table 3.6 List of CDM project proposals

№	Project/project idea title	Initiator	Annual emission reduction (th. t CO_2-eq.)	Investment (th. $)
1	Oil-well gas utilization in Severnyi Shurtan, Garmston and Kumchi fields[1)]	NCC Uzbekneftegaz	148.6	7 550
2	Oil-well gas utilization in Sardob and Markovskoe fields	NCC Uzbekneftegaz	27.1	980
3	Oil-well gas utilization in Umid, Kruk, Zapadnyi Kruk, Sarykum and Yangi Darbaza fields	NCC Uzbekneftegaz	71.1	17 250
4	Oil-well gas utilization in Arkniyaz, Marjon, Yangi Pamuk and Tsentralnyi Pamuk fields	NCC Uzbekneftegaz	44.1	2 150
5	Reduction of the natural gas leakage on compressor plants KS-2 and KS-3 Uztransgaz[2)]	NCC Uzbekneftegaz	58.0	1 150
6	Introduction of gas-turbine units on compressor plants KS-2 and KS-3 Uztransgaz for autonomous electric power generation	NCC Uzbekneftegaz	92.4	64 000
7	Reduction of methane leakage from the main gas pipelines via introduction of SCADA system (3 stages)	NCC Uzbekneftegaz	1 533.9	55 800
8	Improvement of the efficiency of energy consumption in electric motors using gas compressor units on KS Kagan (4 motors)	NCC Uzbekneftegaz	10.9	4 250
9	Same on KS Zirabulak (13 motors)	NCC Uzbekneftegaz	42.4	13 250
10	Same on KS Gallyaaral (14 motors)	NCC Uzbekneftegaz	47.3	14 250
11	Same on KS Yangier (6 motors)	NCC Uzbekneftegaz	22.1	6250
12	Reduction of gas leakage in gas distribution networks with low and medium pressure in Fergana Valley	NCC Uzbekneftegaz	3 490.0	66 482
13	Flare gas utilization in the oil and gas-condensate fields (program project)	NCC Uzbekneftegaz	300.0	26 000
14	Installation of the hot-wells after the heat-insulating units of desulphurization units	NCC Uzbekneftegaz	138.3	1 500
15	Introduction of gas-turbine power plant MHPP	NCC Uzbekneftegaz	207.5	8 156
16	Introduction of the frequency controlled electric drive in the boiler-houses and hot-water units (25 units)	NCC Uzbekneftegaz	9.4	217
17	Replacement of amine desulphurization with zeolitic treatment on MGPL with carrying capacity 8 billion cubic meters of gas a year	NCC Uzbekneftegaz	1 880.0	16 500

№	Project/project idea title	Initiator	Annual emission reduction (th. t CO_2-eq.)	Investment (th. $)
18	Introduction of energy efficient technologies in the system of outdoor lighting network of Tashkent city	Khokimiyat	28.5	8 367
19	Replacement of methyl diethanolamine absorbent in desulphurization units of MGPL with carrying capacity 8 billion cubic meters of gas a year	NCC Uzbekneftegaz	1 666.0	6 500
20	Construction of the booster unit on Gazli UGS	NCC Uzbekneftegaz	260.6	156 350
21	Upgrading of TashHPP (Construction of CCP with capacity 370 MW) [1]	SJSC Uzbekenergo	427.4	265 000
22	Construction of high-voltage transmission line 500 kW Syrdarya HPP – Sogdiana sub-station	SJSC Uzbekenergo	116.9	80 000
23	Construction of gas-turbine unit Con Tashkent CHP	SJSC Uzbekenergo	224.3	133 790
24	Construction of wind-solar power plan with capacity 2 MW operating in parallel with the energy system in Navoi province	SJSC Uzbekenergo	5.8	2 500
25	Construction of HVL 500 kV SS Sogdiana – Talimardjan HPP	SJSC Uzbekenergo	9.6	90 000
26	Construction of HVL 500 kV Novo-Angren HPP – SS Uzbekistanskaya	SJSC Uzbekenergo	100.5	150 000
27	Construction of gas-turbine unit on Mubarek CHP	SJSC Uzbekenergo	334.0	130 000
28	Construction of Kamolot HPS	SJSC Uzbekenergo	22.1	11 000
29	Reduction of N_2O emissions on OJSC Navoiazot (№1) [3]	SJSC Uzbekenergo	141.6	2 030
30	Reduction of N_2O emissions on OJSC Navoiazot (№2) [3]	SJSC Uzkimyosanoat	141.6	2 030
31	Reduction of N_2O emissions on OJSC Navoiazot (№3) [3]	SJSC Uzkimyosanoat	141.6	2 030
32	Reduction of N_2O emissions on OJSC Navoiazot (№4) [3]	SJSC Uzkimyosanoat	141.6	2 030
33	Reduction of N_2O emissions on OJSC Ferganaazot[3]	SJSC Uzkimyosanoat	178.1	3 195
34	Reduction of N_2O emissions on OJSC Maksam-Chirchil[3]	SJSC Uzkimyosanoat	361.8	4 510
35	Construction of cogeneration plant for combined generation of heat and electric power OJSC Navoiazot	SJSC Uzkimyosanoat	855.0	150 780
36	Completion of series of work on the energy saving on the nitric acid production plant OJSC Ferganaazot	SJSC Uzkimyosanoat	49.6	11 000
37	Rehabilitation of ammonia unit – 3 line – introduction of gas reforming outlay under the pressure on OJSC Navoiazot	SJSC Uzkimyosanoat	47.7	5 876
38	Rehabilitation of the carbamide process line on OJSC Marsam-Chirchik	SJSC Uzkimyosanoat	270.8	14 100
39	Rehabilitation of the carbamide process line on OJSC Ferganaazot	SJSC Uzkimyosanoat	78.0	5 000
40	Rehabilitation of the carbamide process line on OJSC of the carbon ammonium salt on OJSC Navoiazot	SJSC Uzkimyosanoat	14.0	100
41	Construction of small power plant Bagishamal-2 [4]	MAWR	20.7	14 142
42	Construction of small power plant Karkidon [4]	MAWR	32.4	10 981
43	Construction of small power plant Shaudar [4]	MAWR	24.6	15 757
44	Construction of small power plant Akhangaran	MAWR	41.1	23 457
45	Construction of small power plant-2 Andijan	MAWR	105.8	28 620
46	Construction of small power plant Hissar	MAWR	50.0	27 900
47	Construction of small power plant Gulba	MAWR	19.2	24 700
48	Construction of Shakhimardan small power plant on Koksu River	MAWR	8.0	5 000
49	Construction of Zarchob small power plant cascade	MAWR	124.5	66 010
50	Solid waste composting on the landfill Akhangaran, Tashkent city[1]	Khokimiyat	57.3	360
51	Prevention of the landfill gas formation on the landfill of Bukhara city with the waste composting	Khokimiyat	4.3	376
52	Prevention of the landfill gas formation on the landfill of Andijan city with the waste composting	Khokimiyat	6.1	526
53	Prevention of the landfill gas formation on the landfill of Namangan city with the waste composting	Khokimiyat	7.0	523
54	Prevention of the landfill gas formation on the landfill of Fergana city with the waste composting	Khokimiyat	4.6	478
55	Prevention of the landfill gas formation on the landfill of Nukus city with the waste composting	Khokimiyat	3.5	508
56	Construction of the combined heat and power generation unit in Bukhara city	Khokimiyat	80.1	40 000
57	Upgrading of the heating system of Fergana city, including energy saving technologies at the consumption level; transition from the open heat supply system to the closed one via installation of the house sub-stations and heat networks replacement	Khokimiyat	47.3	7 300
58	Boiler-house upgrading via gas-turbine unit assembling (GTU) for the combined heat and power generation in Fergana city	Khokimiyat	41.2	10 974
59	Transition of the district heating system to the closed water withdrawal and independent connection of the building heating systems in Sergeli district of Tashkent city (4 pilot areas)	Khokimiyat	50.0	9 200
60	Introduction of the wind power generation plant with capacity 5 MW	JSC Uzstroymaterialy	8.2	6 000
61	Methane recovery and combustion when the excrement treatment on the poultry farms (program project)	Farmers' association	50.0	3 000

№	Project/project idea title	Initiator	Annual emission reduction (th. t CO_2-eq.)	Investment (th. $)
62	Methane recovery and combustion when the livestock and poultry waste treatment (program project on construction of individual biogas units for the rural population)	Farmers' association	25.0	1 000
63	Methane recovery and combustion when the cattle manure treatment in the farms (program project)	Farmers' association	Undetermined	Undetermined
		TOTAL	14 641,4	1 838 735

Table 3.7 List of CDM projects under implementation and consideration

№	Investor	Number of projects	Annual reduction of GHG emission (th. t CO_2-eq.)	Investments ($ th.)
1.	World Bank Carbon Fund	3	633	272 910
2.	MDG Carbon Fund	1	58	1 150
3.	Mitsubishi Corporation (Japan)	6	1 106	15 824
	Ready for implementation	**10**	**1 798**	**289 884**
4.	Preliminary selected by ADB	3	78	40 880

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4. Greenhouse Gas (GHG) Emissions Forecast

4.1. Possible Scenarios of Economic Development

The volumes of GHG emissions in the prospect till 2020 mainly depend on possible scenarios of economic development in Uzbekistan, and will be determined by the growth rates and GDP structure.

The key role will be played by policy and measures on development of energy sector, industrial sectors, service industry, agriculture and housing and communal services, transportation, as well as other sectors of economy and results of GHG mitigation and reduction measures.

Currently there are no government-approved detailed elaborations and quantitative assessments of the long-term development of industries. Principle-based approaches to the long-term strategy and purpose oriented parameters/factors of development of Uzbekistan and its economy for the period until 2020 have been formulated by the Center for Social and Economic Research of the Republic of Uzbekistan (CSER).

The main objective of the long-term strategy for development of Uzbekistan is an increase of well-being standard and quality of people's life in the country by means of sustainable and well-balanced development of economy.

To achieve this objective a number of tasks must be fulfilled including:

- Ensure economic and social security based on stable development of, first of all, energy and food complexes of the country;
- Develop economic competitiveness, not permit lagging in terms of development level behind developing countries (on the whole) and CIS countries, including Central Asian region;
- Increase economic effectiveness by means of intensification of market reforms, rational use of resource potential;
- Establish a single transportation and engineering-communication network, new transport corridors to meet internal requirements and to enter foreign market;
- Priority-driven development of the social sphere, providing for favorable conditions for life activity.

Table 4.1. presents main indicators of the economic development scenarios until 2020. The most conforming to the objective of the long-term strategy for development of the Republic is scenario III (modernizing), which implies:

- Ensuring high economic growth rates within 9-9.5% until 2020, first of all, by means of priority-driven development of industries, service industry and mobilization of the available resource potential;
- Essential increase of the private sector's share in GDP by 2020 up to 85-90%, small-scale business's share up to 60%, formation of new market institutions of economic management;
- Increase of the share of industries from 22.1% in 2006 up to 35% in 2020, service industry – from 39.5% up to 55%, relative decrease of the contribution of agriculture into GDP to 10%, considerable growth of export (not less than 10 times);
- Ensuring sustainable development of strategic oil-and-gas complex, electric-power industry, ferrous and nonferrous metallurgy;
- Improvement of industrial structure, seeking to decrease the share of raw-materials production to 40% by 2020, including one in fuel-energy complex to 10%, increase of the share of processing industries up to 60%, including that of light industry up to 22%, food industry up to 20%;
- Accelerated development of livestock farming, fruit and vegetable growing and wine-growing, essential increase of level of agricultural raw products processing (more than 2-3 times), balanced development of water management, production, market and social infrastructure in the rural area, intensification of agricultural production, active benefiting competitive advantages of agricultural sector;
- Priority-driven development of service industry for improving people's welfare, growth of employment and income rates;
- Formation of a single engineering-communication and transportation network;
- Higher economic growth rate by means of active resource-saving policy, especially in the energy sector, labour productivity increase, reduction of materials consumption, energy consumption and capital intensity of the GDP.

Target parameters of economic development for Uzbekistan until 2020 according to the III (modernizing) scenario are demonstrated in the Table 4.2.

There are assessments done by other national experts, however those assessments are not comprehensive ones. They touch only certain directions of development of one industry branch or another and projections of emissions of certain types of greenhouse gases, which are based on the analysis of retrospective average data on industrial output and demand for fuel resources.

Table 4.1 Main indicators of the economic development scenarios in Uzbekistan until 2020

Indicator	Factual as of 2006	Development scenarios	Projection for		
			2010	2015	2020
GDP growth rate	7.3	I	5.7	5.5	5.0
		II	7.2	7.3	7.4
		III	8.3	9.0	9.5
		IV	8.8	13.2	13.0
Industrial output growth rate	10.8	I	6.0	5.8	5.7
		II	9.0	9.6	11.0
		III	11.5	12.0	13.0
		IV	12.0	13.0	15.0
Agricultural output growth rate	6.2	I	4.0	3.5	3.0
		II	4.8	4.6	4.5
		III	6.1	6.2	6.2
		IV	6.9	7.0	7.0
Service industry output growth rate	11.4	I	8.2	8.0	8.0
		II	9.4	10.0	10.5
		III	13.1	14.0	15.0
		IV	13.1	15.0	16.0

Note	
Scenario I	corresponds to the projected assessment done by Hopkins Institute (USA), in 2005 for the Central Asian countries, with underlying relatively low economic growth rates in Uzbekistan on the assumption of insufficient economic liberalization
Scenario II	basic, providing for economic reform rates and taking into account the achieved results, identified economic development priorities and target indicators to be achieved by the country by 2010
Scenario III	modernizing, based on involvement of internal reserves and capacity, increase of institutional and structural reform efficiency, acceleration of processes of technical re-equipping and new technology introduction
Scenario IV	target-oriented, intended for essential reduction of gap between economic development of Uzbekistan and that of the other developing countries

Table 4.2 Target parameters of economic development for Uzbekistan until 2020 according to the III (modernizing) scenario

Indicator	Factual as of	Projection for		
	2006	2010	2015	2020
Average annual world economy growth rate	3.7	3.6	3.5	4.1
Including:				
- developing countries	6.3	3.8	4.4	4.7
- Uzbekistan	7.3	8.3	9.0	9.5
GDP per capita according to purchasing power parity (USD), including				
- developing countries	7 642	9 029	11 287	14 221
- Uzbekistan	2 146*	2 919	4 500	7 800
Gap between Uzbekistan and medium developed countries	3.6	3.1	2.5	1.8
Indicators in Uzbekistan				
GDP per capita growth rate (%)	6.1	7.4	8.3	8.5
Industry share in GDP (%)	22.1	26.0	30.0	35.0
Service industry share in GDP (%)	39.5	49.0	53.0	55.0
Small-scale business share in GDP (%)	42.1	52.0	55.0	60.0

* Assessment done by the Center for Socio-Economic Research of the Republic of Uzbekistan (CSER)

4.2. Long-term GHG Emissions Forecast

In the course of work on the Second National Communication, national experts carried out researches on possible mitigation of greenhouse gases in the key economic sectors of Uzbekistan using LEAP long-term planning model.

However in practice use of this model demonstrated that nowadays LEAP can be employed in Uzbekistan only partially, as a convenient tool for measuring energy resources consumption and getting a visual picture of GHG emission in certain economic sectors. Considerable gaps in the economic data and relevant information on production volume, factual expenses and cost of techniques or measures couldn't allow using LEAP model to get energy consumption forecast with any degree of differentiation and integration and to analyze mitigation measures prospects with assessment of the cost of emissions mitigation.

GHG emission estimates until 2020 were done in the basis of target parameters of economic development, formulated by CSER, in accordance with the following four scenarios:

- Scenario ***one (I) – basic*** – corresponds to the economic development scenario where average annual GDP growth rate in perspective is 7.2-7.4%, ***without change of the current economic structure and mitigation measures implementation***;
- Scenario ***two (II)*** is estimated on the basis of indicators of ***modernizing*** scenario of economic development, ***without mitigation policy and measures implementation***;
- Scenario ***three (III)*** is also estimated on the basis of indicators of ***modernizing*** scenario of economic development, though ***mitigation measures implementation is taken into account***, meantime energy saving measures should ensure reduction of power requirements of economy by 40% of the level in 2005, as well as reduction of specific GHG emissions by 10% in the other GHG sources.
- Scenario ***four (IV)*** corresponds to the scenario of target-oriented economic development, ***with implementation of mitigation measures***, which ensure reduction of power requirements of economy by 40% of the level in 2005, as well as reduction of specific GHG emissions by 10% in the other GHG sources.

GHG emission projection by ***target parameters of economic development*** has been done for all the scenarios on condition that population of the Republic will grow at a moderate rate and by 2020 will increase by 115.8% as compared with 2005 (1.05% annually).

Besides, two variants of estimates have been done to assess expected minimum GHG emission level on the basis of population changes in the Republic, while no economic factors changes and mitigation measures have been taken into account. Those variants are:

- under the condition of moderate population growth rate (on average 1.05% a year);
- under the condition of high population growth rate (on average 1.7% a year);

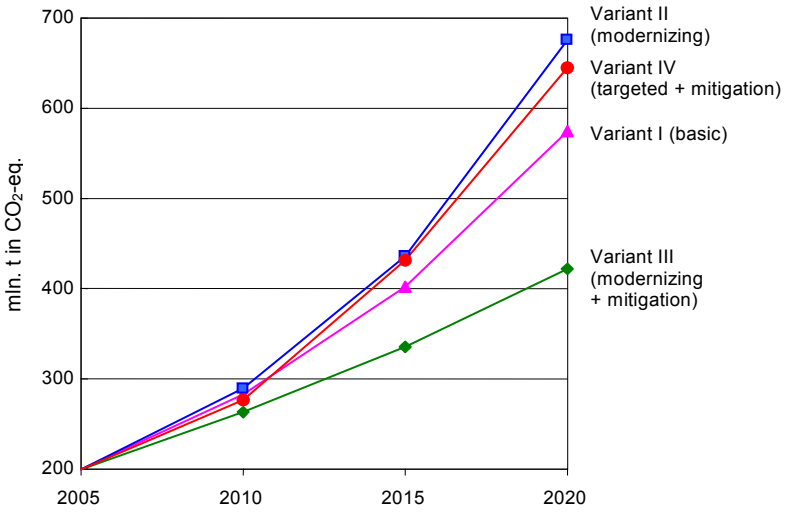

Figure 4.1 *GHG Emissions Forecast Variants until 2020*

The additional assessment of GHG emission has demonstrated that the level of GHG emissions in 2020 will be within the range of 231.1 m. tons to 235.1 m. tons of CO_2-eq. However these attractive in terms of GHG emissions variants cannot be accepted as target ones, as they actually imply retention of the current living standard and do not correspond to the sustainable development policy. Therefore, this level of GHG emissions can be accepted only as the lowest reference point for Uzbekistan 2020.

All scenarios of GHG emissions calculation based on target parameters of economic development until 2020 imply emissions increase (Figure 4.1), which is associated with the anticipated GDP growth.

Table 4.3 The main GHG emissions forecast indicators until 2020

Indicator	Unit of measurement	Factual for 2005	Variants	Forecast		
				2010	**2015**	**2020**
Population	mln. people	26.3	I - IV	27.5	28.9	30.2
Average annual GDP growth	%	7.0	I	7.2	7.3	7.4
			II	8.3	9.0	9.5
			III	8.3	9.0	9.5
			IV	8.8	13.2	13.0
GHG emissions of CO_2-eq.	mln. t	199.7	I	282.6	402.0	574.5
			II	289.4	436.0	675.9
			III	263.1	335.3	422.0
			IV	276.4	431.5	645.2
GHG emissions of CO_2-eq. per capita	t/person	7.6	I	10.3	13.9	19.0
			II	10.5	15.1	22.4
			III	9.6	11.6	14.0
			IV	10.0	14.9	21.3
GHG emissions of CO_2-eq. per GDP unit (in prices of 2005)	Thousand t/billion soum	13.1	I	14.8	14.8	14.8
			II	14.4	14.1	13.9
			III	13.1	10.8	8.6
			IV	13.4	11.3	9.1

Table 4.3 shows four variants of the main indicators of GHG emission forecast until 2020. Subject to the scenarios of economic development of the country, accepted assumptions of economic structure and mitigation measures implementation rate, overall volume of GHG emissions in Uzbekistan in 2020 will vary from 422.0 m. tons (scenario III) to 675.9 m. tons of CO_2-eq (scenario II). The most attractive in long-term perspective until 2020 is scenario III, ensuring high rates of economic development, increase of living standard, reduction of relative GHG emission per GDP unit and minimum GHG emission level per capita.

The outlook for increase of GHG emission indicators per capita in comparison with 2005 is associated with the projected multiple GDP growth in Uzbekistan. By 2020 it will rise 3.6 times against 2005 level.

Calculations demonstrate that under the projected economic growth rates in Uzbekistan GHG emission in 2020 may considerably exceed the current level of emissions. In particular, scenario II provides for their growth for more than 3.4 times.

Only elaboration and implementation of mitigation and reduction measures may decrease GHG emissions growth rate in Uzbekistan. For example, emissions in the scenario III are more than 37.5% lower than the emissions in the scenario II. Elaboration and implementation of such a policy and measures will facilitate implementation of the UNFCCC and the Kyoto Protocol tasks.

The structure of GHG emitted in Uzbekistan is not going to change significantly before 2020. Main GHG types will remain carbon dioxide and methane (Table 4.4).

Table 4.4 Structure of GHG emissions by types of gases (in %)

Name	**2005**	**Variants**	**2010**	**2015**	**2020**
Carbon dioxide CO_2	50.3%	I	50.3	50.3	50.3
		II	52.0	53.5	54.9
		III	51.7	53.0	54.6
		IV	50.9	51.1	51.1
Methane CH_4	44.7%	I	44.7	44.7	44.7
		II	44.0	43.3	42.7
		III	44.0	43.1	41.9
		IV	43.8	42.9	42.0
Nitrous oxide N_2O	5.0%	I	5.0	5.0	5.0
		II	4.0	3.1	2.4
		III	4.3	3.9	3.5
		IV	5.3	6.0	6.9

Changes in the GHG emissions structure are possible in case of essential changes in the structure of the energy balance of the country: reduction of natural gas share and increase of the share of other kinds of energy.

All variants of the forecast for the whole period of the forecast show that the main source of GHG will be energy sector (Table 4.5). Share of this category in 2020 will vary from 83.6% (variant IV) to 91.9% (variant II), i.e. policy and measures on saving all kinds

of energy take on a key role in mitigating Climate Change.

As the volume and trends of emissions under "Energy sector" category are defined both by volume and trends of carbon dioxide emissions, and by volume and trends of methane emissions, it is impossible to provide for the most attractive variant of GHG emissions development (variant III) without undertaking measures on reduction of loss and leakage of natural gas, as well as its utilization. Though the share of GHG emissions under the other emission source categories will not exceed 18-19%, their absolute values will also increase.

Therefore, to reduce the overall level of GHG emission with the projected economic growth it is necessary to develop and implement policy and undertake relevant measures to mitigate Climate Change also on the other categories of GHG sources.

This requires for detailed research both on assessment of emissions volume and on the rates of certain greenhouse gases emission in these categories of their sources.

Table 4.5 Structure of GHG emissions by emissions sources

Emissions sources	Factual for 2005	Forecast			Factual for 2005	Forecast		
		2010	2015	2020		2010	2015	2020
	Varian I (basic)				***Variant III***			
Energy Sector	86.2	86.2	86.2	86.2	86.2	87.7	88.3	88.3
Industrial Processes	3.2	3.2	3.2	3.2	3.2	3.9	5.3	7.4
Agriculture	8.2	8.2	8.2	8.2	8.2	6.5	4.9	3.2
Wastes	2.3	2.3	2.3	2.3	2.3	1.8	1.5	1.2
	Variant II				***Variant IV***			
Energy Sector	86.2	88.6	90.5	91.9	86.2	85.5	84.8	83.6
Industrial Processes	3.2	3.7	4.3	5.1	3.2	4.3	5.0	5.8
Agriculture	8.2	6.0	4.0	2.2	8.2	8.5	9.1	9.9
Wastes	2.3	1.7	1.2	0.8	2.3	1.8	1.1	0.8

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5. Vulnerability Assessment, Climate Change Consequences and Strategies of Adaptation

Assessment of Climate Change impact on natural resources and socio-economic sectors in Uzbekistan and identification of adaptation measures have been done in several stages:

- Assessment of vulnerability to the current Climate Changeability and extreme natural phenomena, identification of climate risk;
- Assessment of vulnerability to the future Climate Changeability and extreme natural phenomena, employing both climate and economic scenarios;
- Identification and analysis of measures on adaptation to Climate Change *on the basis of assessment built of scenarios ("top-down"* method*); and*
- Selection of priority measures on the basis of consultations with the parties concerned (*"bottom-up"* method).

5.1. Observed Climate Trends and Accepted Scenarios

5.1.1. Climate Trends Observed on the territory of Uzbekistan

Assessment of Climate Change on the territory of Uzbekistan has been based on day-to-day observation data since 1951 (Figure 5.1.1), as well as on the longer-term monthly and seasonal data (table 5.1). Analysis of average changes in seasonal temperatures by districts shows that intensive warming is observed throughout the Republic.

Minimum air temperatures increase more than maximum ones throughout Uzbekistan. Rate *(ΔT*/10*years)* of warming for maximum temperatures since 1951 averages 0.22°C, for minimum temperatures – 0.36°C. Exception is the Aral Sea derelict area, where maximum temperatures rise rate is very high and minimum temperatures almost don't increase due to reduction of the water area.

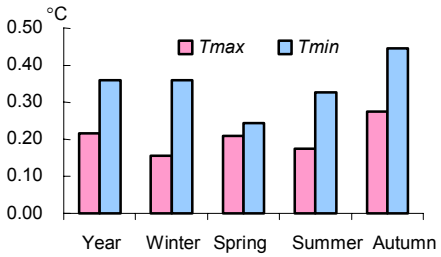


Figure 5.1.1 *Average minimum and maximum air temperatures increase rates (ΔT/10years) throughout Uzbekistan*

Highest warming rates were registered in autumn (Figure 5.1.1). Warming rates observed in Uzbekistan since 1951 more than twice exceed the average ones on the globe.

Statistical assessment showed that the most significant changes were observed in summer and autumn all over the plain territory of the Republic. Warming rates in the mountainous regions are lower. Seasonal air temperature trend increments to standard deviations ratio ($\Delta Tr/\sigma$) is presented in Table 5.1. In many regions of Uzbekistan the increase of minimum temperature has twice exceeded natural changeability.

Significant reduction of low temperature recurrence is observed, even with due account taken of the abnormally cold winter of 2007-2008 (Figure 5.1.2)

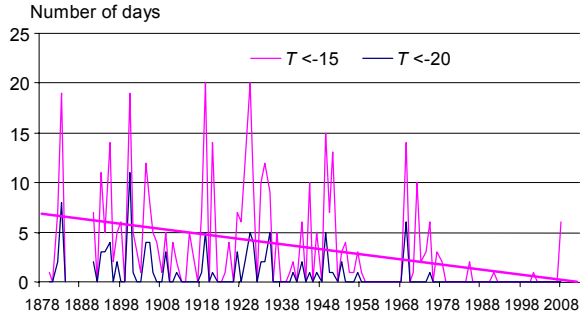


Figure 5.1.2 *Number of days with low temperatures in Tashkent*

Comparison of two periods (1951-1980 and 1978-2007) has shown that the number of days with temperature lower than -15°C in the northern and mountainous regions reduced by 28-48%. Number of days with the temperature lower than -20°C reduced more than 1.5 times throughout Uzbekistan. The overall reduction of the number of frosty days on the territory is presented in the Figure 5.1.3.

Number of days with high temperatures (higher than 40°C) increased near the Aral Sea more than twice, on other territories – by 32-70%, and in the foothills – by 10-12%. The maps show extension of the area, where temperature higher than 38°C is often observed (Figure 5.1.3). Similarly, number of days with high night temperatures increases (Figure 5.1.3).

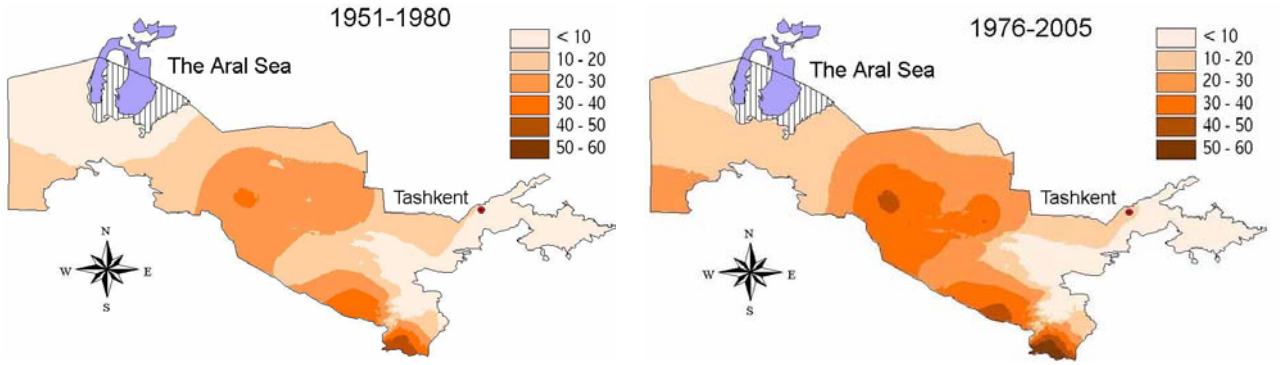
In general, climate extreme state is intensifying. The calculated extreme rate indexes (percentage of time when T_{max} and T_{min} are higher than 90% of their fractile) have positive trends all over the county. Figure 5.1.4 shows change of the index for the Fergana valley.

Analysis of change in the number of days with heavy precipitation revealed its increase. The number of days with precipitation of more than 10 mm increased in plain and foothill territories (Figure 5.1.5).

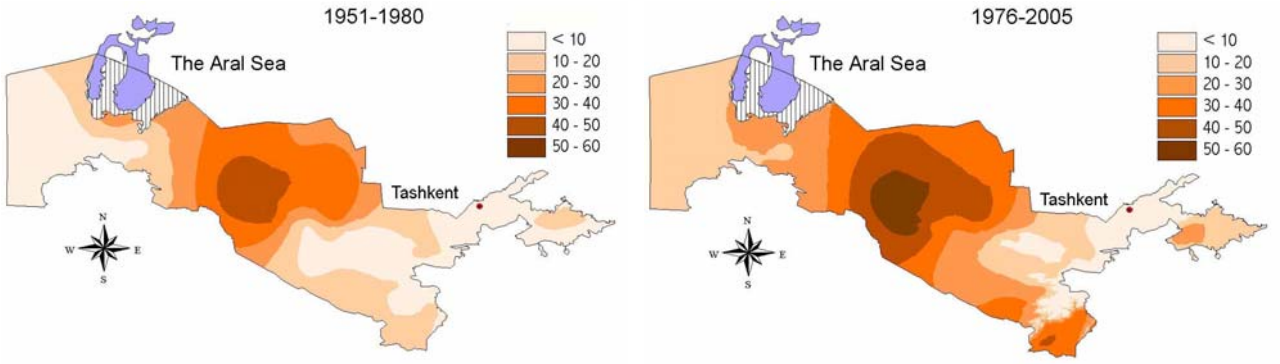
Relatively small (about 9%) increase in the number of days with precipitation of more than 20 mm was observed in mountainous areas, and with due account taken of the greatest frequency of intense precipitation in these areas, this fact should be given special attention.

Table 5.1 Assessment of maximum and minimum temperatures trends *(ΔTr/σ)* throughout Uzbekistan since 1938

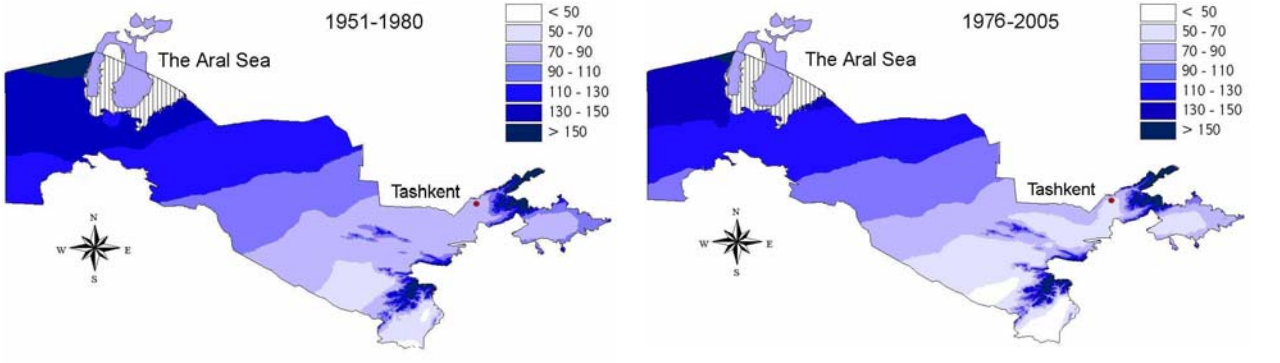
Characteristic	Seasons	Regions of Uzbekistan					
		Northern	Central	Southern	Foothills	Mountains	
						Tyan-Shan Branches	Pamir-Alay Branches
T_{min}	Winter	0.97	0.77	0.51	0.85	0.03	0.02
	Spring	1.46	1.38	1.31	1.16	0.08	0.10
	Summer	2.45	2.25	2.60	1.95	0.31	0.18
	Autumn	1.86	2.23	2.17	1.72	1.50	1.42
T_{max}	Winter	0.13	0.08	0.14	0.13	0.27	0.51
	Spring	0.53	0.41	0.35	0.34	0.29	0.23
	Summer	0.38	0.42	0.22	0.31	0.07	0.00
	Autumn	0.72	0.54	0.72	0.60	0.97	1.03



Number of days with maximum temperature higher than 38°C



Number of days with maximum temperature higher than 22°C



Number of days with maximum temperature lower than 0°C

Figure 5.1.3 *Change of climate indicators on the territory of Uzbekistan*

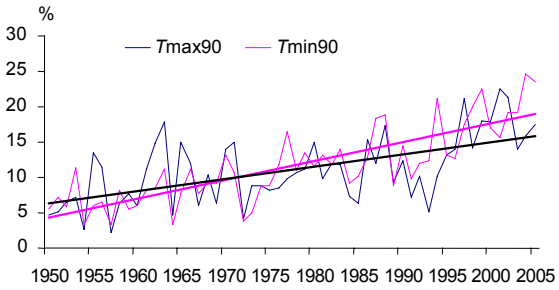


Figure 5.1.4 *Change of extreme maximum and minimum temperatures (the Fergana valley)*

To assess changes in climate aridity, such indicators as number of days with minimum relative humidity less than 20% during warm part of a year and average humidity deficit in the summer period were selected. Humidity indicators are very sensitive to local anthropogenic impact and physiographic conditions. If there is no local anthropogenic impact, the selected indicators register tendency to aridity growth, in spite of the absolute humidity content increase, caused by climate warming. Climate aridity significantly increased during warm part of a year near the Aral Sea; in the mountains the tendency for aridity increase is slighter than on the plain and foothill territories.

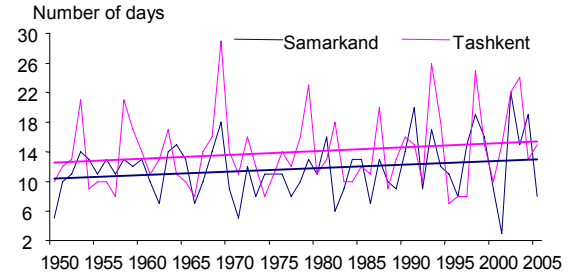


Figure 5.1.5 *Change in the number of precipitation (>mm) days in certain foothill stations*

Although in general the tendencies for precipitation growth are slight in the Republic, high warming rate is the main factor for the climate.

5.1.2. Climate Scenarios

To assess Climate Change impact, climate Scenarios have been developed on the basis of models of general circulation of the atmosphere and the ocean (GCM) data, MAGICC/SCENGEN 4.1. software has been used for this purpose.

Experiments demonstrated that to lessen the uncertainty of regional Climate Scenarios, it is reasonable to average the output results of a number of models. We have averaged data of six models: CGCM1-TR, CSIRO-TR, ECHAM4, HadCM3, CCSR-NIES, GFDL-TR.

Possible range of annual average temperature changes on the valley territory of Uzbekistan in the circumstances of different (high, middle, low) climate sensitivity to growth of carbon dioxide concentration in the atmosphere is illustrated in the Figure 5.1.6.

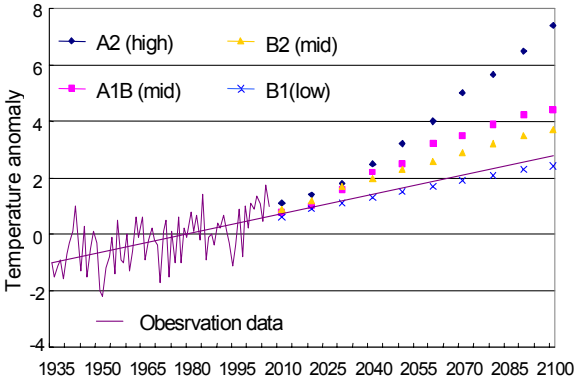


Figure 5.1.6 *Observed and expected changes of annual average temperatures in Uzbekistan in accordance with different emission scenarios and climate sensitivity (averaging of the six models)*

With the purpose to build regional scenarios, middle climate sensitivity to growth of greenhouse gases concentration in the atmosphere was selected and scenarios of A1B, A2, B1, B2 emissions were considered with due account of mitigating impact of sulphate aerosols for three time intervals of 2016-2045, 2036-2065, 2066-2095, which hereinafter will be defined as 2030, 2050 and 2080 taken.

The analysis shows that the differences in expected changes of annual average temperature in A and B scenario groups by 2030, 2050 are comparable with standard error in calculations of mean values of 30-year observational series. Calculated changes of climate characteristics until 2050 in all the scenarios appeared to be rather close (Figure 5.1.7), therefore, only scenarios A2 and B2 were considered to assess vulnerability.

Statistical interpretation method (downscaling) was developed for Uzbekistan on the basis of multiple linear regressions. Equations worked out on the basis of actual data were applied to the output results of the models. The method allowed for detailing data from 5×5° mesh points, i.e. estimating, with due account taken of local conditions, expected changes for 50 stations in Uzbekistan, including middle, maximum and minimum temperatures, monthly rainfalls and daily precipitation maximum, relative humidity and steam tension.

The second stage of statistical interpretation included calculation of extreme values of specified probability for climate Scenario conditions with utilization of theoretical probability distribution functions. Normal distribution was used for temperatures, and Pearson curve of III type for precipitation.

Assessments of standard deviation changes were received with the use of MAGICC/SCENGEN; they

show growth of temperature and precipitation changeability compared to the basic period on the whole territory considered (Figure 5.1.8). This indicates increased probability of extreme droughts and heat periods, as well as cold snaps probability retention.

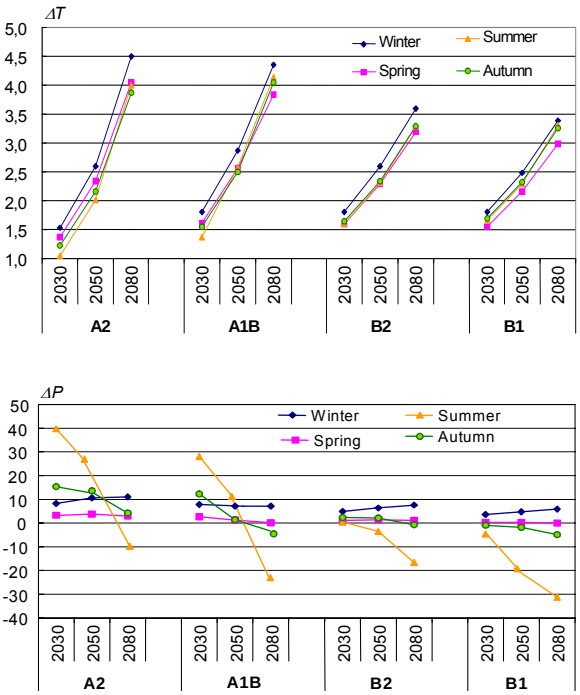


Figure 5.1.7 *Expected increase of seasonal temperatures (ΔT) and changes of seasonal precipitation (ΔP) compared to basic standard on the territory of Uzbekistan in accordance with the emission scenarios*

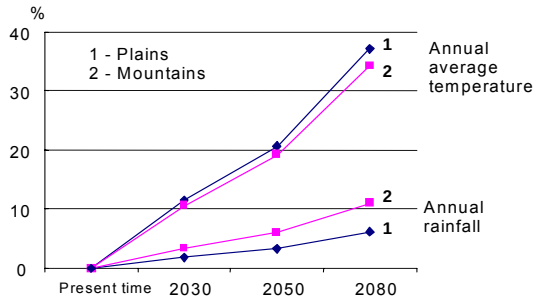


Figure 5.1.8 *Assessment of standard deviation changes in perspective, average for scenarios A2 and B2 for mountains and plain territories of Uzbekistan*

In accordance with the needs for assessment of vulnerability of certain sectors, future periods values of specified probability (fractile 5, 10, 90 and 95%) of monthly average, maximum, minimum temperatures, monthly rainfall and daily maximum precipitation were estimated on 50 stations of Uzbekistan.

Calculated changes in annual average temperatures and annual rainfalls by regions for A2 and B2 emission scenarios are demonstrated in Table 5.2.

Scenarios show essential increase of temperatures on the territory of the Republic, especially in winter time. Increase of minimum temperatures according to calculations will be more intensive than that of maximum ones.

Conclusion was made regarding precipitation on its probable increase at the expense of winter season (December-February), similarly on increase of daily precipitation maximum and the number of days with heavy precipitation. This intensifies the risk of flash floods and mudflows.

According to the scenarios, the expected certain increase in absolute air humidity coincides with the observed trends of air humidity increase.

Figure 5.1.9 shows distribution of empiric quantile of 10% probability (90% precipitation) and estimated values for A2 scenario.

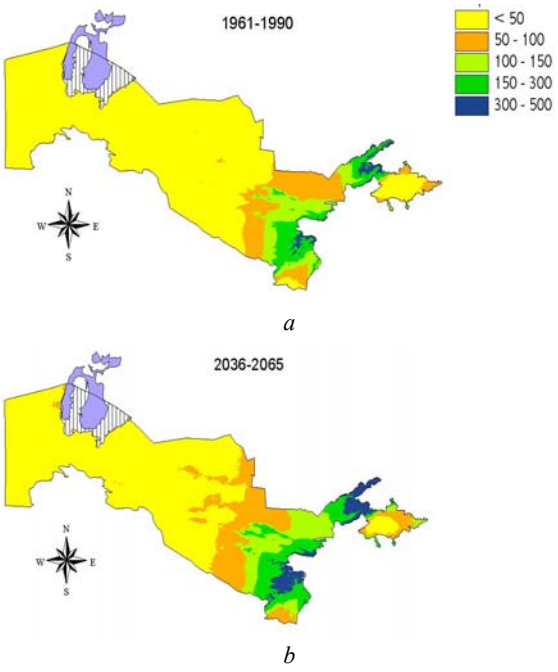


Figure 5.1.9 *Empiric quantile of 10% probability of annual rainfall (mm), characterizing basic period (a), and estimated values for A2 Climate Scenario by 2050 (b)*

Analysis shows that in terms of geographical distribution, there is a little difference between empiric quantile and values estimated for realization of the most "damp" Climate Scenario for Uzbekistan. Locating gradation of probable extremely low precipitation totals for foothills and mountain areas almost remains the same.

As a result of the implemented activities, the necessary climatic characteristics were calculated for climate Scenarios. These characteristics were used to assess vulnerability and Climate Change impact on different socio-economic sectors in the Republic of Uzbekistan.

Scenarios development and Climate Change impact assessment were done in accordance with IPCC methodology, UNFCCC guiding principals, and appropriate methods necessary for each sector.

Table 5.2 Estimated expected changes of average annual average temperatures and annual rainfalls compared to base period (1961-1990) in accordance with emission scenarios

Regions of Uzbekistan	B2						A2					
	Temperature, °C			Precipitations, %			Temperature, °C			Precipitation, %		
	2030	2050	2080	2030	2050	2080	2030	2050	2080	2030	2050	2080
Northern (Republic of Karakalpakstan, Khorezm)	1.3	2.0	3.2	104	105	101	1.1	2.0	3.7	115	116	108
Central desert plains (Navoyi and Bukhara provinces)	1.6	2.3	3.5	104	105	104	1.2	2.3	4.2	114	116	110
Southern (Kashkadarya and Surkhandarya provinces)	1.7	2.5	3.4	104	104	105	1.3	2.4	4.3	116	117	110
Submountain (Samarkand, Djizzak, Tashkent provinces and the Fergana Valley)	1.6	2.3	3.4	106	108	111	1.2	2.3	4.2	115	118	114
Mountains (Tyan-Shan branches)	1.4	2.2	3.3	108	110	112	1.1	2.2	4.1	117	115	108
Mountains (Gissar-Alay branches)	1.3	2.1	2.9	105	106	106	1.1	1.9	3.8	114	116	115

5.1.3. Socio-Economic Scenarios

Socio-economic conditions determine vulnerability of the country to Climate Change and ability to adapt. Intensive population growth increases food demand, and a better developed economy allows for creating safety funds, developing trade and covering food needs through importing, with due account of possible harvest shortage caused by Climate Change and regular extreme climate conditions taken .

The main source of food provision in Uzbekistan is irrigated farming and cattle breeding, forage resources for which are partially provided at the account of irrigated land. Land and water are vital resources for Uzbekistan, especially in the environment of intensive population growth.

In this connection, the indicators of vulnerability to Climate Change will be indicators of water and land supply, as well as grain crops yield, which play principal role in ensuring food security. The same indicators determine capacity for sustainable development, for example, irretrievable water intake, cropland and water consumption per capita and grain crops yield. To assess the selected indicators in prospective, besides climate Scenarios, demographic and economic scenarios were also considered.

Demographic Scenarios. Two approaches were used to build the scenarios:

1. National vision – the assessment was done by the Center for Socio-Economic Research of Uzbekistan and is based on the observed fertility, mortality and population migration trends. Main prerequisites: retention of fertility rate on the present level, retention of mortality level, average annual population growth before 2025 – 1.3%; and

2. Demographic trends in accordance with SRES2000 and correction of growth with the current data. Population growth rate for the group of transition economy countries (REForm), where Uzbekistan is included, did not correspond to the observed ones, though almost coincided with the rate in ASIA region. Therefore, they were used as reference trends for future.

Figure 5.1.10 *Demographic scenarios*

As a result, two scenarios were built. **D1** describes higher population growth (unfavorable scenario, agrees with the A2 emission scenario). **D2** implies lower population growth, which will be a favorable variant for Uzbekistan (agrees with B2 scenario) (Figure 5.1.10).

Economic scenarios. In order to assess vulnerability, it is proposed to consider two scenarios of economic development.

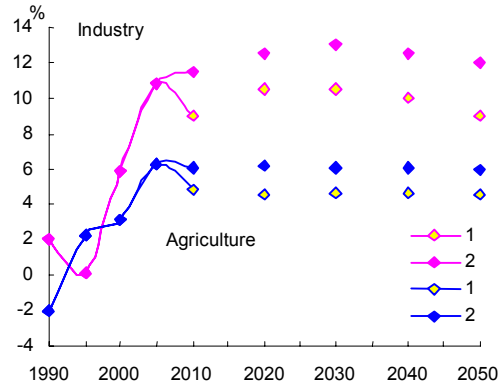
Scenario one – with the higher population growth and moderate economic development rate (basic), scenario two with moderate population growth rate and higher economic development rate (modernizing). Selection of the indicated scenarios was determined by the economic growth rate observed in Uzbekistan (in 2006 and 2007) and the formulated long-term development goals.

1. Basic scenario, provides for retention of the achieved growth rates, it is in line with demographic scenario D1 (with high population growth rate) and Climate Scenario A2; and
2. Modernizing scenario is based on inclusion of inner resources and accelerated introduction of new technologies and higher agricultural sector growth rates. Special emphasis is made on development of industry, trade and service sectors. This scenario is in line with demographic scenario D2 (with moderate population growth rate) and Climate Scenario B2 (Figure 5.1.11).

The main prerequisite of sustainable socio-economic development is management of natural resources, which are used for food production. The main source of food supply in Uzbekistan is irrigated farming. For agricultural products per capita in Uzbekistan on average 1 800 m^3 of water is utilized; this is a significant amount in the conditions of intensive water consumption (water intake for irrigation from surface sources makes up to 93%, and from all the sources equals to 84%).

It is considered that utilization of more than 40% of all renewable fresh water sources for irrigation causes tension between agriculture and other users. Therefore, water resources in Uzbekistan have already become a key challenge in the food production process.

Realization of development variants in accordance with the scenarios (maintaining agricultural products accession rate at 4-6%) is possible in case of water consumption efficiency improvement and water waste reduction.



1 - Basic scenario, 2 - Modernizing development scenario.

Figure 5.1.11 Scenarios of industrial and agricultural sectors growth rates as % of the previous year (assessment done by the Center for Socio-Economic Research)

Alternative variants of agricultural sector development were used to assess Climate Change impact and to analyze adaptation measures with the application of WEAP (Water Evaluating and Planning System) model. Different variants of irrigation network efficiency were considered, regulation of planted acreage and change of cropping mix were assumed.

Prospective development variants and demographic scenarios allowed for assessing future indicators, attributed to sustainable development: water use in all sectors and expected water deficit, water consumption and cropland per capita. This allowed assessing trends of agricultural sector development and ability to ensure food security under the conditions of climate Change.

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5.2. Water Resources

Uzbekistan territory relates to internal drainage of the Aral Sea Basin, including all its rivers and lakes.

Uzbekistan has 17 777 natural watercourses. The Amudarya River Basin comprises 9 930 watercourses, the Syrdarya River Basin – 4 926, and these rivers inter-stream area – 2 921. These rivers mainly have the length less than 10 km, especially, in Amudarya and Syrdarya rivers inter-stream area, where they are represented mainly by the drying out watercourses, and watercourses with the length over 10 km have outflows not every year.

Different directionality of the runoff processes in the mountains and plain determines specific nature of the territory of Uzbekistan division in two zones in terms of the land runoff: area of the runoff formation as well as one of its dissipation.

Surface runoff of the rivers is formed mainly in the mountainous part of the region, in general, due to precipitation in the cold period of the year. Glaciers concentrated in the mountainous regions of Central Asia being not only the source of the clean fresh water but its long-term reserve as well, play an important role in the land runoff formation.

Glaciers on the territory of Uzbekistan are located in the up-streams of the certain rivers (mainly, in the Pskem River Basin) and are represented with the small form glaciers with the mean space of one glacier about 0.29 km^2.

Groundwater compose significant share of the water resources of the country and play an important role in the potable and agricultural water supply, including for irrigation and range watering. Groundwater of the Aral Sea Basin, including Uzbekistan territory, is formed due to the rainfall, seepage from water reservoirs, river courses, channels, lakes and irrigated areas.

Groundwater natural resources in entire Uzbekistan amount around 24 km^3. From entire number of explored fields of the fresh groundwater (357), only 267 are utilized, representing reserve for the potable water supply development in the rural areas.

Bulk volume of ***the return water*** for the period 1990-2000 varies on the average from 28.0 to 33.0 km^3/year. Bulk volume of return water from various water consumers and users amounts 28.3 km^3/year, including 20.1 km^3/year for the Syrdarya River Basin and 11.5 km^3/year for the Amudarya River Basin. Such high volumes of return water are associated with the large infiltration losses from irrigation systems and directly due to irrigation.

Over five hundred lakes are located mainly in the river valleys and mountains. The lakes of anthropogenic nature were formed due to the drainage water discharge to the drainless cavins. Irrigation effluent lakes are formed on the end sections of irrigated areas in the natural relief descents. Most of them are shallow ones; Arnasay is the largest lake.

The Aral Sea and Amudarya River delta

Current period in the *Aral Sea* life, starting from 1961, can be characterized as a period of anthropogenic impact on its mode. Sharp increase of irrecoverable runoff withdrawals, evaporation growth due to the climate warming and low water in certain years led to disturbance of the water and salt balance.

Ecological changes associated with the sea drying out were accompanied with reduction of water inflow to the delta and, as a consequence, deterioration of the domestic water supply – increase of salinity and decrease of the groundwater inflow.

During conventionally natural period the mean annual consumption of the river water inflow to the delta were equal to 1 060-2 090 m^3/s, in 1970s they decreased to 850-1 200 m^3/s, and by 1980s – to 50-500 m^3/s. During this period Amudarya River waters not always achieved the Aral Sea (Figure 5.2.1).

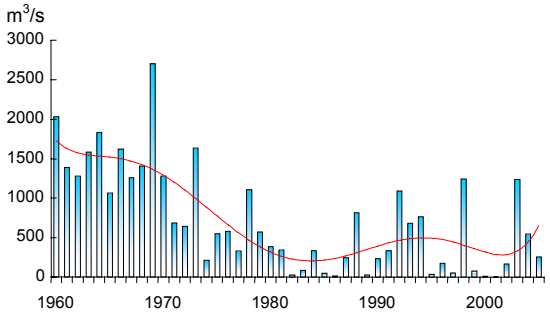


Figure 5.2.1 *Long-term changes of the mean water flow in Amudarya River downstream during vegetation period (Kyzyldjar section)*

Currently, it is difficult to estimate the runoff from Amudarya River to the Aral Sea. Only two stations Kyzyldjar and Parlytau are located in the river delta, and distance between them is equal to 73 km. During the recent years significant runoff exceeding 100 m^3/s was regularly recorded in Kyzyldjar section.

Dried bottom of the Aral Sea

In Parlytau only in 1992 and 1993 runoff with the flows of 234 and 59.3 m^3/s was observed. Therefore, annually for the period 1992-2005 20 m^3/s was passing through the section on the average, which can be

considered as the river runoff from Karakalpakstan to the Aral Sea [1].

The Aral Sea drying out is accompanied with the wide-spread ecosystem degradation in the Aral Sea area and outside it. This led to the situation when currently the region is characterized as a disaster territory. The Sea which used to be the source of the rich flora and fauna existence as well as the natural regulator for the adjacent irrigated territory is degrading to such extent that the desertification processes are intensified on the large areas along with formation of new desert zones.

Frequency of severe droughts in the Aral Sea area due to intensification of anthropogenic stress and runoff variability has recently increased. Under the current and expected climatic changes severization of complicated ecological situation in the Aral Sea area is possible.

5.2.1. Climate Change Impact on Water Resources

Observed changes of the water resources and hydrological characteristics are determined by Climate Change and human economic activity. River water resources and key runoff factors in the Aral Sea Basin are very vulnerable to the Climate Change.

Methodological approach based on application of mathematic models of runoff formation in the mountainous rivers developed for the Central Asian conditions with consideration of the complex multifactorial process of runoff formation and the Aral Sea Basin peculiarities was selected for Climate Change impact assessment on the river water resources from ***runoff formation*** zone.

The models enable considering of the key mechanisms of the surface water formation under the climate factors impact (air temperature, precipitation, evaporation), quality and composition of available information on existing runoff rank and regional Climate Scenarios.

Adaptation and parameterization of the model system to the conditions of uncertainty, current information deficit and climatic situation enables it application for assessment the future status of the water resources affected by the climatic impact.

Vulnerability of the snow reserves in the mountainous river basins

Snow cover role in the feeding of Central Asian rivers is very high since the seasonal snowmelt is the key feeding source of Central Asian rivers. Snow reserves in the mountainous river basins have different response on increase of the air temperature which depends on the height and space of water discharge, its orientation in terms of the moisture-laden air, feeding type (snow, snow-glacial) and the other factors.

The model of the snow cover formation in the mountains was used for the snow reserve assessment. The Figure 5.2.2 provides the course of inter-year variability of estimated snow reserve volumes in the Pskem River Basin along with their change trend.

For the period 1950-2005 the trend of the snow reserve reduction was revealed. It conforms to the positive trends of the air temperature, recorded by observation data of meteorological stations. Air temperature increase in mountainous area deteriorates conditions for the snow reserve formation causing their reduction. In some basins runoff decrease is being observed.

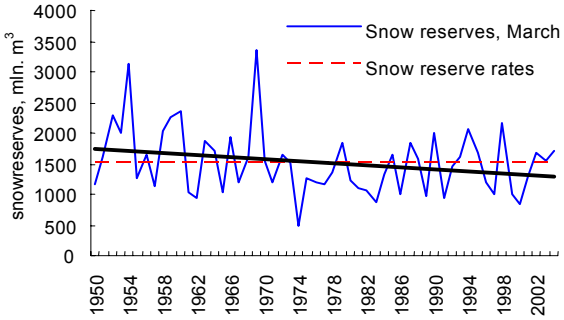


Figure 5.2.2 *Long-term changes of the snow reserves estimated for the end March*

Mountainous glaciation vulnerability

Mountainous glaciation is one of the most persuasive indicators of the Climate Change. All changes of thermal balance of the earth surface and bulk humidification of the mountainous territory are directly reflected in characteristics of the glaciers mode and balance.

Increase of the mean annual air temperature during the recent century less than to 1°C was sufficient to reduce the mountainous glaciation in Central Asia more than to one third.

Change of the glaciation size depends on the system of climatic factors – air temperature, precipitation, solar radiation, claudage, evaporation and pace of the glacier response on the climate fluctuations.

Many experts are dealing with the studies of the glaciation reduction in Central Asia, but, as a rule, the estimates of the glaciation change are limited to the individual glaciers or glacier regions.

Regular glaciological studies on the glaciers of the region were initiated at the end of fifties – beginning sixties last century in connection with arrangement of works in the frame of the program of International geophysical year (IGY). At this period integrated all-year-round glaciological studies of on the glaciers Fedchenko (Pamir), Tuyuksu (Northern Tien Shan), Abramov (Gissar-Alay) were arranged, and the regular field works on glaciation of Pamir, Gissar-Alay, Tien Shan were initiated. These studies materials served as a foundation for development the

first Glacier Catalogue and Atlas of the global snow and ice recourses (1997).

At early 1990s last century the field works were practically stopped, including on the highland stations at Fedchenko and Abramov glaciers.

Currently, the publication of the multivolume edition of the Atlas of satellite images of the global glaciers developed by the US Geological Service is under finalization. Volume F – Asia is under development and will comprise the data on the study and spatial distribution of all glaciation forms.

Computational methods and satellite images of individual glaciation areas on the territory of Uzbekistan enable estimating the glaciation status under the warming conditions, both in the current period and future Figure 5.2.3).

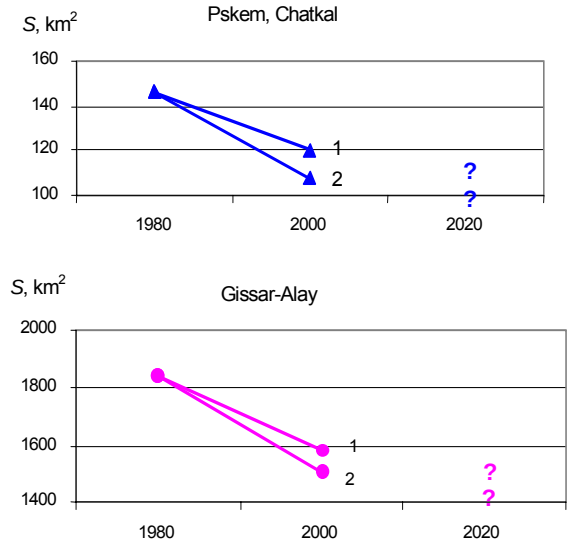


Figure 5.2.3 *Changes of the glacier areas (km^2), calculated via various methods*

Typical relief of mountainous runoff formation area

Studies of resources and current dynamics of Tien Shan glaciation showed that the negative balance of the glacier mass is demonstrated by reduction of glaciation spaces and even disappearance of individual glaciers. The estimates illustrated possibility of reduction the glaciation space of the Western Tien Shan by 2020 approximately to 35% against 1980.

Bosjkyzylsay River, runoff formation area

It is possible to expect that the paces of glaciation reduction under the warming conditions and preservation of existing precipitation level will be similar to ones for the recent years, with high regional variability from 0.2% to 1% a year.

At the same time, stabilization of glaciation degradation process is possible in individual glacier regions along with increase of the glacier reserves in case of precipitation growth in future.

Water resource assessment based upon Climate Scenarios

Climate Change impact on the runoff varies depending on scenario of future Climate Change and is to a large extent associated with the differences in precipitation expected in line with scenarios. Given the high natural variability of observed precipitation by the stations of the region and lack of clear trends of their change, as well as inadequate data coverage of the mountainous area observations, the estimate of expected river runoff were made for two Climate Scenarios – B2 (more humid option) and A2 (more dry option).

For the estimate of the river runoff change in the Aral Sea Basin a series of the model analysis was carried out for the rivers-indicators with various feeding type and located in various hydrological regions; their scheme is provided on the Figure 5.2.4.

The Table 5.2.1 shows the changes of the river runoffs to be expected when the above scenarios implementation. It should be noted, that small watercourses are specifically vulnerable to the climate parameters change.

The estimates of the river runoff of the Aral Sea Basin on the basis of developed Climate Change scenarios demonstrated the following:

- By 2030s in case of implementation Climate Scenarios A2 and B2 there will be no significant

changes of resources in the Syrdarya and Amudarya rivers basins.

- When implementing scenario A2 the long-term Climate Change by 2050 will apparently lead to reduction of Syrdarya and Amudarya rivers runoff. In the Syrdarya River Basin runoff reduction is possible to 2-5% against the reference rate of the current period, and in the Amudarya River Basin – to 10-15%.
- When implementing scenario B2 in the number of hydrometeorological stations by 2030, 2050 precipitation increase is possible to 5-15% and over, which can lead to preservation of the current river runoff or even its increase if some river basins. However, some trend to the runoff reduction is expected in the Amudarya River Basin by 2050 (less than 10%).
- The highest climate aridization in the mountainous area of runoff formation is expected in the long-term projection. According to the scenario A2, potential runoff reduction in the Amudarya River Basin achieves 20%, and in the Syrdarya River Basin – 15%.

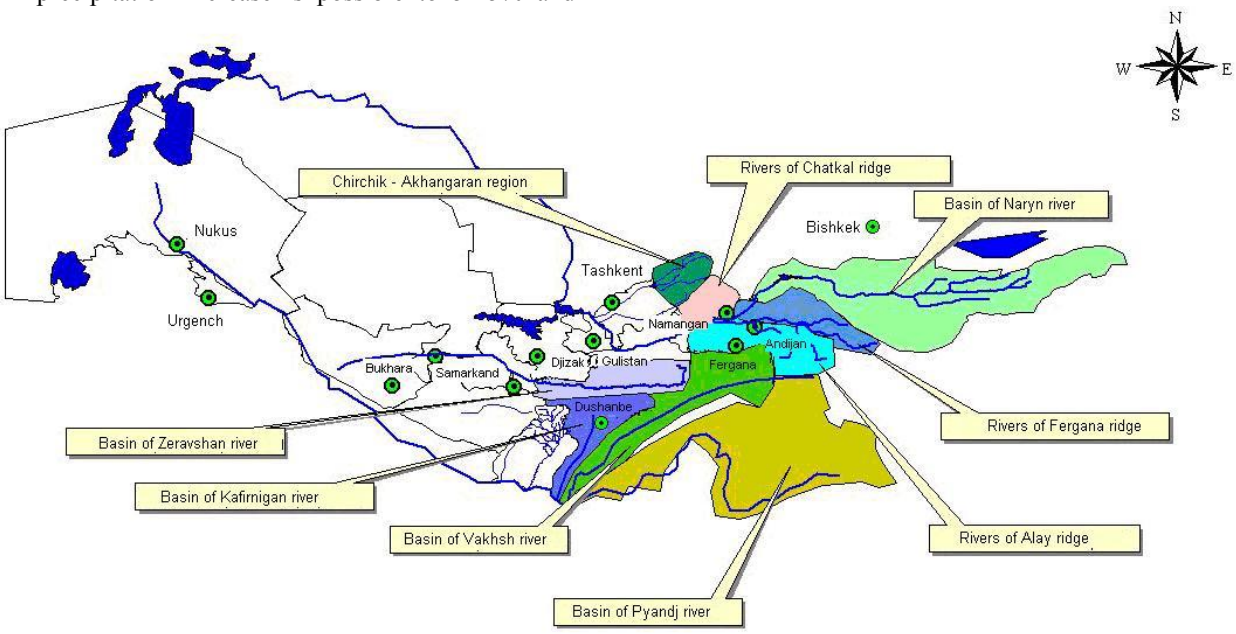


Figure 5.2.4 *Scheme of hydrological regions of the runoff formation area for Amudarya and Syrdarya rivers*

Table 5.2.1 Estimates of the vegetation runoff of the rivers-indicators by Climate Scenarios A2 and B2

River, station	Vegetation runoff rate (m^3/s)	Vegetation runoff change (% of the rate) for Climate Scenarios					
		B2			A2		
		2030	2050	2080	2030	2050	2080
Pskem – Mullala	128	95	91	91	96	96	90
Chatkal – Charvak	195	95	94	92	98	97	92
Inflow to Charvak reservoir	323	95	93	92	97	97	91
Akhangaran – Irtysh	36	98	96	95	103	101	91
Palshaata – Tostu	9	74	75	74	78	80	77
Chadak Djulaysay	10	58	58	56	62	62	57
Gavasay – Gava	6	57	56	55	61	61	56
Karakuldja – Aktash	38	96	97	98	99	101	101
Yassy – Salamalik	37	101	100	97	107	105	96
Tar – Chalma	82	96	98	95	106	108	101
Kurshab – Gulcha	25	88	86	84	96	96	87
Zeravshan – Dupuli	256	104	103	102	98	84	88
Kafirnigan – Tartki	255	99	100	99	99	93	79
Vakhsh – Komsomolabad	988	75	72	70	73	69	72
Jbikhingoy – Tavildara	266	80	75	62	71	67	62
Kyzylsu – Samanchi	97	91	90	87	94	89	77

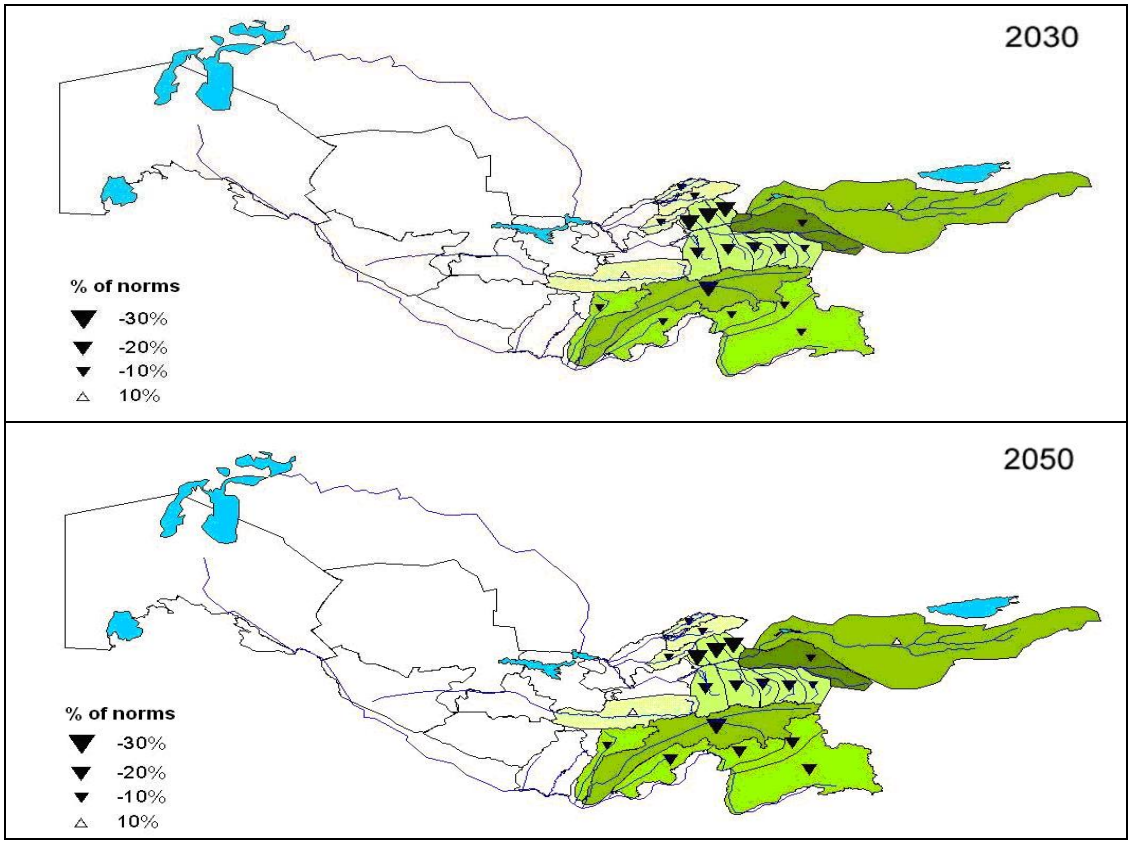


Figure 5.2.5 *Schematic map of vegetation runoff abnormalities (% of the rate) when implementing scenario B2*

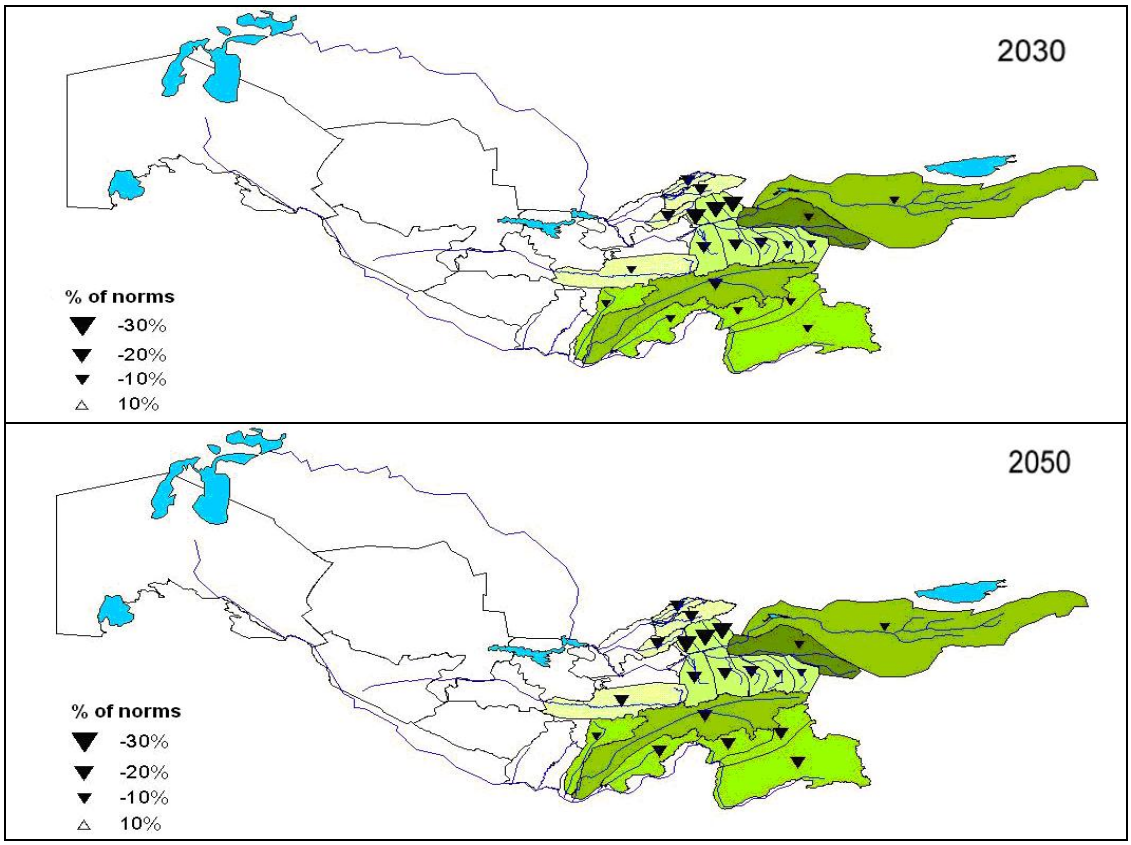


Figure 5.2.6 *Schematic map of vegetation runoff abnormalities (% of the rate) when implementing scenario A2*

The averaged estimated runoff results on hydrological regions made with application of mathematic models of mountainous river runoff formation are shown on schematic maps (Figures 5.2.5-5.2.6).

As it has been already mentioned, multiple-valued runoff estimate associated with high variability of precipitation mode and its expected changes in line with scenarios demonstrates the necessity of consideration all potential options of the future runoff change. However, the following conclusions can be made:

- for the short-term runoff increase is not expected along with the high natural variability, even in case of precipitation growth;
- for the long-term by 2030 the practical preservation of the current runoff rates is assumed;
- river runoff will reduce along with the further increase of the air temperature;
- the Amudarya Basin rivers and small watercourses are the most vulnerable to the climate warming;
- intensification of the runoff variability is expected in all basins;
- time shift of the spring flood to earlier periods and runoff reduction in vegetation period.

Assessment of extreme river runoff for Climate Scenarios conditions

Assessment of probability of the climate abnormalities occurrence and corresponding river runoff abnormalities, is of a great interest for agriculture and water economy, as well as for the other economic branches.

The Figure 5.2.7 provides the annual vegetation runoff for the Akhangaran River Basin as well as model estimates of extreme vegetation runoff for 2030, 2050 and 2080, obtained on the basis of Climate Scenarios by quantiles. Calculations were made for two options: 1) very warm and dry conditions in the runoff formation area (combination of quantiles of the air temperature T95 and precipitation P05); 2) very humid and cold conditions (combination of quantiles T05 and P95).

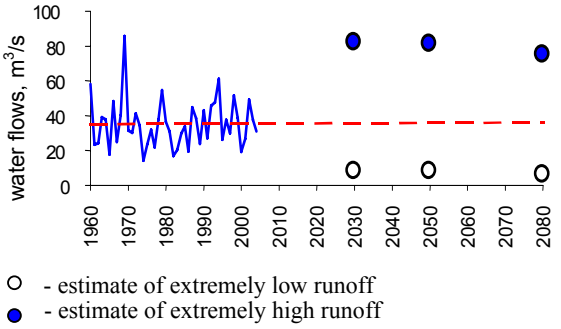


Figure 5.2.7 *Potential assessments of extreme vegetation runoff in the Akhangaran River Basin*

Analysis of extreme low water cases showed that in such years significant precipitation reduction was observed in winter period (< 50% of the rate), causing dramatic snow reserve reduction at the end winter. Precipitation below the rate is frequently observed in spring and the air temperature can be higher than the rate or equal to it.

Table 5.2.2 Water resources: key threats and Climate Change adaptation measures

Vulnerability indicators	Estimate by scenarios	Problems and bottlenecks	Adaptation measures
Snow reserve reduction in the mountainous river basins	Increase of seasonal snow line, reduction of the snow reserve volumes in the lowest and medium mountainous areas	Inadequate monitoring of the snow and is reserve status Inability of application of many assessment and forecast methods due to the lack of background information from meteo stations in the runoff formation area outside Uzbekistan Hindering of the assessment and forecast methods development due to the informational deficit	Improvement the monitoring of the snow and ice reserves, including the ground and remote surveillance Complex assessment of current condition of glaciations on Pamir-Altai and Tien Shan Development of methodological base of assessment and forecast of the mountainous snow reserve and glaciation status
Glaciation reduction in the mountainous river basins	Reduction of glaciation spaces, glacial recession. Short-term – increase of the glacier runoff contribution. Long-term – glacier runoff reduction		
Reduction of available water resources Enhancement of natural variability and general trend of growth in number of extreme years in terms of their dryness	***Short-term perspective*** Reduction of the water resources of the snow-fed rivers with low watershed height ***Long-term perspective*** Reduction of runoff of the rivers with glacier and snow-ice feeding type Increase of frequency of occurrence and extent of extreme low water (hydrological drought)	Lack of hydrometeorological monitoring for building of methodological modeling base, runoff assessment and forecast Restricted financial capacity and poor technical capabilities for studies and observations Lack of investment attraction	Introduction of IWRM system Control and re-allocation of river runoff in transboundary context Development of water resource monitoring, including improvement of the water recording system and water quality management Improvement of hydro-ecological monitoring Preservation of irrigation mode of water economy system operation Rain precipitation utilization Development and introduction of the drought early warning system Enhancement the knowledge and skills on the water resource sustainable management Public awareness and education in the careful attitude to the water and land

In the years of the deepest low water estimated on the basis of extreme quantiles of the air temperature and precipitation calculated for Climate Scenarios conditions, vegetation runoff in the Amudarya and Syrdarya River Basins may reduce to 25-50%.

Analysis of situations leading to hydrological drought in the Aral Sea River Basins may serve as methodological ground for development the early drought warning, which, in its turn, will enable the timely preparation for the low water conditions and planning the activities on its after-effects mitigation.

Climate Change impact on the water resources has the ***wide spectrum of the long-term adverse effects***. It causes the necessity of the regular updating and enhancing the knowledge in the field of the future Climate Changes and their impact of the river runoff studying, integral regional assessment conducting and the regional water resource monitoring development.

Despite the fact, that river water resource reduction is possible to the mid XXI century, adaptation to Climate Change after-effects (both due to the human activity and natural factors) is already now one of the priority objectives. The Table 5.2.2 provides some adaptive measures for the water resource sectors, and introduction of principles of integrated water resource management (IWRM) in the region is one of the most important ones.

5.2.2. Problems of Water Supply in Climate Change Conditions

Potential reduction of the river water resources will lead to the number of problems associated with the population and agricultural sector water supply; and these problems may become specifically crucial ones in the law water years.

Expected Climate Change may significantly affect the country's sustainability development, in particular, the agriculture based on irrigated farming. In the current situation in the irrigated farming Climate Change will inevitable lead to the water deficiency intensification.

Expected air temperatures increase in the arid area will cause the evaporation growth increasing the water losses in irrigation zones along with irrigation rates; it will activate the salt migration processes; aggravate exhaustion of the groundwater reserves; and intensify desertification processes.

Desertification due to saline soil spreading

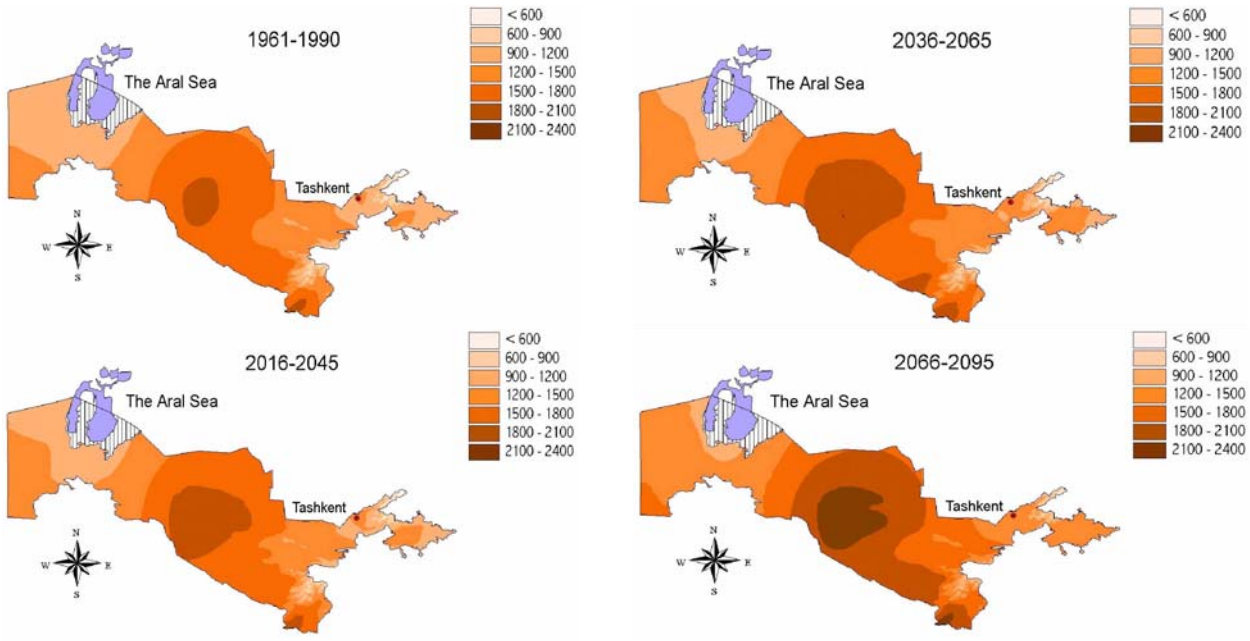


Figure 5.2.8 *Annual evaporative capacity (mm of layer) along the territory of Uzbekistan for the reference climatic period and estimated parameters in line with scenario A2*

The outputs of the evaporative capacity background assessment for the reference period and for the long-term by 2080, provided on the Figure 5.2.8, demonstrate increase of potential evaporation along entire territory of Uzbekistan, especially, in the desert areas.

Along with intensive population growth and necessity of agricultural output expansion, this situation causes increase of water consumption, water deficiency and further intensification of the Aral Sea crisis.

Assessment of irrigation water consumption

Irrigation mode and, correspondingly, evaporation capacity are determined with climatic factors, vegetation type, soil properties and groundwater depth level (in line with hydro-modular regional assignment of the territory), as well as type and extent of the soil salinity.

Climate warming will lead to increase of one of the expenditure items of the water balance – evaporation, and, as a sequence, cause the growth of number and rates of vegetation, off-season and washing irrigation. In the long-term under the water resource deficiency it is necessary to estimate additional consumption of irrigation water and irrigation mode for the new climatic conditions.

Values of evaporative capacity, bulk evaporation from the cotton, winter wheat, rice, alfalfa, vegetables seeds and backyards for the provinces of Uzbekistan along with irrigation rates were estimated using the CROPWAT and ISAREG models for the reference period and for Climate Change scenarios for 2030-2080.

The estimates showed that the winter months were more reagent to the warming. The value of the annual evaporative capacity in the irrigation areas will have minor increase: by 2030 for all provinces to 1.2-4.4%, by 2050 – to 3.1-6.2%. More significant increase is expected to 2080s (7-16%), and Karakalpakstan, Khorezm, Bukhara, Tashkent and Djizak provinces are most vulnerable ones.

Potential causes determining the low paces of evaporative capacity increase in irrigation areas are as follows:

- observed and expected increase of the air humidity;
- observed reduction of the wind velocity;
- anthropogenic impact – expansion of irrigation massifs in the recent decades (Karshi and Djizak steppes) and appearance of irrigation effluent lakes, including enlarging of Arnasay lake system.

Assessment of evaporation from the key crops was made on the basis of evaporative capacity estimates.

Evaporation from the cotton seeding against the reference period to lesser extent will increase in Fergana Valley provinces – by 2030 to 1.3-2.7%, by 2080 to 6.1-8.3% depending on scenario. The highest evaporation increase from the crops is expected for Karakalpakstan, Khorezm, Bukhara, Kashkadarya and Surkhandarya provinces for scenario A2 – to 10.8-14.1% (Figure 5.2.9).

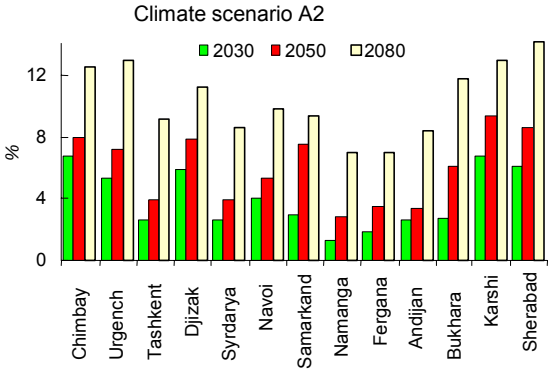


Figure 5.2.9 *Change of evaporation from the cotton in line with the Climate Scenario A2*

For the winter wheat slight increase of evaporation is expected only by 2080s in Fergana Valley provinces – to 7.8-9.9%. Evaporation from the crops in Khorezm, Navoi, Bukhara and Samarkand provinces will increase to 8.5-10.1%, and in the rest ones – to 10.0-16.8%.

Rice – is the most water consuming crop, and its seeding practically similar responses Climate Change in all provinces of its cultivation (Figure 5.2.10).

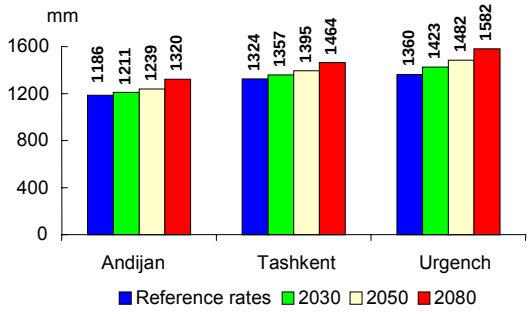


Figure 5.2.10 *Evaporation changes from rice for the key cultivating areas*

Alfalfa and vegetable crops. The highest evaporation rate from alfalfa is expected by 2080 in Surkhandarya, Kashkadarya, Khorezm, Bukhara an Tashkent provinces as well as in Karakalpakstan (10.4-16.4%), and in the rest provinces to 7.8-10.6%. Similar, evaporation from the vegetable crops will increase along entire territory of Uzbekistan.

In general, ***bulk evaporation from the cotton, winter wheat, alfalfa, vegetables and rice*** during vegetation period by 2030 will have minor change (increase to 1.3-9.9%), by 2080 increase of the bulk evaporation is expected in the range of 7.1-16.8% depending on the crop, cultivation area and Climate Scenario. Expected increase of evaporation from all crops due to the climatic conditions change, on the average for Uzbekistan will achieve: by 2030 – within **5**%; by 2050 – **7-8**%**;** by 2080 – **10-14**%**.**

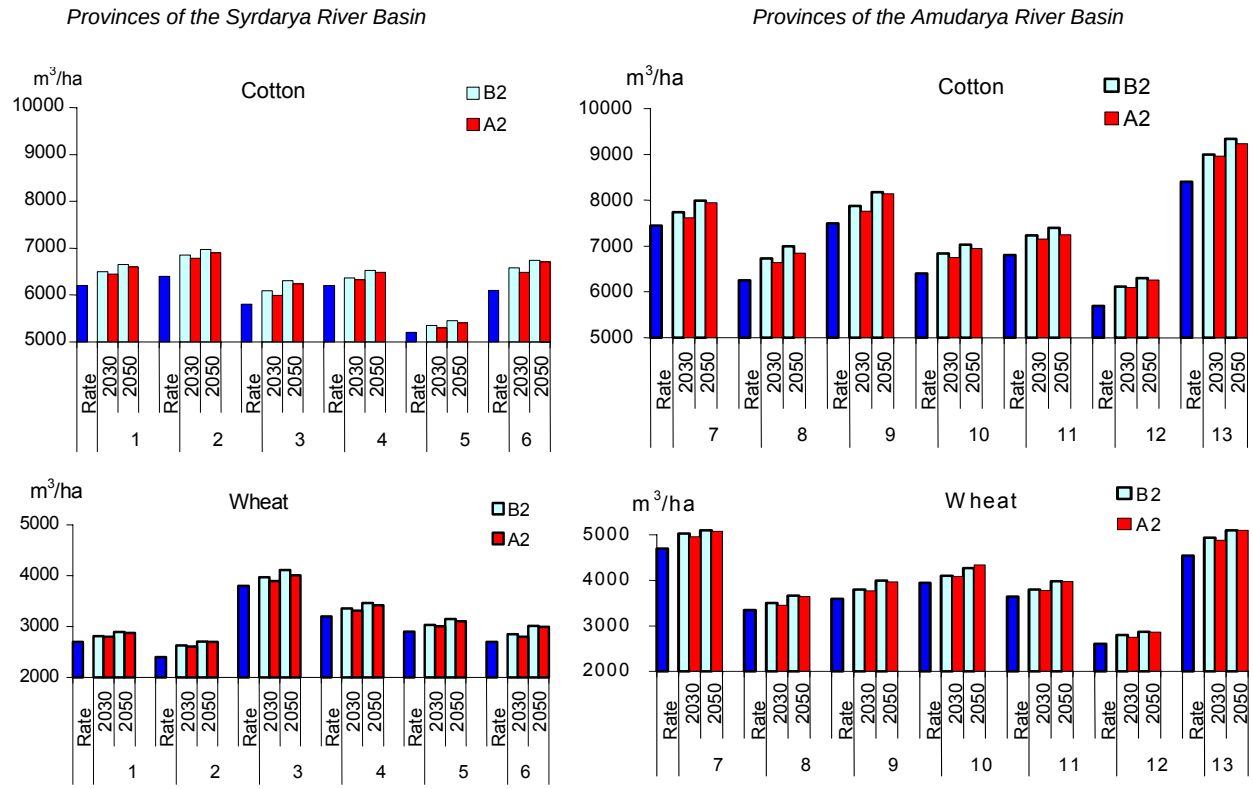


Figure 5.2.11 *Assessment of irrigation rate dynamics in line with Climate Scenarios B2 and A2 by the provinces:*
in the Syrdarya River Basin: 1) Andijan; 2) Djizak; 3) Fergana; 4) Namangan; 5) Syrdarya; 6) Tashkent.
in the Amudarya River Basin: 7) Bukhara; 8) Karakalpakstan; 9) Kashkadarya; 10) Khorezm; 11) Navoi; 12) Samarkand; 13) Surkhandarya.

The long-term bulk evaporation increase will lead to the growth of irrigation rates. The highest increase of irrigation rates is typical of the cotton, rice and vegetables. The wheat is less irrigation water consuming crop, but dramatic growth of irrigation rates is possible in all it cultivation provinces.

The Figure 5.2.11 provides the change of irrigation rates in all Uzbekistan provinces grouped by the river basins, from cotton and wheat.
The estimates of irrigation rates for the reference period and for scenarios of Climate Change demonstrated expectation of potential increase of irrigation rates due to the Climate Change, on the average within **5%** by 2030, **7-10**% by 2050, and **12-16**% by 2080.In general, warming consequences for the irrigated farming in Uzbekistan include:

- increase of irrigation rates;
- growth of irrigation water deficiency;
- intensification of irrigated land salinity;
- enhancement the air drought signs as well as extremely high temperatures;
- and, as a consequence, reduction of the yield power of the modern varieties of agricultural crops.

In the arid years the water deficiency after-effects will be specifically high – the gross grain harvest will decrease both in individual provinces, and in general in the country.

Analysis of the aggregate costs and losses with WEAP application

Forecasted water supply estimates for the long-term have the high extent of uncertainty, since require thorough analysis of larger multiple information volume. The forecasted estimates need to consider economic development, scientific and technical progress, both in the technology of water consuming types of production and in solution the water supply problems; demographic trends and trends in productive power allocation; requirements on environment protection; changes of the water sites mode under the impact of economic activity on their basin territories and in the river valleys, as well as climate conditions changes.

At the same time, currently the practice of many aspect settlement does not have reliable methodological ground, first of all it relates to assessment the nature response to anthropogenic impact, lack of objective mythology of assessment the economic efficiency of activities affecting environment and natural resource management conditions affecting, reliability of the water and land ecosystem productive capacity, in particular, of irrigated farming, is absolutely insufficient.

All this in number of cases leads to underestimate of various important aspects of the water resource

utilization problem under the rapidly changing conditions.

Therefore, Climate Change after-effects have to be considered in the context of various global changes and impacts affecting the local ecosystems and population. Demographic and the other changes may provide significant impact on growing problems associated with the lack of foodstuff and water supply. Growth of Uzbekistan population will require buildup of the jobs and. correspondingly, increase of industrial and agricultural output, expansion of irrigated arable lands and agricultural intensification.

Forecast of the basin water resource changes requires integrated assessment of the future socio-economic development, climatic changes, long-term estimate of available water resources, options of agricultural sector development and the other factors.

The *Water Evaluation and Planning System* (*WEAP*) was used for solution of set up objective in Climate Change context; this system in terms of its purpose and task-orientation is *an integrated one* focused on solution of the wide range of objectives associated with the assessment issues of the future water supply and water use status *with the balance principle*.

Built-in potential of the WEAP system simulation and design of scenarios of the future river basin development serve as a methodological basis for assessment the socioeconomic and climatic changes in the water sector of the country via WEAP means.

Landscape of runoff dissipation area

Integrated approach to the water supply and water consumption change for the long-term is based on development scenarios and focused for assessment of the following factors:

- future climatic changes;
- socioeconomic development scenarios with consideration of various options of demographic situation development in the country;
- agricultural water consumption with consideration of cultivated crops composition and their areas, etc.;
- environmental requirements;
- destabilizing factors.

The latter ones include:

- growth of population and rural population excess (over 60%);
- potential increase in water withdrawal for Afghanistan from Amudarya River to 8-9 km^3 a year, which currently amounts 2-2.5 km^3;
- change of water availability under Climate Change impact;
- acknowledgement of requirements on environment protection;
- intensification of desertification processes.

Scenarios developed by the Socioeconomic Studies Centre RUz provided the following development outlook (section 5.1.3):

- demographic situation – scenario D1 – intensive paces of the population growth;
- demographic situation – scenario D2 – moderate paces of population growth (Figure 5.2.12);
- scenario of change the irrigation areas and cropping pattern (CP).

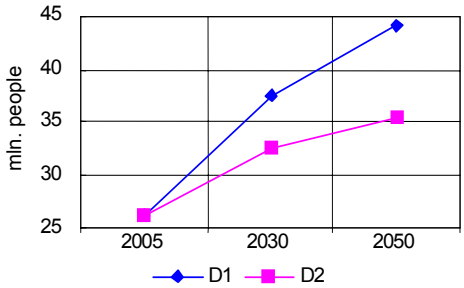


Figure 5.2.12 *Dynamics of changes of Uzbekistan population in line with scenarios*

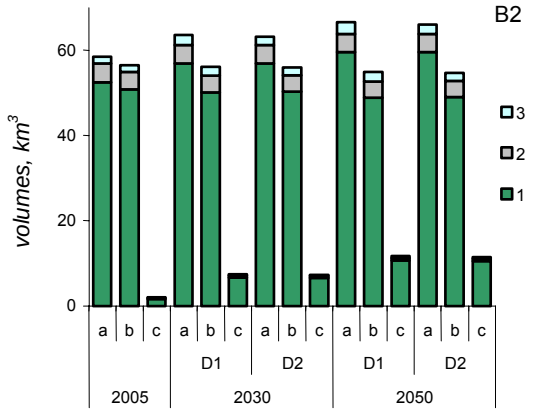
The estimates of the water demand and capacity of this demand satisfaction have been considered through:

- water availability change for 2030s and 2050s in line with Climate Scenarios B2 and A2;
- growth of irrigation rates for 2030s and 2050s in line with Climate Scenarios B2 and A2;
- growth of Uzbekistan population in line with demographic scenarios D1 and D2 for 2030s and 2050s;
- change of the cropping pattern of agricultural crops for 2030s and 2050s in line with CP scenario with practically unchanged irrigation area;
- non-irrigation water supply.

Total required water withdrawals in Uzbekistan in 2005 achieved 59 km^3. According to accepted development scenario by 2030 they will grow to 62-63 km^3, and by 2050– to 65-66 km^3.

Integral estimations of secured water withdrawals along Uzbekistan in 2005 amounted 57 km^3. By 2030 they will decrease to 55-56 km^3, and in 2050 – to 52-54 km^3.

Therefore, this estimate showed that the total water deficiency in Uzbekistan in 2005 was equal to 2 km^3, and by 2030 its increase to 7 km is possible^3, and by 2050 – to 11-13 km^3 (Figure 5.2.13), when implementing Climate Change scenarios A2 and B2.



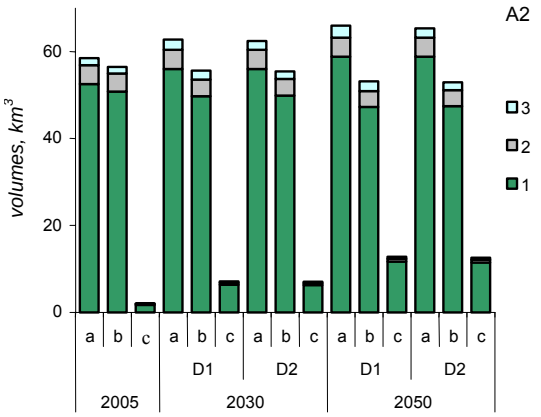


Figure 5.2.13 *Dynamics of change of the total water withdrawals and water deficiency in line with scenarios:*
a) required water withdrawals;
b) secured water withdrawals;
c) water deficiency.
1 – for irrigation;
2 – for non-irrigation water supply;
3 – for the potable water supply.

5.2.3. Impact of Warming on Quality of Surface Water

Water contamination, change of their chemical composition and properties leading to their quality deterioration take place under the impact of external and in-reservoir factors. External factors – discharge of waste waters and collector-drainage waters, atmospheric inflows, etc.

Large-scale development of new lands, extensive development of the industry, livestock production, construction of collector-drainage systems, growth of water withdrawals from the river courses and return water discharge provided negative impact in the river basins of Uzbekistan, especially, in their downstream.

There are no clear watercourse contamination sources ***in the runoff formation zone,*** and all changes of the physical-chemical indicators of water, composition and structure of water biocenosis have the natural character predetermined with the orthography peculiarities and general landscape situation.

At the same time, intensifying processes of deforestation, erosion, expansion of recreational and urban areas in elevated direction and accompanied waste contamination, river runoff withholding by numerous local water withdrawals causes hydrological river eutrophication in the bottom mountainous cover. Growing anthropogenic stress promotes vulnerability of the snow-rain-fed small rivers to the Climate Changes.

In the area of runoff intensive consumption downstream of Amudarya River, growth of water salinity is being observed. During the low water years the mean annual values of water salinity level may increase by 1.5 and in certain months – by 2-5 times.

The Figure 5.2.14 provides the data on the chemical ingredients in Amudarya River water exceeding MPC rates upstream (Termez) and downstream (Kyzyldjar) of Amudarya River. Percentage of MPC rates excess grows both, along the river and in temporal dimension by individual ingredients, such as salinity level, magnesium, chlorides, COD.

Existing discontinuity of the studies does not allow obtaining any links of water level and of such priority components as phenol, oil products, nitrites, BOD-5.

Under conditions of progressing climate aridization and retention of existing situation with water resource management further growth of river water salinity level can be expected.

Sudochie Lake during an extremely law water period

Plain lakes of Uzbekistan located in the area of the runoff dissipation and insufficient humidization have

experienced significant changes during the period of intensive runoff withholding for irrigation, reservoir construction and hydraulic reclamation conducting.

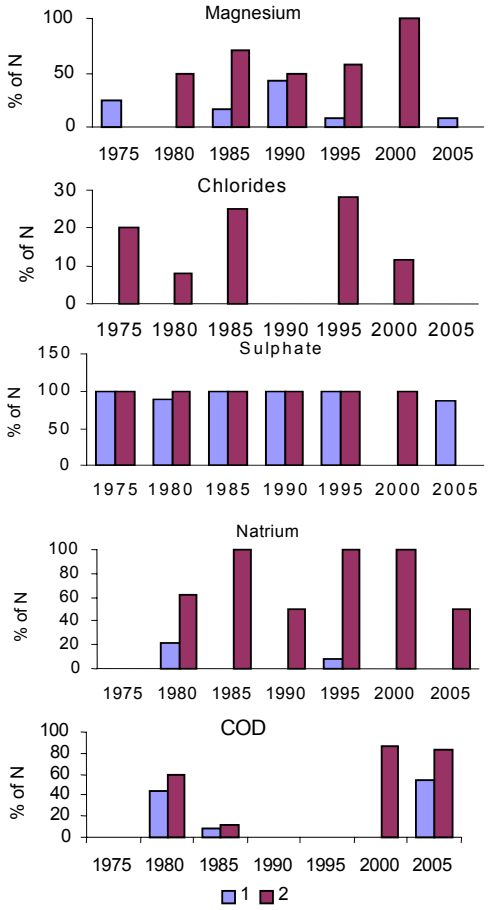


Figure 5.2.14 *MPC excess in % of the total number of observations (N) by the key hydro-chemical indicators in Amudarya River upstream and downstream*
1 - upstream – s. Termez,
2 - downstream – s. Kyzyldjar.

Many lakes became extinct, the other ones transferred to the status of irrigation-waste ones with the feeding by collector-drainage waters. Sudochie Lake fed by the river water in the past, during the recent decades exists exclusively via collector-drainage and wastewaters.

High evaporative capacity, up to 2000 mm and over is typical practically of all plain lakes, causing salinity level dependence on climatic factors. The annual salinity level course is being observed – reduction in winter-autumn period due to decrease of salinity level of river and collector-drainage waters incoming to the lakes, and increase of precipitation along with evaporation decrease.

In low water years, salinity level of lake water increases. During these periods water salinity level of the original river-fed lakes grows – by 2.5 times, and in the lake chain locking reservoirs – by 6-9 times.

River-fed lakes have lower salinity level compared to ones fed with collector-drainage water. For the running-water lakes with collector-drainage water the water salinity level increases by 1.5-5.6 times – in original lakes and by 1.7-4.1 times – in the locking ones.

Closed lakes have the highest salt concentration. In general, under the arid climatic conditions salinization processes laminate in the closed lakes. Such water sites are the most vulnerable ones to Climate Change and most of all require preventive organizational and technical measures focused on control / prevention of their progressive salinization and silting.

The Aral Sea. To date the water salinity in the Great Aral Sea has increased more than by 7 times achieved over 78% – in the western basin and 100% – in the eastern one, in other words, the Great Aral Sea turned to polyhalinic lake.

The sea drying led to appearance of thermal halinic and density vertical stratification in the western basin and formation of hydrosulfuric contamination area starting from 22 m depth, not typical for this reservoir before.

It is possible to assume, that under Climate Change conditions with retention of existing situation, reservoir drying and salinity along with thermal hallinic stratification will grow at progressive paces, which will transform the Aral Sea, especially its western part, in an absolutely inanimate reservoir in the nearest future.

Mountainous lakes of Central Asia located in the runoff formation area on the territory of Uzbekistan and cross-border states – Tajikistan and Kyrgyzstan are mainly the potential source of clean and fresh water. The total salinity of the drain inflow lakes depends on salinity level of inflows and their annual and long-term course.

5.2.4. Analysis of Strategy and Adaptation in the Zone of Intensive Water Resources Consumption

Water supply problem in Uzbekistan may worsen due to the future reduction of available water resources, which will dramatically bring down irrigation capacity of the water economy system and, given Uzbekistan territorial location in the area of runoff spread and transit will affect its irrigated farming.

Contradiction of interests among the countries located in transboundary rivers upstream and downstream may be resolved only on the basis of the weighted approach to implementation of the projects changing established balance of the water use from transboundary rivers and considering international standards and rules.

Use of transboundary rivers resources in line with requirements of Convention on transboundary watercourses and international lakes has to be based on development the constructive principles and approaches jointly with the regional structures for the search of mutually acceptable decisions convenient for all concerned parties with consideration of the power and irrigation needs and interests of the countries.

The current practically complete use of the river water resources and potential unfavourable change of the river system water content require development the adaptation strategies and measures focused on the cardinal change of water consumption and water use approaches.

The radical reorganization of agriculture has to become the key strategic activity and be focused on:

- reformation and re-orientation of economy development strategy to efficient utilization of available water resources;
- large-scale introduction of the water saving technologies in the water consuming industrial branches, agriculture and communal utilities sector;
- improvement of irrigation and drainage system for reduction the water consumption per product unit;
- shift to utilization of irrigation water with increased salinity;
- focus on expansion of irrigated land pool mainly via development of the shifted lands (in-farm increments);
- improvement the level of mechanization and automation of the water allocation in the river basins and irrigation regions;
- shift to non-waste system of the water resource utilization;
- potential water resource replenishment via involvement of unconventional sources (conservation of the rain precipitation, active impact on the clouds) within conservation of ecological balance;
- shift to a flexible planning system of the optimal volume of agricultural output.

When the long-term planning of agricultural activity, it is necessary to consider the vulnerability of the surface water resources and adaptation measures limited nature under conditions of anthropogenic Climate Change. The actions have to be taken in all economic branches for mitigation the adverse effects as well as for support of economic activity development, environment protection, etc.

Water supply accompanied with the water withdrawal from the sources and their runoff control by reservoirs is inevitable associated with disturbance of the natural mode of water sites and adjacent territories causing universal, frequently, unfavourable environmental impact. Therefore, solution of the water supply problem has to be not only rational in terms of economic efficiency, but to consider the social aspects and ***requirements of environment protection***.

River in the Western Tien Shan foothills, fall mean water

Therefore, integrated rational water resource management is gaining in the socioeconomic importance and is one of the key prerequisites of environment conservation. IWRM is a long-term process requiring reforms at all cycle stages of the planning, water resource management and regional collaboration development.

Rational water resource management requires development, signing and observance of inter-governmental agreements on establishment the rules of each transboundary water site control, including control of runoff by reservoirs and hydroelectric plants.

The aspects of the volume assessments of the future available water resources and water demand for irrigation needs are key ones for the planning of the state sustainable development and closely associated with consideration of Climate Change impact. Not only the short-term perspective has to be considered (2020-2030), when significant water resource changes are not expected, but the long-term perspective as well. Research has to be expanded and deepened in the following fields:

- identification of potential timeframes of hazardous changes in the regional climatic system with application of Climate Scenarios for various time intervals;
- improvement of mathematic models and estimation methods for assessment the future water resource status, runoff formation components and water use;
- water deficiency impact assessment on all socioeconomic sectors;
- improvement of runoff forecasting methods under anthropogenic impact conditions;
- management theory.

Table 5.2.3 Water resources in intensive utilization area: key problems and adaptation measures

Climate Change impact	Factors reducing adaptive capacity	Adaptation measures to Climate Change
Reduction of available water resources Enhancement of runoff variation in time and space Water quality deterioration Change of annual Изменение runoff re-allocation (shift of hydrograph peak to the earlier dates) Runoff reduction in vegetation period Increase of irrevocable losses in irrigation areas Water consumption increase in irrigated farming and the other water use branches (evaporation growth, increase of irrigated rates) Water consumption increase in the industry and public water supply	Inadequate monitoring of water resources in the area of their intensive utilization Low progress of agricultural reforms Limited financial and poor technical capacities Insufficient investment attraction Water use disagreement in transboundary context	***Management and monitoring*** Introduction of the system of water resource integrated management via involvement of all concerned parties and its tailoring with the land resource management *Improvement of* the system of the water recording and quality management Improvement of hydro-ecological monitoring Enhancement of the knowledge and skills of sustainable management ***Introduction of control systems*** Ensuring of the strict recording of the water resource allocation and reporting, control over their utilization in all economic sectors Maintenance of the stable level of the water supply of the country and economic sectors with consideration of transboundary nature of the key water resources ***Institutional development*** Institutional development in the field of water use and water consumption Support in implementation of the number of agricultural reforms and enhancement of the role of WUAs and FAs Improvement of the legal and institutional principles in the private farms' formation and development ***Development of legal mechanisms*** Development of comprehensive system of integrated water-land resource management including formation of organizational-legal, economic mechanisms of the water-land relation control, water and land protection and rational utilization Development of new version of Law RUz "On water and water use" with consideration of transition to the market relations and principles of water use and WUAs development Development of incentive system for the farmers, in particular, in terms of procurement and price formation policy ***Sectoral measures*** Development of the public water consumption system, water pipe-line system rehabilitation and installation of the water flow meters for all users Transition to the closed-recycling water supply system in the industry and power sector

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5.3. Agriculture

5.3.1. Agricultural Crops Productivity

Key factors affecting crops efficiency

Agriculture is one of the priority sectors of Uzbekistan's economy. Under Climate Change conditions vulnerability assessment and selection of adaptation measures for the agroindustrial complex is of a specific importance for food security. Another task of similar importance is integration of recommended measures into the National priorities of the state.

Numerous factors influence agricultural production and crops efficiency, the main factors being:

- available water supply, water resource management and allocation system, irrigation and collector drainage network condition, water quality;
- ameliorative land condition, soil fertility, agro-technical interventions technology;
- agricultural climatic resources, adequate heat and moisture supply for crops;
- rational agricultural crop distribution by available water and thermal resources;
- impact of dangerous hydrometeorological weather phenomena.

After acquiring of the state independence by Uzbekistan, radical reforms of ownership forms took place in agriculture of the country; the production and market infrastructure were established, which facilitated increase of some types of agricultural output and rural population's proceeds.

Existing *ameliorative condition* of agricultural lands hinders the further growth of agricultural crop productivity as well as increase of proceeds of commodity producers in this industry. The lack of integrated and systematic approach when planning the ameliorative activities during the recent years have caused decline in the scale and quality of ameliorative works, rise of ground water mineralization and water table level.

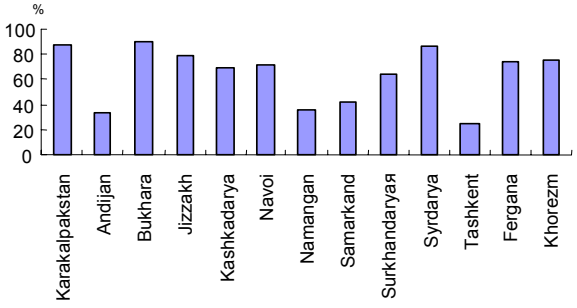

Figure 5.3.1 *Area of the land salinization in % of entire irrigated land*

According to Ministry of Agriculture and Watyer Resources (Minselvodkhoz) data of 2005, 51% of total irrigated land area is saline, of which 4% is strongly saline, 17% – moderately saline and 30% – slightly saline. Land prone to salinization are located mainly in the lower course of Amudarya River: in the Republic of Karakalpakstan, Bukhara, Kashkadarya, Khorezm provinces and in The Syrdarya River Basin – Central Fergana, Syrdarya and Djizak provinces (Figure 5.3.1). During 1995-2005 the areas with moderate and strong salinization increased by 14%.

> ***Reference***
> Soil is considered saline if contains in its mass more than 0.10% of salts that are toxic for plants or more than 0.25% salts of dissolved solids (for non-gypseous soils). For instance, cotton yield reduces by 20-30% in even slightly saline conditions, maize – by 40-50%, wheat – by 50-60%.

Increase of ground water consumption in aeration zone is expected due to the Climate Change. This will lead to growth of secondary salinization, land degradation and crop yield reduction.

Currently, irrigated land in Uzbekistan has low natural fertility – on the average land quality class is evaluated at 55 points (out of 100 points). The area of the most valuable land of over 60 points has diminished by 11% during the recent decade.

Soil erosion impacts agricultural crop productivity and pastoral vegetation. Around 56% of land in Uzbekistan is prone to deflation, about 20% - exposed to water erosion, in some particular provinces (Kashkadarya, Surkhandarya, Samarkand) this figure goes up to 50-80%, especially on mountainsides, at foothills and in adyrs.

Potential changes in *agroclimatic resources* caused by escalation of summer and autumn mean temperatures in upcoming decades will not make any significant impact on agricultural crop production in both, irrigated and rain-fed farming. The impact will increase only by 2050-2080, especially for the Northern regions where warming will cause a significant increase of vegetation period duration. Growth of agricultural crops yield in favourable agrometeorological conditions will be possible only with optimal *moisture availability (section 5.2)*, which remains a determining factor for productivity in Climate Change conditions.

Climate factors influence on crops productivity prevails in some years over the others. The most unfavourable weather conditions affecting crop yield include frosts, high and low temperatures, showers, hail, hot winds, dust storms, etc. For some provinces, the links between changes of cotton yield and meteorological factors have been revealed. Precipitation exceeding the normal rate by 1.5-2 times during 'planting–germination' period in Tashkent Oblast leads to reduction of cotton yield (Figure 5.3.2), same has been observed in Fergana Valley as well. This is associated with a reduced

temperature, formation of soil crust, delay of field operations and the necessity to replant.

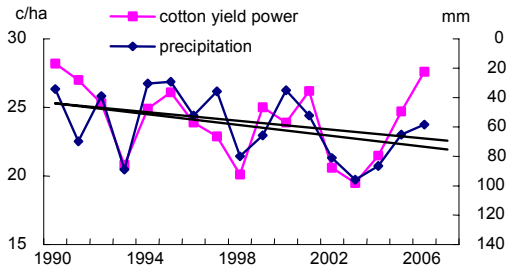

Figure 5.3.2 *Inter-annual fluctuations of cotton yield and precipitation amount in March in Tashkent province*

A positive correlation of cotton yield and air temperature during plant "sowing- sprouting" period is typical of Fergana Valley (Figure 5.3.3). For crops provided with sufficient moisture, higher air temperatures reduce the initial period of vegetation and facilitate a rapid accumulation of plant mass. Spring temperature increase caused by Climate Change will be a positive factor for formation of cotton yield, whereas precipitation increase in this season according to Climate Scenarios may provide negatively impact the productivity.

Cotton is most vulnerable to arid phenomena during the period of fruits formation and accumulation (June-August). Increase of the number of days with extremely high air temperatures (over 39°) caused by Climate Change will cause decrease of yield in several provinces: Bukhara, Kashkadarya, Tashkent and others. In low moisture conditions, yield losses due to extremely high temperatures may average at 9-15%.

At the current stage, the impact of the complex of unfavourable (mostly ameliorative) conditions on crop yield is observed practically in all provinces of Uzbekistan. The Figure 5.3.4 shows the dynamics of yield for cotton, rice, and maize in Tashkent Oblast and Republic of Karakalpakstan. It should be noted that after a long period of crop yield decrease, some positive trends in crop productivity have been observed in Uzbekistan in the last few years.

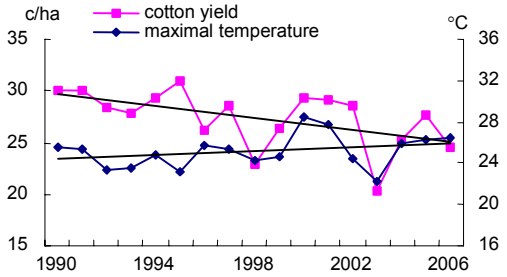

Figure 5.3.3 *Inter-annual fluctuations of cotton yield and mean maximal air temperatures for April and May in Fergana Valley*

The factors positively affecting crops productivity include *increase of carbon dioxide concentration*. It was proved that increase of carbon dioxide concentration combined with optimal moisture leads to increase of plant mass and yield of wheat, barley, sorghum, cotton and the other crops. However, for in Uzbekistan conditions, moisture deficiency and high salinization may completely eliminate this positive effect, since these factors impact crop productivity more significantly.

According to the estimate, if optimal *moisture supply* and satisfactory condition of ameliorative land is provided, the crop yield increase will average 10% on in most Oblasts of Uzbekistan due to increase of CO_2 concentration.

Thus, a set of various factors influences the agricultural crops productivity in Uzbekistan. Depending on established conditions (natural and climatic, socioeconomic, etc.) these factors manifest themselves to various extent. Long-term consideration of those is an important condition for food security assessment. However, the influence of climatic and other factors on crop productivity is complex. Assessment of mainly the impact of *water availability* on agricultural crop yield seems most feasible.

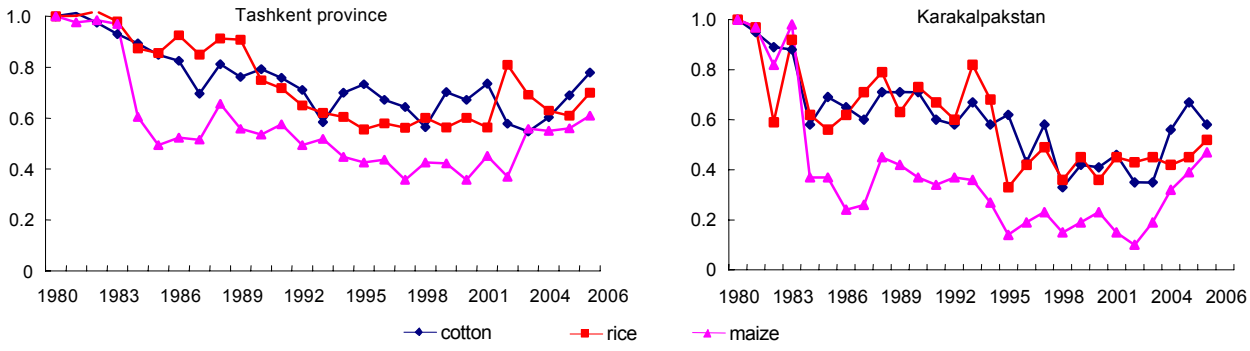

Figure 5.3.4 *Change of yield of cotton, rice and maize against 1980 for Tashkent province and Republic of Karakalpakstan*

Assessment of agricultural crops productivity loss

CROPWAT and ISAREG models were applied for assessment of Climate Change impact on key agricultural crops (cotton, winter wheat, rice, alfalfa and vegetables). Evaporative power, gross evaporation, irrigation rates (section 5.3), crop yield losses as well as long-term changes of these parameters according to Climate Scenarios A2 and B2 were calculated for Uzbekistan provinces.

Yield losses we assessed by yield proportion with optimal irrigation practice and irrigation water deficiency. The model was adapted for Uzbekistan via adjustment coefficients for various crops. Assessment of yield losses was carried out for the modern crops with existing land ameliorative condition and irrigation technology. The data by Minselvodkhoz on crops structure in prospective till 2011 were used for calculations. The estimates of the Centre for Socioeconomic Studies were applied for the later periods.

The Figure 5.3.5 demonstrates potential (mean and maximal) losses of various crops yield in Uzbekistan against the baseline period, with consideration of irrigation water deficit caused by evaporation.

Maximal losses were calculated using the values of close to mean quintiles characterizing extreme values of air temperature (p95) and precipitation (p50) according to Climate Scenarios data.

By model estimates, mean losses of cotton yield just due to evaporation increase are expected to be from 4% by 2030 to 10% by 2050, winter wheat – from 2% by 2030 to 4% by 2050, at that, maximal losses for majority of crops in extreme years may achieve 14%.

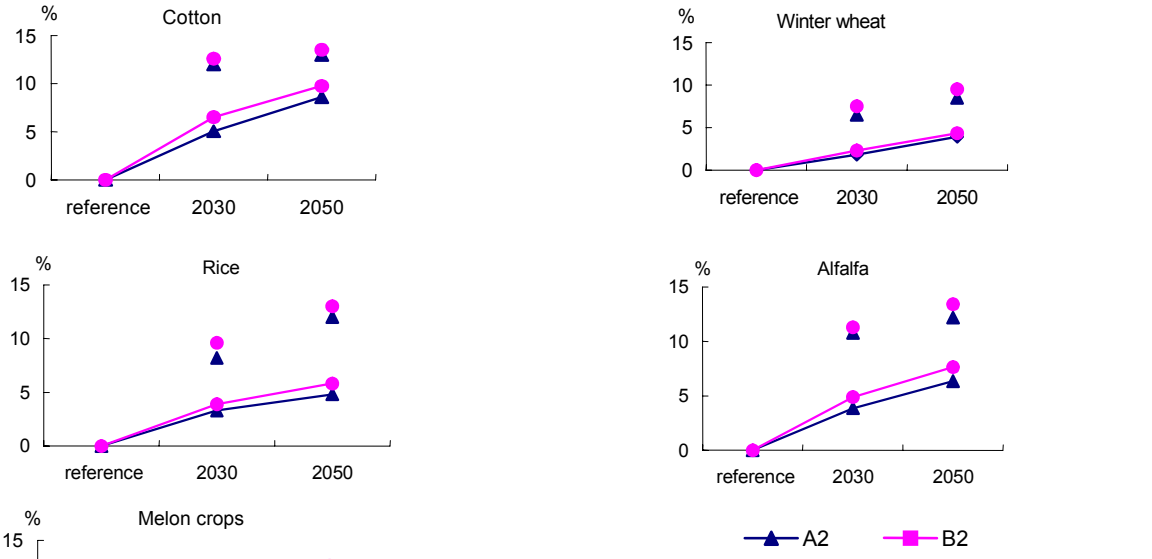

Figure 5.3.5 *Mean and maximal losses of various crops yield in Uzbekistan with irrigation deficiency caused by evaporation*

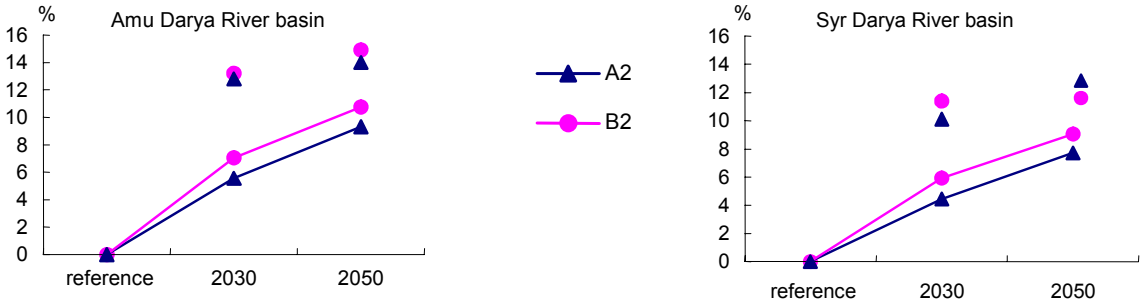

Figure 5.3.6 *Additional increase of the mean and maximal irrigation rates to compensate the losses of agricultural crops yield associated with evaporation increase in Amudarya and The Syrdarya River Basins*

Additional increase of the mean and maximal irrigation rates required for compensation of agricultural crops yield losses associated with evaporation increase in Amudarya and The Syrdarya River Basins for scenarios A2 and B2 is shown on the Figure 5.3.6.

Cotton plantations in Uzbekistan

Main losses of agricultural crops yield and adverse impact of Climate Change on food security with water resource deficiency will be largely shaped by flows of Amudarya and Syrdarya Rivers in future periods.

The data by provinces were grouped by river Basins for assessment of potential *crop yield losses* due to the Climate Change, since the long-term flow pattern of Amudarya and Syrdarya Rivers differs (subsection 5.2). Assessment of yield losses was carried out for the modern varieties with consideration of the existing salinization degree and the condition of irrigation and collector drainage network at current level of irrigation technology. Table 5.3.1 demonstrates model assessments of yield losses by crops for the future periods, depending on river flow in by Climate Scenarios A2 and B2.

The analysis showed the following:

- higher water consumption of a crop, higher is its vulnerability to change of hydrometeorological and hydrological conditions (rice, cotton);
- in prospective till 2030, potential mean losses of yield do not exceed 2-5% all over Uzbekistan;
- by 2050 the mean losses of yield due to climatic factors alone reach 11-13% for cotton and 5-7% for wheat in the Syrdarya River Basin; 13-23% for cotton and 10-14% for wheat in The Amudarya River Basin.
- in some arid years yield losses in The Syrdarya River Basin may achieve 15-17% by 2050, and 17-28% in The Amudarya River Basin.

On ***bogharic land*** of Uzbekistan, winter crops locate in the area of piedmont plains and foothills, as well as in range of subdued mountains. Depending on geographic location, slope direction, soil conditions the altitude of rain-fed area varies within the lower limits of 270-400 m to 1500-2000 m above sea level.

For the low mountainous bogharic regions, reduction of crop productivity will be the most probable effect of rapid increase of air temperatures. The adverse impact of the temperature increase on grains yield is in increase of gross evaporation, accelerated plant development and reduction of yield formation period.

Winter crops on bogharic land in Samarkand, Djizak and Kashkadarya provinces are most vulnerable to Climate Change. Yield will be identified by interplay of precipitation dates and vegetation phases. In general, precipitation increase expected by Climate Scenarios will be compensated by evaporation costs.

Orchards and vineyards occupy significant area, mainly in piedmont zone. Softening winter thermal conditions will allow for enlargement of vineyards areas through new piedmont regions development, as well as reduction of vineyard area to be covered for winter season; growth of summer temperatures is favourable for sugar degree increase.

Table 5.3.1 Yield losses (%) by crops depending on the year dryness by scenarios

Crop	Territories related to the river basins	Losses by scenarios			
		2030 – unchanged flow		2050 – flow reduction by scenarios	
		A2	B2	A2	B2
Cotton	Syrdarya	4.3	6.1	13.4	10.8
	Amudarya	5.7	7.3	23.1	13.7
Winter wheat	Syrdarya	1.7	2.1	5.7	6.5
	Amudarya	1.9	2.4	14.1	10.3
Alfalfa	Syrdarya	3.2	4.2	9.5	10.8
	Amudarya	4.1	5.5	19.1	12.3
Rice	Syrdarya	3.1	3.3	6.3	7.3
	Amudarya	3.9	4.3	13.3	10.3
Vegetables	Syrdarya	1.8	2.3	5.1	5.9
	Amudarya	2.6	3.4	14.4	10.3

5.3.2. Pastures

Desert ranges

Pastures are the primary feeding source for sheep breeding and as of 2006 they occupy 21 207.3 thousand ha, mainly desert ranges. Mean yield of desert ranges amounts to 1.4 -2.5 metric centners/ha and only in semi-desert piedmont regions it increases to 3.5 centners/ha. In favourable years the yield may be twice as much, and in unfavourable ones it decreases by two-three times.

Existing condition of range vegetation is characterized by thinness caused by anthropogenic and climatic factors. Intensifying anthropogenic impact on plant formation caused significant changes in phytocenosis in all areas of Uzbekistan. Sharp degradation and desertification problem retaining in arid and steppe zones will aggravate due to increase of livestock population and Climate Change, which will lead to reduction of range productivity.

Overgrazing and low watering of pastures is and will remain the main factor of range degradation. In such conditions the amount of plant species in phytocenosis reduces by 2-4 times.

In general, range productivity declined by 23% during 1995-2005 in Uzbekistan. In particular, a significant productivity decline occurred in the Republic of Karakalpakstan (27%), Navoi province (26%), Bukhara, Djizak and Surkhandarya provinces (17-18%), and to a lesser extent in Samarkand and Kashkadarya provinces (6-10%).

Expansion of the low yield areas is associated with deterioration of environmental condition of soil – their salinization causing reduction of biological productivity. Drying out area of the Aral seabed, surface of effluent saline lakes, and solonchaks are large sources of salt and dust spreading to pastures. There are about 120 km^2 of salt spreading sources only in Bukhara province.

For assessment of Climate Change related water sufficiency of range vegetation in prospect till 2030 and 2050, CROPWAT model was applied. Calculations were made for the most widespread plants of the desert area: white saxaul, astragalus, sandhill sedge and sagebrush.

Mountainous pastures

According to the model estimate, by 2030 and the more so by 2050, spring-summer vegetation of all desert plants species will start 5-10 days earlier compared to the baseline period due to air temperature increase; the gross evaporation will increase causing more rapid reduction of soil moisture reserves. Due to this, vegetation withering and the period of relative summer comfort will overall start as many days earlier as the vegetation. Therefore, due to Climate Change spring-summer vegetation period duration will practically not change and only its terminal dates will shift.

Calculations of range productivity demonstrate that with temperature growth and minor increase of precipitation in late winter and early spring yield without consideration of changes in land degradation and salinization, by 2030-2050 pasture yield will be: 1.9-2.1centners/ha for white saxaul pastures on sandy soils; 2.9 centners/ha for shrub ranges on sandy soils, 1.7-1.8 centners/ha on gray-brown soils. Such level of productivity will not allow meeting the fodder needs of growing livestock population.

The long-term air temperature increase by scenarios A2 and B2 will be the most apparent in winter season. According to the estimate, reduction of winter season is expected in the South and East of the desert area, and in semi-desert area by 20-30 days, by 20 days - in Central part of the desert area and by 10 days in the North.

Growth of air temperature in winter in Central Kyzyl Kum will cause change of water and thermal conditions, winter will become shorter and warmer, i.e. more favourable for sheep wintering. Temperature increase by 2050 will lead to replacement of winter regime with vegetation winters. Ephemera vegetation currently starting in the autumn will continue during winter. However, winter

vegetation does not promote grass growth in the spring, and ephemera pastures yield may decrease.

Increase of air temperature in the warm period, increase of the period duration with low water availability will negatively affect formation of autumn fodder reserves and hinder livestock production.

During minimum yield years when the annual fodder reserve is equal to 50-70% of normal rate, grazed livestock population consumes practically all this reserve. In such years grazing pressure especially increases.

Forecasted Climate Change, retaining of salt and dust spreading sources, low water availability on the pastures, and growth of livestock population will intensify range degradation providing significant impact on formation of fodder reserves and conditions of farm animal grazing. In this context, the following adaptation measures are recommended:

- introduction of the rational range utilization techniques and rationing of economic load to ecosystem;
- establishment of guaranteed fodder reserve based on irrigation and conditional irrigation for range livestock production development;
- utilization of mineralized and artesian water as well as temporal foothill effluent as irrigation sources;
- introduction of planted ranges with high yield fodder crops;
- over-grassing of ranges and establishment of various type of pastures (spring-summer, autumn-winter and year-round);
- rehabilitation of strongly degraded ranges;
- forest-phytomelioration of dried Aral Sea seabed and areas affected by salt and dust aerosols; reclamation of technogenically disturbed lands;
- restoration of mountainous, desert and flood-land areas, and forests;
- establishment of agro-bio-cenosis for fodder crop cultivation via desert phytomelioration;
- water acquiring via application of condensation on-ground structures for distant pasture cattle tending water supply;
- improvement of range vegetation condition monitoring techniques.

5.3.3 Assessment of Climate Change Impact on Karakul Sheep

Astrakhan (Karakul) sheep breeding plays an important role in Uzbekistan livestock production. Astrakhan sheep are the most adapted to the hard fodder and weather conditions of Central Asian deserts.

Astrakhan lambs

Currently over 4 million of Astrakhan sheep heads are grazed on the desert and semi-desert ranges of Uzbekistan. The normal vital activity of farm animals can be carried out only under optimal conditions, among them meteorological factors are very important. These factors impact the extent of tension experienced by thermoregulatory system of the organism, disease tolerance, growth and development, which, in general, determines the livestock productivity.

Thermal stresses depending on a complex of meteorological factors (solar radiation, air temperature and humidity, soil temperature, wind velocity, fleece state, physiological condition, etc.) are calculated using the thermal balance method.

For assessment of change of thermal pressure on Astrakhan sheep caused by Climate Change, equations of constraints for the thermal load with the maximal daily air temperatures were used in accordance with Climate Scenarios.

According to Scenarios A2 and B2, the thermal stress on Astrakhan sheep in May increases by 2-7%, growing 5-11% more by 2050, and 8-18% by 2080 (Figure 5.3.7).

Practically at all stations considered, highest growth of thermal stress on animals was observed specifically in September. In this context, wool cutting terms must be shifted to later period. However, delay with the autumn wool cutting causes cold sickness amongst the sheep that did not regain their fleece before the frosts.

For the cut sheep not to be affected by unfavourable hot conditions causing overheating of the organism, the wool cutting should shift 3-5 days earlier by 2030, and 10-15 days earlier by 2080.

July thermal pressure on Astrakhan sheep will grow not so intensively. In the North of Uzbekistan, in prospect till 2030 by scenarios A2 and B2 average thermal stress on Astrakhan sheep will increase by 5-7%, 8-9% by 2050, 13-14% by 2080. In the South of the Republic thermal stress will grow by 2-4% by 2030, 5-7% by 2050, and 9-12% by 2080.

After summer heat in autumn the sheep are in more favourable thermal conditions. However, at this period as well, sheep experience distress due to high day time temperature. Expected increase of air temperature will cause growth in number of unfavourable hot days to 0.5-1.7 days a decade.

In September a more significant increase of thermal stress on Astrakhan sheep is possible: 5-11% by 2030, 8-16% by 2050, 13-25% by 2080 (Figure 5.3.7).

Artificial covers and facilities for shielding the animal body from direct solar rays reducing level of thermal stress are recommended as adaptation measures. Intensive night grazing and watering are prerequisite for enhancing of nutritional state and milkiness.

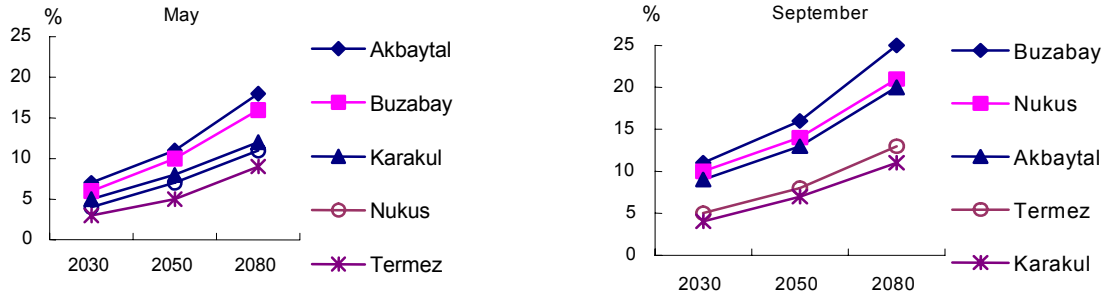

Figure 5.3.7 *Deviation of thermal stresses on Astrakhan sheep from baseline (%) in May,, average for scenarios A2 and B2*

5.3.4. Possible Benefits and Risks induced by Climate Change for Agriculture

Climatic conditions change determines the necessity for agricultural practice adjustment in the future. Warming facilitates movement towards the North of thermophilic crops (cotton, grapes, ground-nut, persimmon, pomegranate, fig, etc.); higher carbon dioxide concentration in air promotes increase of yield, in particular, for type C-3 plants (wheat, rice, barley, potato, etc.). Plants of type C-4 (maize, sugarcane, sorghum, millet, and some fodder crops) have lower response to increase of CO_2 concentration, but are able to use water more efficiently.

However, with existing agricultural practice in Uzbekistan's conditions, significant reduction of agricultural output is possible in future. Assessment demonstrated that it can already occur at warming by 2, 0-2, 5°C (by 2050). According to Climate Scenarios, increase of arid and hot period duration is expected along with increase of evaporation, precipitation and, probably, frequency of heavy precipitation. As a result of more intensive hydrological cycle losses of soil moisture will grow and soil erosion and salinization process will accelerate. In a number of regions currently vulnerable to droughts more long-lasting and intensive periods of arid weather will come.

Table 5.3.2 Potential benefits and risks in agriculture when Climate Change

Potential benefits	Risk factors	Negative consequences
Increase of vegetation period, especially, for industrial crops With optimal water availability and satisfactory land ameliorative condition increase agricultural crop productivity and range vegetation is possible via growth of CO_2 concentration Expansion of cultivation area of intermediate and late crops towards the North Potential of multiple land utilization under the various crops Improvement of livestock wintering conditions and kittening under the free-range livestock production conditions	Decrease of irrigation rates due to water resource deficit Intensification of soil salinization Increase of impact duration and intensity of unfavourable meteorological factors Intensification of pathogenic flora and fauna expansion (weeds, pests, wilt and the other diseases) Increased arid and hot period of the year Reduction of range yield Increase of the thermal stress on the animal organism	Intensification of water stress impact, increase of water demand Losses of agricultural crops yield due to irrigation water deficiency, air drought, land degradation, intensification of water and wind erosion, soil salinity and reduction of humus concentration Fodder base deterioration and livestock production decrease

Key risk factors for Uzbekistan agriculture are associated with the following aspects:

- climate aridization;
- intensification of water resource deficiency;
- additional thermal stress on animals and plants, especially with water deficit;
- expansion of areas of spread of plant disease, weeds and pests.

Potential benefits, risk factors and negative consequences are shown in Table 5.3.2.

5.4. Climate Change and Food Security in Uzbekistan

Agriculture of Uzbekistan plays the key role in ensuring of economic and social sustainability. Its condition impacts the potential for increase of the population wellbeing, economic abundance, consumer market equation, and food security to a large extent.

Key trends of agricultural development and food security

> ***Reference***
> By FAO definition, food security means guaranteed access for the planet population, citizens of the country and region to the most important foodstuffs at any time and in any amount required for their active and healthy life.

Ensuring food security via domestic production is a priority for Uzbekistan. Up to 80% of the foodstuff required for the population is produced in Uzbekistan.

Currently, Uzbekistan is self-sufficient in cotton oil, fruit and vegetable production, grapes, melons, etc. During recent decade, the cattle, sheep, goat and poultry population increased due to private farming (Table 1.5, section 1.5), also production of main types of livestock is stably growing.

The level of grain production per capita is the most integrated criterion of food security, and the level of food status sustainability is evaluated through indicator of output volumes of carry-over grain stocks remaining in reserve before the next harvest.

Up-to-date, a significant growth of wheat yield is observed in Uzbekistan, and, despite high birth rate, positive trends of the grain production per capita are maintained in the country (Figure 5.4.1). The policy of covering domestic wheat demand remains a long-term priority for Uzbekistan, not eliminating import of grain and other foodstuff in acceptable amounts.

Uzbekistan is the area of risky farming and over 90% yield is cultivated on irrigated land. For instance, according to the estimate, due to water resource deficiency caused by drought in 2000-2001, losses of grain crops yield (Figure 5.4.1) amounted to 14-17%. Apparently, food security will be under the threat further on in case of unfavourable climatic conditions and insufficient water availability along with reduction of land fertility and significant population growth.

Due to Climate Change and growth of air temperature, evaporation from irrigated fields increases. This will lead to increase of water consumption in irrigated areas. According to the model estimate, by 2050, on the average in Uzbekistan, irrigation rates increase may achieve 8-11%.

Losses of yield of winter wheat, rice, vegetables, and melons due to evaporation increase by 2030 will not exceed 4% overall. But by 2050, mainly, losses of these crops yield only due to climatic factors may achieve 7-14%.

Reduction of irrigated arable land area due to increase of the soil salinity and degradation is another unfavourable factor affecting agricultural output of the Republic.

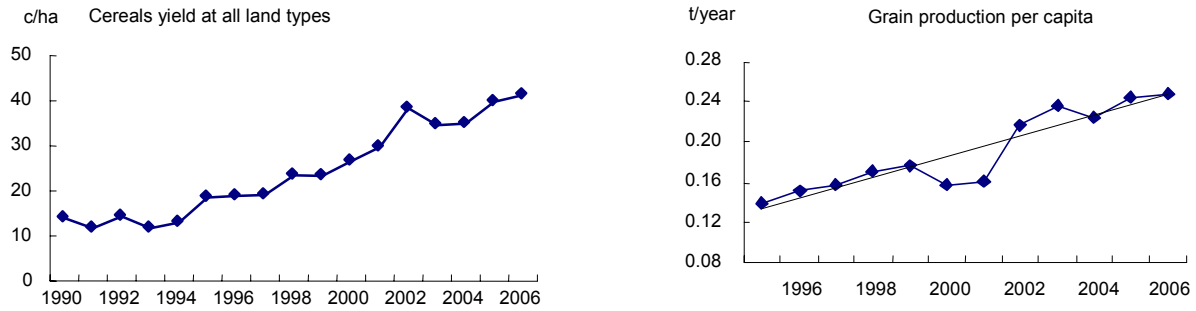

Figure 5.4.1 *Change of the wheat yield and grain production level per capita in Uzbekistan*

Moreover, in some regions of the country due to water resource deficit, unfavourable soil and amelioration land conditions, arable land is underused (Figure 5.4.2).

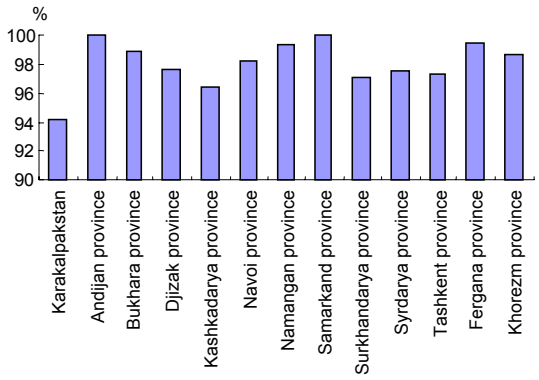

Figure 5.4.2 *Cultivated area in % of entire irrigated arable land*

According to Minselvodkhoz, for food security stabilization and long-term diversification of agricultural production, reformation of the crops structure is planned in prospective till 2011. Relative to 2005, a reduction of cotton cultivation area by 4.5%, and grain cultivation area by 6.7% is possible in the Republic. Expansion of the following areas is expected: rice - by 23.8%, vegetables – by 40.8%, melons – by 42.2%, potato – by 54.9%, fodder crops – by 28.7%. Rice is supposed to be cultivated only in 4 provinces instead of eight, mainly in Khorezm province (on 27 thousand ha). At that, the yearly growth of agricultural output has to achieve 4.5-6.2%.

For implementation of plans the following is required: implementation of the national programs on improvement of land ameliorative condition and water economy development on the highest level; adequate limit of water resources received from sources of interstate significance and favourable climatic conditions.

According to the estimates of the Centre for Social and Economic Research, by 2050, reduction of cultivated areas and decrease of cotton share from 40 to 30-36% is expected for optimization of long-term water saving, mainly in Karakalpakstan, Andijan, Bukhara, Syrdarya, Tashkent and Khorezm provinces. By 2050 wheat share in crops structure will probably decrease to 30-36%, fodder crops share – to 13-17%, potato, vegetables and fruits and berries – to 15-17%. By baseline scenario (maintenance of achieved rates of growth of economic development and high rate of population growth), the gross grain harvest will stabilize at the level of 6,500 thousand ton; according to updated scenario (with higher paces of agricultural sector growth and lower paces of population growth) – it will increase to 7,200 thousand tons; gross raw cotton harvest will amount to 3,700-3,800 thousand tons and 4,000 thousand tons respectively.

Maintenance of raw cotton production sufficient for stabilization of annual export and exchange balance of the country is supposed to be carried out through increase of yield and fiber quality, increase of irrigation systems and irrigation techniques efficiency as well as favourable social factors.

For ensuring the food security of the country it is necessary to consider that due to the population growth the share of cultivated areas per capita will reduce from 0.15 ha in 2006 to 0.11-0.09 ha by 2050. Cereals output per capita will reduce from 0.25 t/year to 0.15-0.16 t/year, raw cotton – from 0.14 t/year to 0.086-0.11 t/year.

According to the model estimates (WEAP), by 2050 intensification of water deficiency up to 11-13 km^3 is expected associated with climatic factors. Moreover, sustainable population growth and structural economic changes will increase the number of water users in agriculture causing water withdrawal increase and agricultural output instability.

Therefore, predicted trends of economy development, complicated demographic situation along with Climate Change and available water resources provide the ground to expect aggravating of the problem in agrarian sector of Uzbekistan, and, hence, destabilization of food security.

The combination of negative factors with intensive population growth, in particular, by unfavourable scenario, may lead to agricultural output deficiency of 10-15% by 2050, compared to the current period.

In this context, settlement of the issues of integrated approach to planning and management of agricultural land and water resources, development and implementation of the programs on improvement of the land ameliorative condition and water economy development is the most crucial and immediate modern problem.

Table 5.4.1 Strategic areas in agriculture and adaptation measures to the Climate Change

Strategic areas	Adaptation measures	Challenges and bottlenecks
Reduction of losses and water saving in agricultural sector	Adjustment of water consumption rates taking into account the natural peculiarities, land ameliorative condition and Climate Change; revision of water use limits Revision of water use standards on the basis of evidence based UN programs "ISAREG" и "CROPWAT" recommended by FAO Development of the zonal indicators of water potential productivity for providing the privileges to water users Improvement of irrigation and drainage system and increase of irrigation systems efficiency Improvement of condition of operating rice irrigation systems Reduction of water losses via forestation the field edges Chemicals utilization for evaporation reduction from water surface Education on water conservation (saving) practices	Restricted financial and insufficient technical capacity. Insufficient attraction of investments
Improvement of irrigation technology	Introduction of irrigation rotation, water-efficient processes with application of the state-of-the-art hardware and irrigation technology Improvement of existing irrigation techniques (application of surface furrow irrigation, night irrigation, sprinkling irrigation, subsoilwater irrigation, drip irrigation, etc.) Specification of the regional assignment in terms of irrigation technique by provinces given the local peculiarities and variation of water consumption by crops Upgrading the systems of pump irrigation for water resource saving Selection of agricultural crops less consuming irrigation water	Restricted financial capacity for universal introduction of recommended measures and further scientific research and observations. Lack of investments
Improvement of agricultural engineering	Shift to the advanced techniques of effect the seed quality and plants for acceleration their growth and development, improvement the efficiency of macronutrients and micronutrients in soil Recovery of eroded, saline irrigated lands, including desalinization of saline soils and removal of toxic water soluble salts Reduction of wind erosion impact, conducting phytomeliorative activities with application of trees planting Recovery of strongly degraded ranges, introduction of he range management techniques Removal from agricultural crop rotation hardly ameliorated and low-yielding lands, as well as their utilization as the ranges and reserves Development of new approaches to saline soils reclamation with application of new cutting-edge technologies Improvement of plant protection means with application of chemical and biological methods	
Consideration of change of agricultural climatic indicators by the area	Development of the guidelines on crop composition given their water demand due to Climate Change Selection of the drought resistant agricultural crops, improvement of allocation pattern of agricultural crops for current period and in the long-term Expansion if the area under crops with the short vegetation period as well as with winter vegetation ones Introduction of the cotton-alfalfa crop rotation, application of bioengineering achievements for recovery of soil fertility Intensification of selection activities on introduction of high-yield early- and late-ripening varieties; efficient application of mineral and organic fertilizers	
Organization and legislative practice	Development of the system of land resource integrated management including formation of organizational legal and economic mechanisms of the land relations control, as well as the land protection and rational utilization Improvement of existing legislation on water and land-related aspects, enhancement the farming culture, respect of the legal basis of the land users, strengthening the liability for the soil fertility conservation and maintenance Improvement of the nationwide structure of hydrological and agricultural meteorological monitoring system Enforcement the policy aimed on introduction of resource saving and low-waste (safe) technologies of agricultural output cultivation as well as improvement of agricultural output processing techniques Development of agricultural climatic expert-advisory system enabling utilization of updated scientific and practical information in the field of agronomy, both in large and small farms	Lack of the farmers' awareness and education Restricted financial capacity Low activity of farmers' associations

Analysis of agricultural sector activities for food security ensuring

Perspectives of agricultural output development are mainly determined by the soil climatic conditions, water resource availability, land ameliorative condition, optimal structure of crop allocation, and observance of agricultural engineering of crop cultivation, as well as demand dynamics and world prices for agricultural output along with potential of further development of irrigated farming.

In the area of insufficient humidification adaptation measures due to Climate Change have to be focused on water resource saving through:

- a widespread introduction of water saving technologies;
- optimization of crop allocation;
- expansion of drought resistant and salinity tolerant crops plantations;
- expansion of winter crop cultivation, crop rotation.

In the area of sufficient humidity, Climate Change adaptation measures have to be focused on utilization of additional resources associated with the climate warming through:

- increase of the share of more productive fodder crop species;
- increase of specific weight of livestock farming;
- expansion of economically cost-efficient irrigated farming focused on intensification and stabilization of agricultural output;
- development of highly intensive farming, mainly for cotton production.

Moreover, adaptation strategies and activities in agriculture need to be efficient in terms of their feasibility, financial costs, and usefulness in current period and in the long-term.

Adaptation measures provided in Table 5.4.1 are proposed for ensuring food security under the Climate Change.

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5.5. Hazardous Climatic Phenomena and Risk Management Opportunities

Global warming facilitates increase of periodicity of extreme and hazardous hydrometeorological phenomena. Uzbekistan is the most vulnerable to such phenomena as droughts, high temperatures, heavy precipitation, mudflows, floods and avalanches.

High country's vulnerability to the hazardous hydrometeorological phenomena causes governmental response on population protection from extreme situations associated with mudflows, floods, landslides and their effects mitigation. The National hydrometeorological service (NHMS) of Uzbekistan provides forecasts and warnings; Ministry for Extreme Situations (MES) is operating in close coordination with local authorities.

Practice shows that extreme natural phenomena regularly take place, but their effects degree entirely depends on extent of country or certain region preparedness for countering the natural disasters. In this context, the change of natural risks on the territory of Uzbekistan associated with ongoing Climate Change has to be evaluated.

5.5.1. Hydrological Drought and its Consequences, Forecast and Early Warning

The warming is accompanied with increase in number of abnormally arid and warm periods, which changes the cycle of water resource formation, facilitated aridization and reduction of the land fertility, as well as appearance of additional adverse effects along the Aral Sea Basin, especially, in the Aral Sea region.

Hydrological drought, first of all, is determined with the weather and natural conditions in the **river flow formation area** – rainfall regime, air temperatures, processes of formation and melting the seasonal snow cover and glaciation.

Assessment of changes of rainfalls and air temperatures in the mountainous river basins and calculations of the show cover made with application of hydrological models demonstrate that extreme low water occurs with rainfall deficiency in January-March and with elevated air temperatures. Under such conditions there is no sufficient snow accumulation causing flow deficiency in vegetation period. For instance, in 2000 low water year inflow formation in Charvak reservoir can be traced on the charts provided on the Figure 5.5.1, where flow hydrograph, annual rainfall and air temperatures trends are illustrated for the Pskem and Chatkal River Basins contributing the water inflow in the reservoir.

Area of the flow dissipation and consumption. In Karakalpakstan, Khorezm, Bukhara and Navoi provinces located in the middle and downstream of Amudarya River Basin the droughts occur much more frequently, both as a sequence of natural reasons (climate, remoteness from the natural water flows and area of the flow formation), and due to anthropogenic factors – water use and consumption practice.

Hydrological drought is closely linked with the soil drought. In arid 2000 with rainfall deficiency in autumn-rwinter period unfavourable conditions for the harvest formation were observed. By the end April in certain regions withering of winter crops with irrigated cultivation was observed. Due to the drought, harvesting area under the cotton was 68 thousand ha less compared to the cultivated one. In the rain-fed area already in beginning May complete crop withering and burnout occurred.

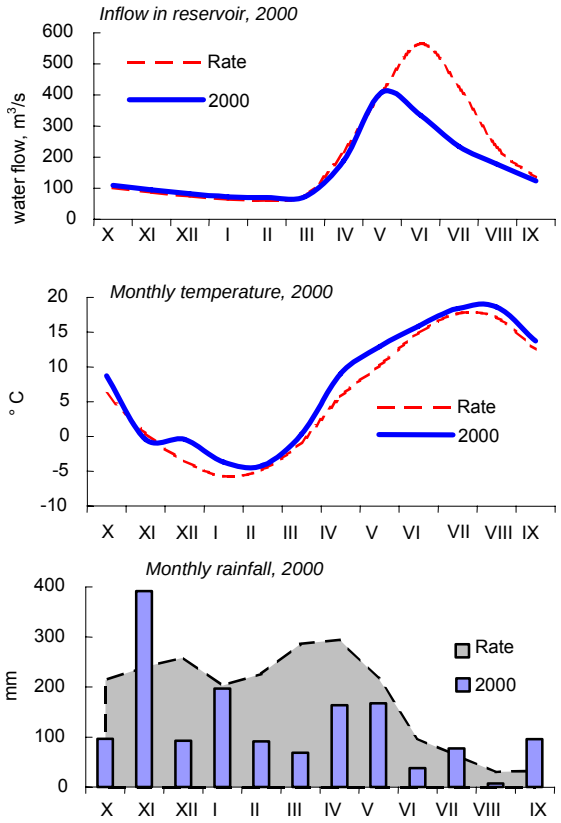


Figure 5.5.1 *Annual flow allocation in Charvak reservoir, air temperatures, rainfall in 2000 low water year*

Due to the low water and uncontrolled water resource use the drought was observed in Amudarya River downstream (2000-2001), causing extensive damage.

Due to expected future reduction of water resources in the area of the flow formation, increase of water consumption in all sectors due to the Climate Change and intensive population growth in the region, the drought risk may significantly elevate.

Water supply to rural population

Currently, Uzbekistan has not established the drought early warning system including the measures on prevention and mitigation of the drought consequences, though potential for this system establishment is available in the Republic. Rather developed organizational structures are in place (MES, Uzgidromet, Minselvodkhoz, etc.); the concept of the drought early warning system was developed based upon application of all existing scientific findings in the field of the forecast of all drought forms (system of mathematic models describing the process of the mountainous rivers flow formation, model set of information database, etc.); recommendations on overcoming the drought consequences. Uzbekistan is in charge for establishment of the drought early warning system in the frame of the Regional action program.

Qualitative monitoring in the area of the river flow formation required for analysis the processes of the snow accumulation in the river basins and timely detection of the hazardous trends is the foundation of development of the drought early warning system. Long-term (monthly and seasonal) forecasts are the other important component of the drought early warning system.

Therefore, enhancement and development of the system of hydrometeorological monitoring and improvement the quality of the long-term hydrological forecasts are the measures for the drought management and its consequences mitigation.

Under the growing water resource deficiency development and introduction of the drought early warning system will be one of the key measures of adaptation to the Climate Change and reduction of its adverse effects. Obtainment of the early information on the water resource condition, potential after-effects differentiated by the provinces, will enable preparing to the future drought impact and implement action plans developed in advance. This will reduce potential damage for the population, agriculture and entire economy.

The system of measures focused on prevention and mitigation of the drought adverse effects includes:

- identification of the single cross-border water use concept under expected hydrological drought conditions;
- drought forecast and assessment of its socioeconomic consequences;
- development and implementation of the task-oriented programs focused on the drought prevention and risk reduction for agriculture;
- ensuring preparedness of the management agencies and systems for prevention and mitigation of hydrological drought for extreme situations liquidation;
- development of the drought monitoring, collection, processing, exchange and providing the information on the drought prevention and assessment the vulnerable territories;
- preparation of population, officials of the management bodies to the actions under the drought;
- liquidation of hydrological drought after-effects;
- implementation the measures on the social protection of population affected by the drought;
- establishment and operation of the Drought Monitoring Centre.

5.5.2. Hazardous Hydrometeorological Phenomena

Mudflows and floods. All rivers in Uzbekistan, including temporal water streams within the mountains and foothills are hazardous in terms of mudflows. The territories potentially vulnerable to the risk amount about 12% of the country space, with population at least 4 million people. While development of the piedmont and low mountain territories this share of population is increasing.

The lower areas of the river valleys where the mudflow mass deposits occur are the high risk areas of mudflows and floods.

On the average, for Uzbekistan rivers 22 mudflows a year are, they frequently cause the tragic consequences. Intensive rains as well as inrush of the highland and moraine lakes, frequently due to intensive snowmelt, are responsible for the mudflow formation. Period of the highest mudflow risk is

March-July (96% of total mudflow). Frequently, mudflow formation has transboundary nature, and mudflow origin takes place on the territory of the cross-border countries, and adverse effects appear on the territory of Uzbekistan (Figure 5.5.2).

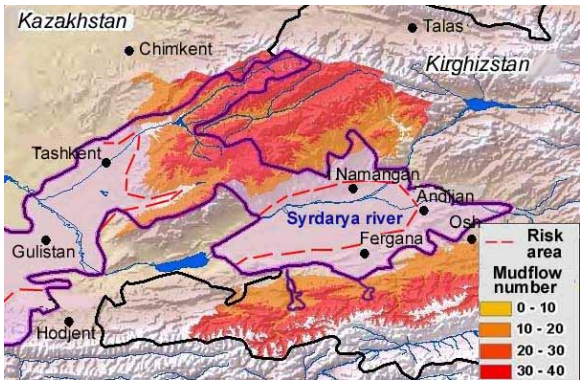


Figure 5.5.2 *Mudflow number per century and mudflow risk areas in Fergana Valley and Chirchik-Akhangaran Basin*

Key factors of mudflow activity intensification in line with the Climate Scenarios:

- rainfall increase and their variability enhancement;
- increase of the daily rainfall peaks;
- increase of the rain precipitation share;
- snowmelt intensification;
- rain flood overlapping over the melting one.

For the Climate Change impact assessment statistical approach was applied. Analysis shows that around 90% of the mudflows are formed with the shower involvement. The daily peak of precipitation, mean annual number of rains, quintiles of daily precipitation and mudflow periodicity were selected as the key indicators. Assessment of the changes of the rain-related mudflow periodicity for the Climate Scenarios A2 and B2 for 29 rivers with the longest observation periods was made on the basis of statistical dependences among selected indicators.

Assessment demonstrated that change of the mudflow risk extent for various altitudinal zones will occur in line with the values of the rainfall change. The largest increase of the mudflow periodicity is possible when implementing scenario A2 (Table 5.5.1).

Numeric evaluations of the rain flood peak flows 1%-occurrence were made with application the methods developed for the Central Asian region. Calculations illustrated increase of the peak flows of the rain and caused by them the mudflow floods (Table 5.5.1) Small rivers of the low mountain area of Uzbekistan are the most vulnerable ones, where the mudflow formation occurs due to the rare but very intensive rains.

In entire Uzbekistan increase of the mudflow number can be expected by 2030-2050 to 19-24%, compared to the current situation, along with the lower increase by 2080 (12-13%). Increase of the mudflow risk period is also expected.

Table 5.5.1 Climate Change impact assessment on the mudflow activity indicators

Climate Change impact	**Assessment of localization and impact scale in line with scenarios, compared to current situation**			
	localization	2030	2050	2080
Potential change of the mudflow periodicity (%) scenario A2	Low mountains	+49	+35	+9
	Medium mountains	+19	+22	+12
	Highlands	-10	+30	+25
Increase of the peak flow of the mudflow floods (%) for scenario A2 and B2	Small rivers	10 35	16 22	21 52
	On the average for Uzbekistan rivers	12 22	21 27	29 32

Therefore, the future risks from the mudflow activity on Uzbekistan rivers will increase. Specific danger represent the river plain floods and low river terraces, with potential bank destruction, stream-way deformation, mudflow mass deposit, block appearance and increase of the flood level.

Outburst risk lakes. Particular catastrophic mudflows are originated when the highland lakes outburst. Territory of Uzbekistan is threatened with 271 lakes of various origins, and their majority is located outside Republic. The largest one – Sarez Lake located in Tajikistan, in the central part of Murgab River (Amudarya River Basin).

In increased water availability years the monitoring of the highland periglacial and rock-dammed lakes is being conducted. Aerial visual observations are carried out in the period of the maximal water mass accumulation in the lakes, and the field ones (Ikhnach and Shovurkul lakes) – in the outburst risky period (Figure 5.5.3). Data on the lakes condition are delivered to the MES of Uzbekistan and the other concerned organizations. However, currently, the possibility of aerial visual observations of the outburst risky lakes located outside the Republic depends on the cross-border states (Kyrgyzstan and Tajikistan).

Figure 5.5.3 *Rock-dam between the lakes Ikhnach – large and Ikhnach – lower (the traces of the ravine erosion are clearly traced on the dam body)*

Climate Change impact assessment on the outburst risky lakes showed that increase of the air temperatures in the mountainous area and intensification of the rainfall variability would cause increase of altitudinal limit of the lakes existence, probability of the new lakes formation in the area of the glacial recession will increase along with their outburst danger. In general, the mudflow risk from the lake outburst in the upper mountains will grow.

Avalanches. Avalanche activity is shown practically everywhere where scarp slopes exist and heavy snow cover underlay. Avalanches impact on many sectors, transport sector is specifically vulnerable with high probability of the human lives losses (Figure 5.5.4).

Periodicity of the avalanching and avalanche sizes as well as altitudinal scope of their impact are the informative indicators of avalanche hazard. Under Uzbekistan conditions altitudinal scope from 2000 to 2900 m is the most probable one for the avalanche formation (73.4% of all avalanches has been recorded). The main area of the avalanche deposition is located in the range of the altitudes from 1.400 to 2.900 m; however, the avalanche hazard is being traced lower as well.

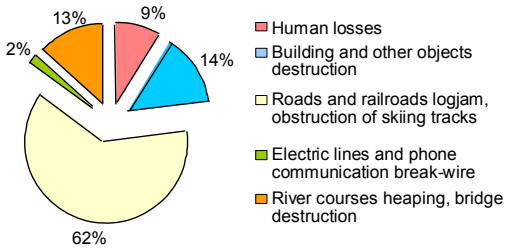


Figure 5.5.4 *Avalanching damage distribution in Uzbekistan*

Assessment of the avalanche risk for the motorway section Tashkent – Osh in the region of mountainous pass Kamchik demonstrated that in absence of the avalanche control in average in terms of the winter conditions years 10-28 people may lose their lives on the highway, and in extreme years – 21-42 people. It should be noted, that in winter 1999-2000 when the total snow accumulation amounted about 50% of the standard one, 29 people lost their lives due to the avalanche, therefore various measures of the avalanche protection as well as monitoring are carried out here.

Monitoring of avalanche hazard is conducted in recreation area of Uzbekistan – Chimgan. Large-scale map of the avalanche hazard were developed for this purpose.

For assessment the avalanche hazard for future the data of the Climate Scenarios (temperature and rainfall on the mountainous stations) were applied along with the data of probability of the avalanche formation depending on the mountainous slopes degree and snow cover thickness. The estimates were carried out with application of the digital relief model.

Assessment of the avalanche hazard elements was made with application of regressional relationship among the air temperature, gross precipitation for the various periods, snow cover characteristics and snow-slide activity. Snow cover and avalanche activity characteristics were calculated for the future (by 2030, 2050, 2080) for the avalanche stations of Uzbekistan and schematic maps of avalanche regime were developed with GIS application for Chirchik-Akhangaran Basin (Figure 5.5.5).

Cartographic analysis showed that reduction of the avalanche hazard indicators was expected for Tashkent province recreation areas, densely populated regions and Kamchik pass. However, many territories still remain in the area of the high avalanche risk in terms of avalanche period duration, number of avalanches and their potential peaks.

According to the estimates, on the average for scenarios, the avalanche hazard in Uzbekistan due to the climate warning will reduce approximately by 1.2-1.3 times by 2030-2050 and more than by half by 2080.

Probability of the sites destruction will slightly reduce (2-14% by 2050 compared to the current period).

By 2030 the avalanche period duration practically remains the same, and in the long-term (by 2080) its reduction by half in the low mountain basins is possible.

With the general trend of the avalanche activity reduction due to the Climate Change in Uzbekistan, the upstream of Akhangaran River Basin remains the most avalanche hazardous one in terms of all avalanche mode indicators (Figure 5.5.5). This determines specific necessity of the measures for mitigation the adverse effects of the avalanche activity in this region.

Measures on mitigation the adverse effects of the floods, mudflows and snow-slides are split into three types:

1. Organizational measures:
- Ensuring protection measures when construction the sites in the mudflow and avalanche hazardous areas;
- development of monitoring of avalanches, mudflows and outburst risky lakes;
- improvement of information warning system, including interstate one, on potential mudflow and avalanche hazard.

2. Technical measures:

- protection of the residence and sites from the mudflows and avalanches with the help of hydrotechnical and avalanche-protection constructions (debris basins, mudflow flumes, tunnels, avalanche-protection galleries, etc.) in the most risky regions;
- carrying out preventive avalanche release;
- warning systems introduction.

3. Exploration and plans:

- development of the large-scale maps of the avalanche and mudflow hazard;
- development/updating of recommendations for the planning institutions and decision makers;
- improvement of the forecast techniques of the hazardous phenomena and warning systems;
- improvement of insurance system.

Existing strategy and specific activities on reducing the risk of the mudflow and avalanche hazard are specified in the Decree by the President of the Republic of Uzbekistan of February 9, 2006 *"On the high priority measures on protection the population and territories from extreme situations associated with the mudflow-flood and landslide phenomena as well as on their consequences liquidation*".

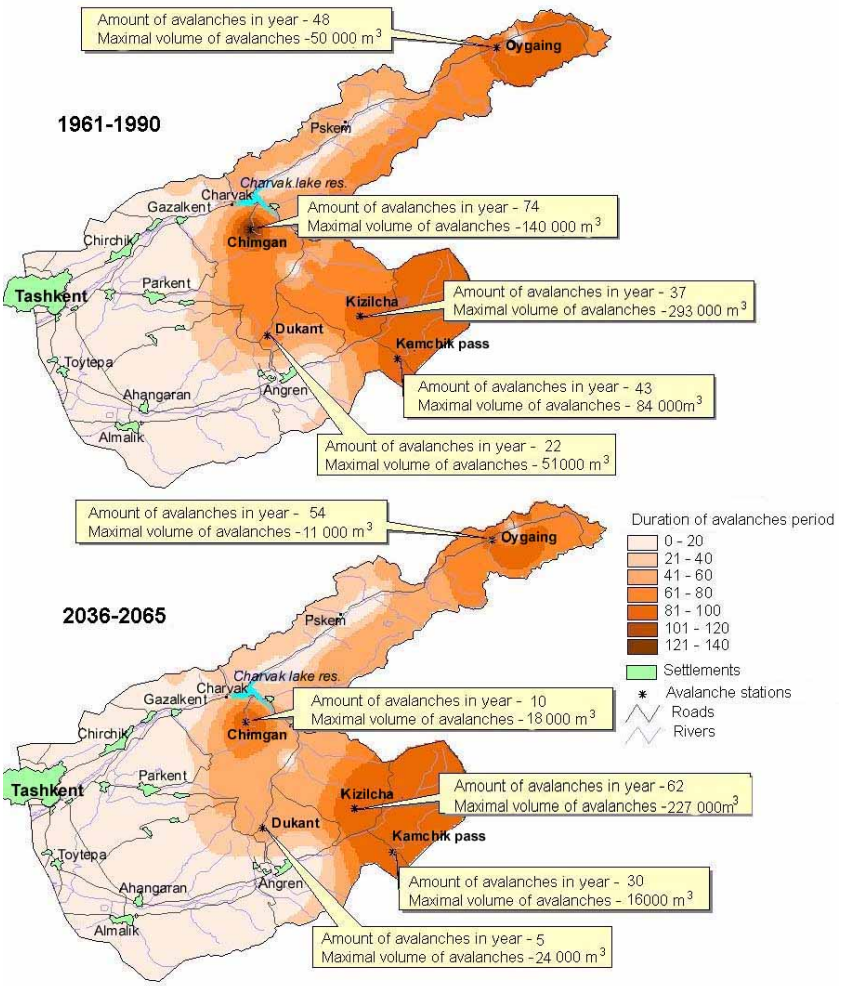


Figure 5.5.5 *Schematic map of the avalanche mode indicators for Chirchik-Akhangaran Basin for the reference climate period and by 2050, on the average for scenarios A2 and B2*

Frosts. Frosts relate to the hazardous meteorological phenomena (minimum temperature reduction to 0°C and lower in the air or on the soil surface in vegetation period against the positive air temperature).

Assessment of the shift of extreme frost mean dates for long-term was carried out on the basis of statistical links of the overpass the mean daily air temperature through 10°C and extreme frost dates, as well as the data of the Climate Scenarios. The Figure 5.5.6 provides the mean climatic (1961-1990) and estimated data of the last spring frosts for the future periods for the Climate Scenarios A2 and B2. According to scenarios, extreme frost dates will shift towards the winter on entire territory of the Republic.

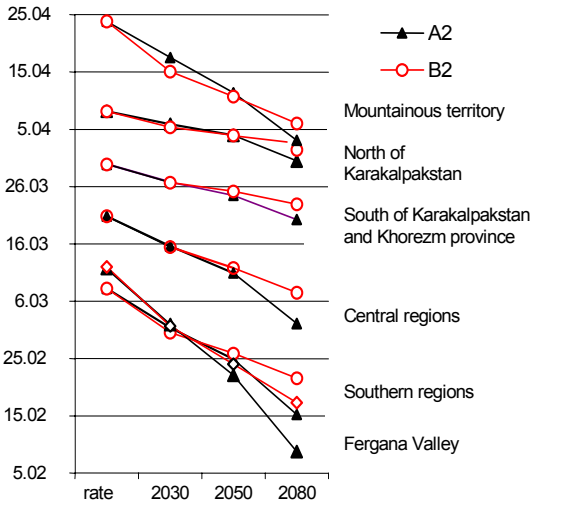


Figure 5.5.6. *Mean climatic and estimated data of the last spring frosts for the future periods for scenarios A2 and B2 in various regions of Uzbekistan.*

The most significant shifts are expected in the Fergana Valley, where in line with two Climate Scenarios by 2030 the mean dates of the last frosts will fall to the beginning spring, by 2050 – to the third decade of February, by 2080 in line with scenario B2 – to the second decade of March, and in line with scenario A2 – to the first decade of March.

The Figure 5.5.7 provides the mean and estimated data of the first autumn frosts in Uzbekistan regions for scenarios A2 and B2. The most significant shifts of the first frosts are expected in the mountainous area: by 2030 this date will shift towards beginning of second decade of October, by 2050 – towards the mid second decade of October, and by 2080 extreme autumn frosts will fall on beginning the third decade of October.

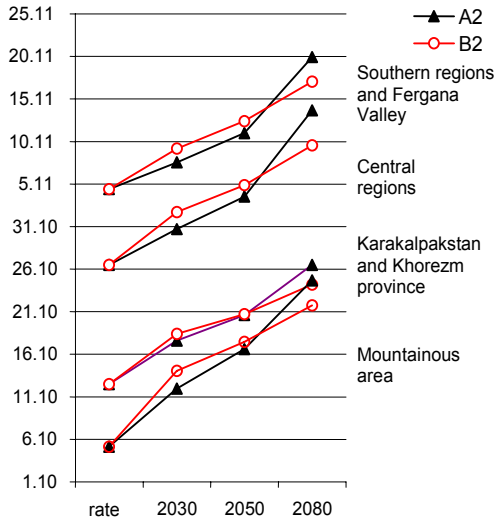


Figure 5.5.7 *Mean climatic and estimated data of the first autumn frosts for the future periods for scenarios A2 and B2 in various regions of Uzbekistan*

Due to retention of the risk of the late spring and early autumn frosts on the territory of Uzbekistan against the climate warming, the following activities are required:

- development of the forecast techniques of the spring and autumn frosts;
- improvement the frost protection methods and means;
- updating the microclimate regional assignment of the agricultural land frost hazard;
- cultivation of agricultural crops in the optimal terms for each crop given the Climate Change.

Heavy precipitation and hail. Heavy precipitation relate to extremely hazardous weather phenomena. Long widespread rains and short showers hinder the vehicular traffic eroding the roads and takeoff strips at the small airdromes, and sometimes destroy the buildings. Moreover, they cause the mudflows. Heavy snows create additional loads on constructions and complicate the transport operation, as well as cause the avalanche formation and avalanching.

Significant and heavy rains in spring may lead to the soil crust formation and cotton seed collapse, germination damage and replanting on expansive areas. Showers in early spring may also cause collapse of inflorescence and buds of the fruits and berries, i.e., provide significant damage to agriculture.

The studies show, that the warming in Uzbekistan is accompanied with enhancement of the weather extremeness, in particular, increase of the heavy precipitation.

Excess periodicity of the heavy precipitation in Uzbekistan is observed on the foothill and mountainous stations of the Tashkent, Samarkand, Djizak and Kashkadarya provinces.

The Figure 5.5.8 provides the chart of the changes of days a year with precipitation over 15 mm/day, where the positive trend and variability of the rainfall is traced for the recent decades.

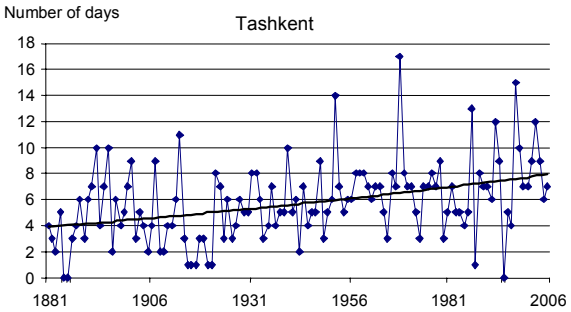


Figure 5.5.8 *Periodicity of the number of days with precipitation over 15 mm/day*

Hail also relates to the hazardous phenomena. In Uzbekistan hail is a relatively rare phenomenon and unevenly falls on its territory. At the plain area from 1 to 6-7 hail days are possible during one decade. In the foothills on the average hail 1-2 days are recorded, and in the low mountain area (1,000-2,000 m) – from 3 to 5 times a year.

Chust, Kasansay, Yangikurgan and Chartak regions of Namangan province with developed irrigated farming are the most hail hazardous ones in Uzbekistan.

Weather modification is carried out in the regions of Uzbekistan, mainly in Namangan province, the most vulnerable to the hail damage in order to prevent this hazardous phenomenon.

It should be noted that currently, significant trends in the hail cases have not been recorded in Uzbekistan, however, it can be assumed that in the long-term the hail fall frequency will grow with increase of the heavy precipitation periodicity.

Air drought. High air temperature and low air humidity are the key causes of this disastrous phenomenon. One of criterion of atmospheric

drought is deficiency of the water vapor saturation over 50 hPa.

The largest number of days with the air drought in Uzbekistan is recorded in Bukhara and Surkhandarya provinces (Figure 5.5.9), along with the large number of days/year with the air temperature over 40°C.

The records demonstrate increase of the arid days number in significant part of Uzbekistan territory. In the long-term, given expected intensive increase of the air temperatures in line with scenarios, retain of revealed trends and the relevant increase of number of days with the air drought can be expected.

In the air drought days in certain regions crop distress, drop of the buds, cotton flowers and fruit elements along with the grain drop from the head are being observed. These conditions are extremely hazardous in combination with the irrigation water deficiency – the yield reduces or fails on expansive territories.

Under the irrigation water deficiency more frequent air drought will aggravate the adverse effect on agricultural output, since extreme weather conditions (high temperatures, low humidity and wind), aside from direct adverse impact increase the crop water consumption, water losses in irrigation system, and intensify the processes of the salt accumulation in soils.

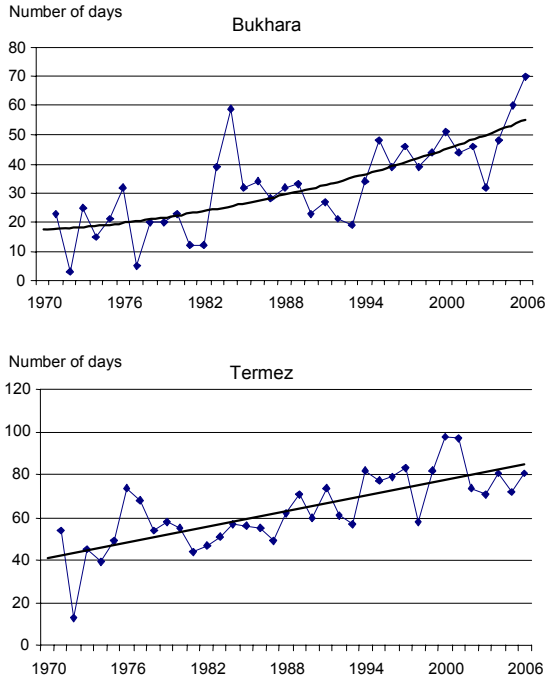


Figure 5.5.9 *Periodicity of the number of days/year with the partial pressure deficiency over 50 hPa*

5.5.3. Climate Risk Management

The observations show that in Uzbekistan due to the Climate Change increase of periodicity of the hazardous hydrometeorological phenomena is expected. The Government, state, professional and commercial organizations have to receive the full-scale information on possibility and necessity of mitigation the adverse after-effects of the hazardous phenomena on economy, environment and human health.

The early population warming will reduce vulnerability via implementation of efficient measures on reduction the risk of hazardous phenomena.

The National Hydrometeorological Service of Uzbekistan is responsible for providing the forecast and climatic information, the data on the hazardous phenomena and ensures their prevention and spread **(Block schematic diagram).**

Monitoring of the areas with the high danger of the hydrometeorological phenomena. Currently, NHMS of Uzbekistan is implementing the measures focused on the climate risk management – maintenance and publication of the state cadastres (climatic, water cadastres and hazardous phenomena).

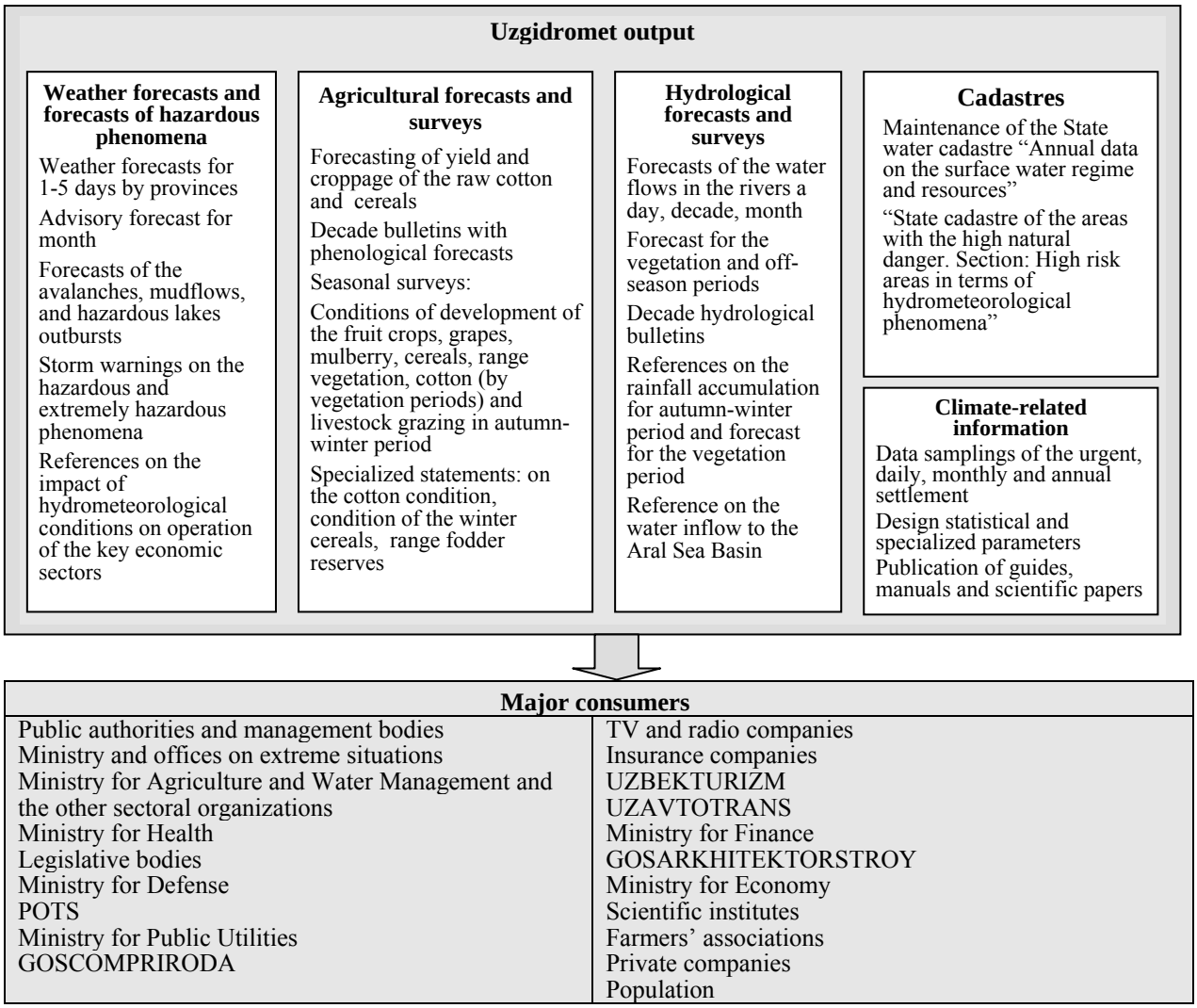
The annual publication "State cadastre of the areas with the high natural danger. Section: High risk areas in terms of hydrometeorological phenomena" is being issued since 2006 in Uzbekistan for the monitoring of the hazardous hydrometeorological phenomena, assessment of their trends and consequences.

This cadastre comprises the data on extreme air temperatures, frosts, heavy precipitation, strong wind, air and hydrological drought, overflowing, floods, water-logging, occurred mudflows and avalanching. This publication comprises also the information on material damage and the other adverse consequences due to the hazardous hydrometeorological phenomena recorded on the territory of Uzbekistan during the recent year. This cadastre maintenance will enable making well-grounded decisions when design, construction works implementation, tourism planning and more rational allocation of the agricultural crops cultivation.

Improvement of forecasting and servicing on the basis of the monitoring and scientific research expansion and improvement ***is the primary strategy*** enabling climate risk management and mitigation of after-effects of the climate-related hazardous phenomena.

More reliable short-term hydrometeorological forecasts for agriculture may assist in on-line water management and improve the efficiency of irrigation water use, and this is one of the key measures of adaptation to the arid climatic conditions.

Block schematic diagram



Agriculture and water management are specifically vulnerable to the Climate Change caprices. In case of the large-scale droughts (combination of abnormal hot weather conditions in vegetation period with the water resource deficiency) – expansive areas are vulnerable to the risk of the crop failure, and this, ultimately, affects the food security of the country.

Early warning system is focused on the early warning on expected drought in order to enable correcting the management of available water resources, including operation mode of the key reservoirs. Local authorities may activate the relevant programs of the effect mitigation. Development and introduction of these systems, including the relevant action plans – *is the second strategy* of the climatic risk management.

Measure enabling improvement of the climatic risk management are associated with capacity building of all NHMS of the region with development of research applying the new forecasting technologies and techniques as well as active exploration of the hydrometeorological processes, with development of information dissemination system. Specific needs of the capacity building are listed below.

- Development of above-ground system of hydrometeorological surveillance, including the area of the outflow formation located in the cross-border Republics.

- Expansion the network of specialized avalanche stations, establishment of glaciological stations.
- Application and development remote monitoring techniques.
- Renewal of observations over the upper atmosphere in Uzbekistan.

5.5.4. Role of Insurance in Risk Management

Management of the risks of the natural disasters, technogenic factors and the other phenomena in all economic sectors and private life are the crucial universal problem.

According to statistics, the number of hazardous natural extreme situations all over the world is annually growing by 4% on the average, and related economic losses – by 10.4%. Weather risk insurance is wide-spread in economically developed states. Around 40% of all natural damages are insured and compensated by insurance companies.
In Uzbekistan developing insurance system based on the risk management technology is one of the key elements of the nationwide protection, in particular, from the weather risks.

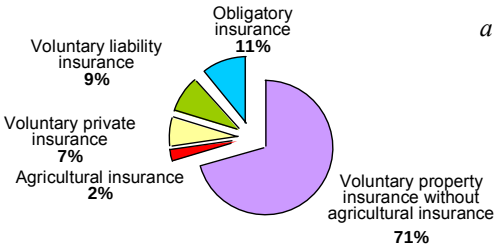
Insurance activity in Uzbekistan is regulated by legislative and normative-legal acts. According to the Law "On insurance operation" insurance is subdivided into two sectors:

- life insurance;
- comprehensive insurance.

As of July 1, 2007 24 insurance companies in Uzbekistan got the license and are operational. Two companies got the license in the life insurance sector and one insurance company was operational. One reinsurance company was dealing exclusively with reinsurance.

Well organized insurance system allows rather reliably compensating the damage from the hazardous weather phenomena, when all other protection measures are not possible.

During the recent 5-6 years insurance market of Uzbekistan is dynamically progressing via the active national policy.



- Improvement of the forecast methods of the weather and hazardous phenomena.
- Active exploration on the hazardous hydrometeorological processes and phenomena.

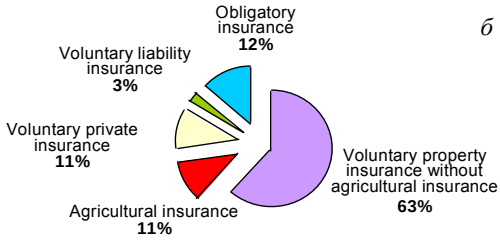


Figure 5.5.10 *Structure of consolidated insurance bonuses (a) and payments (b) in Uzbekistan*

Thus, according to the data by the State inspection on insurance supervision under the Ministry for Finance of the Republic of Uzbekistan, collection of insurance bonus for the period 2000-2006 grew almost by 6 times, and insurance payments increased by 2.5 times.

In terms of the property insurance and insurance of agricultural crops these indicators increased by 7.3 and 3.1, respectively, which means development of insurance kinds associated with various natural phenomena.

In consolidated bonus structure agricultural insurance amounts 2% on the average for the recent years (Figure 5.5.10 a), and in the payment structure – 11% (Figure 5.5.10 b).

During several years payment amounts on agricultural insurance dramatically exceeded bonus amounts (Figure 5.5.11). This fact proves the high risk of agricultural production in Uzbekistan, and indicates justifiability of agricultural insurance, to certain extent, compensating the losses of commodity producers.

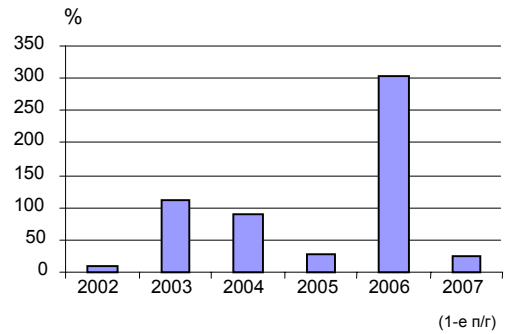


Figure 5.5.11 *Share of payments (%) against bonuses on agricultural insurance*

Agricultural insurance system in Uzbekistan comprises the following types of insurance:

- voluntary crop insurance from replanting;
- voluntary insurance from under-yield;
- voluntary insurance of the orchards and vine-yards from under-yield;
- voluntary insurance of agricultural livestock;
- voluntary insurance of agricultural hardware purchased on the leasing basis.

Damage or collapse of agricultural crops, livestock and hardware due to the natural disasters: hail, showers, storms, hurricane, frost, snow, low water or water lack in irrigation sources, seed molding due to excessive moisture content, seedling damage? dry winds (garmsil), pests, biological diseases, lodging due to the lasting rains, flood, erosion, lightening, landslide, soil settlement, water table rise, mudflow, fire, etc. – are the primary insurance risks in these insurance types.

Under the Climate Change with growth of weather phenomena extremeness the National Hydrometeorological Service of Uzbekistan needs to enhance collaboration with insurance companies of the Republic. Information on hazardous phenomena serves as a ground of insurance activity in terms of the payments when insurance case occurs. When insurance case occurrence qualified expert assessment has to be carried out on occurrence of hazardous natural phenomenon; the conclusion has to be made whether the weather phenomenon achieved adverse or hazardous values in terms of criteria for the given type of operation.

Criteria of hazardous phenomena for the various economic sectors need to be developed on the basis of actual information with consideration of geographical peculiarities of the regions.

For reliable estimate of the weather risk damages insurance system has to specify “insurance from hazardous hydrometeorological phenomena” as an individual category and the schedule of providing Uzgidromet with information on payments for insurance cases associated with these phenomena has to be developed.

Despite of significant increment of the key indicators of insurance organizations’ operation, insurance market of the Republic has number objective reasons for its insufficient development and unsolved problems. The key problems of insurance operation development in the Republic are as follows:

- low demand on insurance services due to the poor transparency of insurance market, as well as legislative framework requiring improvement;
- low level of insurance market infrastructure development, lack of efficient agency networks, insufficient level of priority insurance types development;
- lack of legislative basis on individual types of insurance complying with international practice;
- poor professional level of insurance companies’ employees.

In order to overcome existing shortcomings in insurance service system of Uzbekistan, the Program of reforming and development of insurance market for 2007-2010 was adopted, it specifies the following priority fields and immediate objectives:

- Further improvement of legislative and normative-legal basis of insurance, its operation and insurance supervision.
- Expansion, increase of the scope, spectrum and improvement the quality of provided insurance services.
- Ensuring transparency and reliability of domestic insurance market, increase of the level of insurers’ capitalization, enhancement of their financial sustainability and paying capacity.
- Improvement of system of training, advanced training and capacity building of insurance sector employees.

Association of professional members of insurance market was established in Uzbekistan with the following key operation fields:

- analysis of insurance market business environment, development of proposals on its better transparency, competition development, expansion, increase of the spectrum and quality improvement of insurance services;
- assistance to potential foreign investors in investment the funds in insurance sector of the Republic of Uzbekistan;
- active raising of public awareness on insurance aspects;
- Improvement of system of training, advanced training of insurance staff, development of professional code of ethics standards for professional members of insurance market.

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.6. Climate Change Consequences for Population Health

When assessing Climate Change impact on population health in Uzbekistan, a consideration was given first of all to the dynamics of indicators describing and characterizing thermal and meteotropic diseases, seasonal infections, malaria as well as certain parasitic diseases. The following indicators were analyzed:

- indices of thermal discomfort and thermal stress, as well as duration of the heat waves;
- disease incidence and mortality rate due to cerebrovascular diseases;
- diarrhea incidence (acute intestinal infections);
- climatic indices characterizing period of malaria transmission;
- leishmaniasis incidence;
- melanoma incidence.

Analysis of existing vulnerability was carried out on the basis of observation data, future vulnerability – assuming implementation of Climate Scenarios built in accord with the GHG emission scenarios A2 and B2.

5.6.1. Direct Consequences

Climate Change direct consequences for human health are increase of thermal diseases, human deaths and injuries during hazardous phenomena associated with climate. In Uzbekistan, the latter are mainly represented by mudflows, floods, and snow-slides. Climate Scenarios assessments demonstrated an increase of the peak flood flow and mudflow frequency which increases direct risks for population health. The avalanche risks retain practically up to the year 2050.

When thermal stress is growing and human organism goes through thermal imbalance a more rapid weariness and increase of traumatism are possible along with disturbance of digestive apparatus functioning as well as disorder in carbohydrate and protein metabolism, distress of neural axis functions, and blood circulatory system. It should be noted, that in 2004 mortality rate from cardiovascular diseases in Uzbekistan amounted around 60%.

Thermal and cardiovascular diseases. In summer climatic conditions on the territory of Uzbekistan are rather stressful. The peak air temperatures in the cities achieve 45°C and in desert areas – 49°C; a real threat of heat stroke exists in such periods. Thermal discomfort is observed during all summer months almost all over Uzbekistan, excluding the mountainous regions.

A mapping of the territory was made to identify the risk zones in terms of degree of thermal discomfort and indices trends that describe *strong thermal discomfort* (combination of the peak temperatures >38°C, minimal ones >22°C with mean daily water vapor pressure e > 17 hPa) were assessed.

Long-term data analysis shows that significant increase of the number of days with strong thermal discomfort (Figure 5.6.1) is observed along the territory of Uzbekistan. In some regions of Uzbekistan the trends of thermal discomfort increase are intensified by the local anthropogenic impact (reduction of the Aral Sea water body, increase of humidity in irrigation areas, etc.).

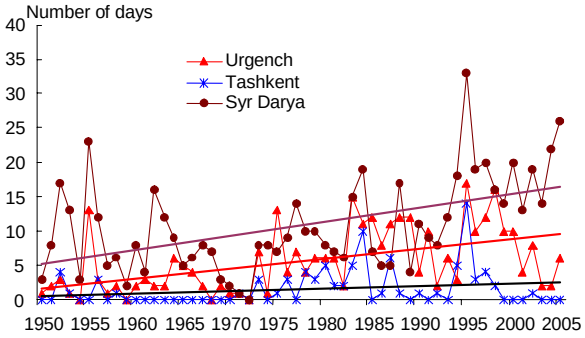

Figure 5.6.1 *Change of the number of days with the strong thermal discomfort in some cities of Uzbekistan*

Assessment of hot days number change (*Tmax* > 40°C) from 1951 revealed their dramatic increase (in the Aral Sea Basin – twice as much, in desert area – by 1.5 times, in the foothills – by 12% in the average). Central desert territories (Navoi and Bukhara provinces), Aral Sea Basin and south of the Republic (Kashkadarya and Surkhandarya provinces) are the risk areas due to hot air temperatures impact on human health.

According to Climate Scenarios, increase of humidity, peak and minimal air temperatures is expected which means enhancement of observed trends and growth of thermal diseases risk. The risk increase was estimated via calculation of the maximal thermal load experienced on hot test days by a human unprotected from solar rays, with application of human thermal balance method.

Heat loads on human organism. Analysis of the maximal heat loads on human being for the reference period demonstrated that at day-time in summer a significant area of Uzbekistan falls under the category of extreme heat loads (FLE > 607 W and heat loads within 34-100 W correspond to thermal comfort status).

Heat loads have significant correlations with monthly peaks of air temperature. The monthly peaks of day- and night time air temperatures and connection equations for the 40 stations in Uzbekistan were

applied for calculation of heat loads for the future periods in line with Climate Scenarios A2 and B2. Differences among the values calculated for various scenarios turned out small, which allowed averaging the outputs. The Figure 5.6.2 illustrates increase of the maximal heat loads by separate stations in Uzbekistan in May and September.

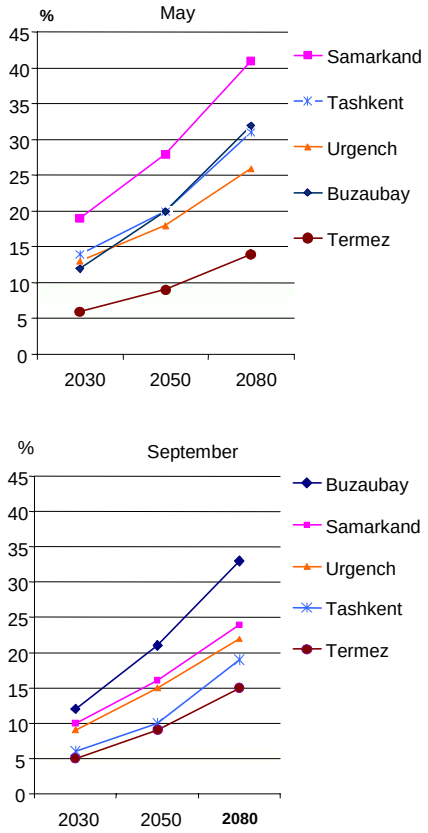

Figure 5.6.2 *Expected changes of the maximal thermal stresses on human being in day-time by Uzbekistan stations (% of the rate in 1961-1990)*

In the month of May by 2030, the maximal heat loads on human may increase by 6-18%, 9-28% by 2050, and 14-40% by 2080 compared with the baseline rate. Slightly lesser growth of heat loads is expected in July and September. The desert and piedmont regions as well as the urban heat islands are the most vulnerable ones in terms of heat load increase.

It was identified, that the month of May, normally favourable in terms of heat loads, will become uncomfortable for those in the open air due to Climate Change in the future. By 2030 the area where human will experience extreme heat load will significantly expand, and the zones with an increased health risk associated with heat loads will appear.

According to the estimate, based on Climate Scenarios, night heat loads are still within the comfort zone on a significant area of Uzbekistan. However, the fast pace of growth of this indicator, particularly in the urban areas, where heat islands intensify the negative impact, need to be considered.

Heat waves – periods of abnormally high air temperature lasting for several days. Analysis of changes of the index of heat wave duration (Heat Wave Duration Index – HWDI) demonstrated positive trends in HWDI rows, as well as in frequency of extremely high day- and night air temperatures, irrespective of season of the year (Figure 5.6.3). In this context, all territory of the Republic can be considered as the risk zone.

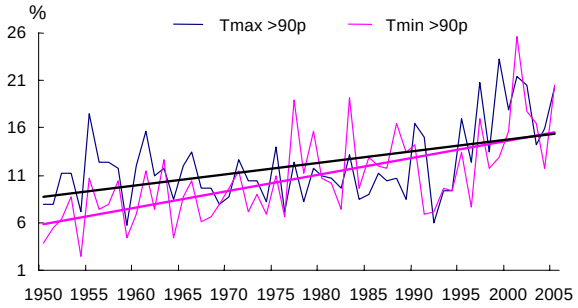

Figure 5.6.3 *Changes of the number of days a year with extremely high and low air temperature peaks (Nukus city)*

The data for Nukus city show that mortality rate from cerebrovascular diseases during hot test months (June – August) exceeds mean annual rate by 17%, and in months with sharpest weather shifts (April, November) - by 13%.

Comparison of heat wave duration index with mortality rate from cerebrovascular diseases demonstrated that mortality rate increase coincided with maximal values of heat wave duration (Figure 5.6.4).

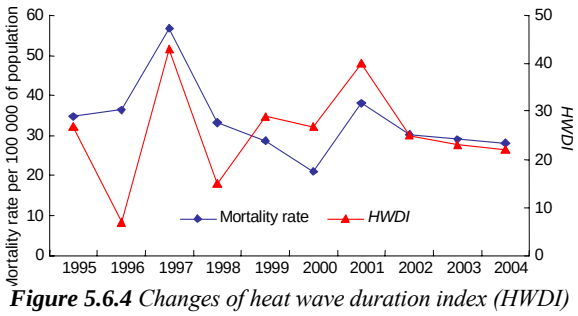

Figure 5.6.4 *Changes of heat wave duration index (HWDI) in Nukus city along with mortality rate from cerebrovascular diseases*

In Uzbekistan heat waves can be observed during southern cyclones, high warm air outflow, and the longest ones occur during summer thermal depression. For assessment of population health risk, a mapping of the country territory was made based on heat wave duration index. Currently, the largest duration of heat waves is observed in the Central and Northeastern areas of Uzbekistan.

Expected changes were calculated for future periods in accord with Climate Scenarios A2 and B2 based on the link between the peak air temperatures and HWDI. A more significant HWDI increase is expected in the North-western part of the Republic; in

line with scenario A2, already by 2030 increase by 30-40% against the reference rate is possible over here, and in line with scenario B2 – by 40-50%. Increase by 15-30% is expected in the central desert and piedmont regions. Fergana Valley remains the lower risk area. In the long-term the risk of unfavourable heat wave impact significantly increases practically for the entire territory of Uzbekistan. For instance, by 2050 the heat wave duration may double overall by scenarios in the Northwestern part of Uzbekistan, indicating the necessity for preventive measures.

5.6.2. Indirect Consequences

Indirect Climate Change after-effects occur through increase of the frequency of seasonal and infectious diseases as well as those associated with change of the transmitters' habitats and lack of clean drinking water and food.

Malaria incidence risk. Malaria used to have wide-spread occurrence in Uzbekistan in the past. Currently, this disease is very rarely recorded. However, population of Uzbekistan living on the border with Afghanistan and Tajikistan is subject to risk. Thus, malaria incidence in Surkhandarya province in 2000 reached 3.71 per 100 000 of population.

Given that air temperature and humidity are the limiting factors for the complete life cycle, of both the disease agent and its transmitter, assessment of changes of duration of potential malaria incidence period all over Uzbekistan was made.

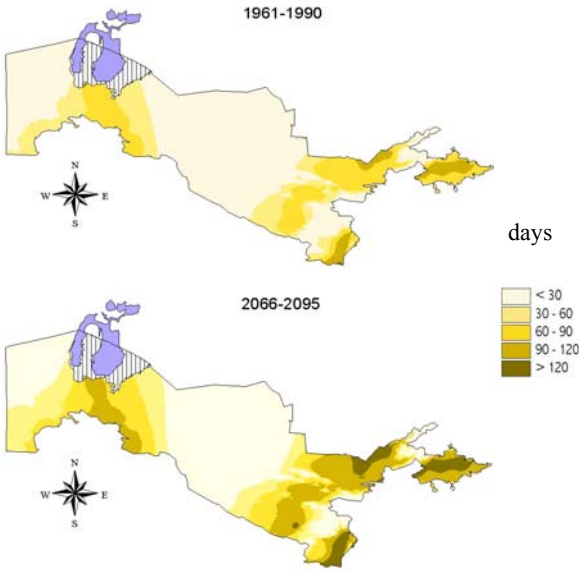

Figure 5.6.5 *Changes of the duration of period when vital activity of malaria transmitter and agent is possible (scenario A2)*

The dates of sustainable transits of mean daily air temperature through 17°C as well as the relative humidity over 50% were selected as criteria given that humidity is much higher in the irrigation areas and nearby water sources. Calculations and mapping (Figure 5.6.5) were made for the baseline climate period (1961-1990) as well as for the future periods based on Climate Scenarios A2 and B2 with almost identical results.

Map analysis demonstrates that currently the risk of malaria transmission exists in irrigated areas of Surkhandarya, Kashkadarya, Tashkent, Syrdarya, Djizak provinces and in Fergana Valley. Downstream Amudarya River in irrigation areas, meteorological conditions allow for malaria incidence as well but duration of such period is shorter.

Due to climate warming, the risk of malaria incidence in Uzbekistan just due to the climatic factors may intensify, especially, in the valley of Surkhandarya, in Tashkent and Syrdarya provinces and in Fergana Valley.

The key preventive measure of the adverse after-effects is prevention of malaria import into the Republic. Since 2001 the measures on prevention of malarial incidence are successfully implemented in the frame of the National program on epidemiologic surveillance over malaria in the Republic of Uzbekistan for 2001-2005. Implementation of the program activities 'Enhancement of counteraction to malaria in Uzbekistan: Focus on the vulnerable population' was launched under the GF support. The measures resulted into reduction of malaria incidence by half in Surkhandarya province.

Feral Herd Infections. A zoonotic type of dermal leishmaniasis has been registered in Uzbekistan,. During the recent years, the incidence reduction is observed thanks to prevention activities. Growth of disease incidence is recorded during years with low precipitation; however, the cause-effect links have not been clarified yet. The incidence fluctuations can be associated with the change of population of the key dermal leishmaniasis carriers – great gerbil and mosquitoes – transmitters.

Climate warming on the plains of Central Asia caused an increase of gerbil population affecting epizootologic situation in natural nidus of infection, including especially dangerous ones. The natural plague focal points in Central and Southern Kyzyl Kum manifest epizootic activity reduction trend in summer and increase in autumn-winter period. Therefore, epidemically important plague period has shifted towards colder period of year.

According to Climate Scenarios, an increase of hot and dry periods is expected along with significant

warming of winter months and intensification of precipitation variability. It will further affect the dynamics of transmitters' and carriers' population in the natural infection nidus. Therefore, enlargement of specialized monitoring and research for assessment of the situation in the natural plague nidus is required along with improvement of anti-epidemiologic activities.

Acute intestinal diseases. Living conditions represent an additional risk factor. Environmentally unfavourable situation is observed in Khorezm, Navoi and Fergana provinces in Uzbekistan, with the worst one occurring in the Republic of Karakalpakstan.

Domestic water quality significantly deteriorates closer to Amudarya River outfall. The share of water samples not meeting sanitary-chemical standards is 60% and microbiological standards – 16% of water in Karakalpakstan waterways is of poor quality. Along with that, rural populations in Karakalpakstan and Khorezm have the lowest domestic water supply provision (56.2% and 70.9% respectively at the beginning of 2008). In certain remote regions of Karakalpakstan only 22% of population have access to centralized water supply.

Though water supply averages 83.8% in Uzbekistan, with 78.5% for rural areas; rural population throughout the Republic uses 'aryks', water reservoirs, rivers and channels as potable water sources, therefore, the villagers are more often sick. In all regions of Uzbekistan the peak season of acute intestinal infection incidence is recorded in warm period of year – from May to October-November, and children are the most vulnerable group in this context.

Periodic droughts causing deterioration of sanitary and epidemiological situation are additional risk factor. Under hot climate conditions hygienic norm of water consumption increases, and toxic effect of harmful substances contained in drinking water grows along with epidemiological role of water sources with low quality water. Due to climate warming this trend will progress.

Tashkent city with the most favourable situation in terms of all indicators was selected as indicator for Climate Change impact assessment, and the long-term assessment will be more representative. A significant statistical link of acute intestinal infection incidence with air temperature and previous month incidence was identified. Links with previous month disease incidence appeared to be the most obvious (correlation factor achieves 0.93).

Obtained dependence between mean monthly air temperature and disease incidence is statistically significant (Figure 5.6.6), and equation of constrains can be applied for assessment of incidence trends in Tashkent, assuming that increase of air temperature corresponds to future Climate Scenarios. Assessment demonstrated that in general the potential risk of disease incidence increase during a year, due to climate warming alone it will grow by 8-10% till 2050 to, and 15-18% by 2080 (Figure 5.6.7).

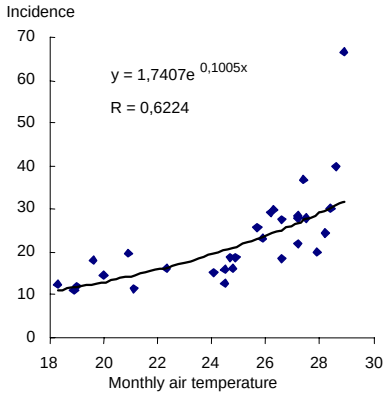

Figure 5.6.6 *Correlation of diarrhea incidence and mean monthly air temperature in Tashkent (May-August)*

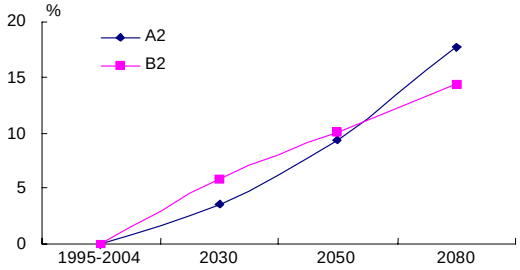

Figure 5.6.7 *Trends in diarrhea incidence in Tashkent based on Climate Scenarios*

Dermal melanoma. In a number of Uzbekistan provinces increment of the disease incidence is observed (Karakalpakstan, Andijan, Djizak, Khorezm provinces and Tashkent city), while in some provinces the incidence is declining. However, due to depletion of the ozone layer incidence growth all over the Republic is possible. According to the satellite observations data (NASA), at 30-60° n.l. of the Northern hemisphere a negative trend in total ozone content against 1980s retained in 2006 (-3% per decade). In view of which, monitoring of total ozone content over the territory of Uzbekistan along with study of interrelation of the disease incidence with ultraviolet radiation fluctuation and other factors is needed.

5.6.3. Strategies and adaptation measures

Health care sector of Uzbekistan is implementing a number of adaptation measures with support from international financial institutes. Project "Health-1" was completed; Project "Health-2" is ongoing; both are focused on improvement of funding the healthcare system with consideration of market conditions as well as equipping rural medical stations in a number of provinces (WB credits, etc.).

The projects aimed at improvement of motherhood and childhood protection system, strengthening of material and technical base of the obstetric institutions and hematological service, as well as four projects focused on water supply improvement are implemented with funding from ADB. Agreements were signed with Islamic Development bank (IDB) for enhancement of the system of emergency medical assistance. A contract was concluded with PRC for procurement of diagnostic equipment and its installation in oncology clinics of the Republic. Activities on HIV/AIDS, tuberculosis and malaria control are implemented with support of the Global Fund.

The following measures are recommended for mitigation of Climate Change adverse effects in the healthcare sector:

- harmonization of control, warning and prevention system with consideration of other countries' experience and WHO recommendations;
- scientific research and public awareness building;
- prevention of environment pollution, ensuring sanitary standards observance;
- introduction of water purification technologies, maintenance of thermal comfort in premises and reduction of urban heat islands;
- improvement and adaptation of urban planning, design, and architecture to meet the requirements of Climate Change;
- improvement of legislation in healthcare and urban development aimed at adaptation measures implementation.

Table 5.6.1 provides identified changes in vulnerability indicators and the list of potential activities if the public health sector.

Table 5.6.1 Public health: key threats and responses

Observed changes in vulnerability indicators	Assessment in line with scenarios	Vulnerable areas, populations and factors intensifying vulnerability	Climate Change adaptation measures
Thermal diseases: Increase of heat load on human organism, thermal discomfort intensification	Increase of hot days amount and air humidity; intensification of thermal discomfort and heat load	Risk zone – the entire territory of the country Risk groups – people working in the open, old and sick people Factors intensifying vulnerability – high share of rural population	Preventive medical examination for identification and control of vulnerable population Increase in public awareness on the negative impact and preventive measures Introduction of medical warning system relative to hot weather periods
Cardiovascular diseases: Growth of mortality rate in hot test months Positive link between mortality rate and heat wave duration (cerebrovascular diseases)	Significant increase of heat wave duration and heat loads on human organism throughout Uzbekistan	Risk area – entire territory of the country Risk groups – old and sick people Factors intensifying vulnerability – part of rural population does not have access to medical aid	Development of the regional criteria for warning initiation Action plan development for strongly hot period Maintenance or increase of thermal comfort in premises, reduction of urban heat islands (ventilation, shading of the buildings, planting of trees and plants shading the walls and windows in summer)
Infectious diseases: Growth of acute intestinal disease incidence in hot months of the year throughout the territory Positive relation between air temperature and disease incidence	Increase of disease incidence due to the growth of temperature and drought intensification	Risk area – entire territory of the country Risk groups – children and rural population Factors intensifying vulnerability – high population density and its growth rates, water deficiency, periodical droughts	Improvement of infection diseases control systems Ensuring of observation of sanitary hygienic requirements Provision of population with good quality tap water Increase of liability of business entities for not meeting the requirements of environmental safety
Malaria: Increased disease incidence is observed in the South of the Republic	Increase of duration of the period favourable for disease agents and transmitters	Risk areas – irrigated lands, oasis, coastal territories of reservoirs Factors intensifying vulnerability – high population density, infection sources availability in Afghanistan and Tajikistan	Public awareness on increase of the risk of malaria incidence due to climate warming Implementation of the Programme 'Enhancement of counteraction to malaria in Uzbekistan'
Leishmaniasis: Growth of disease incidence in the arid years Infection natural focal points: Appearance of plague epizooty in winter period	Increase of duration of the period favourable for disease transmitters Epizooty enhancement in winter period	Risk area – desert territory of the Republic (great gerbil habitat) Factors intensifying vulnerability – high population density and its growth rates, stagnant reservoirs availability, periodic droughts	Improvement of supervision over population of disease carriers and transmitters Public awareness on increase of the risk of parasitic diseases and preventive measures Expansion of research relative to analysis of cause and effect links Improvement of the system of anti-epidemic measures

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5.7. Biodiversity and Ecosystems

5.7.1. Biodiversity

General situation. During the last 30 years, a reduction of some and extinction of other animal and plant species are observed in Uzbekistan. Anthropogenic changes affected practically all ecosystems, up to their complete destruction in some cases. The largest changes are typical for the land in and above river flood plain areas, water and per-aquatic ecosystems, especially, in river lower reach, including Aral Sea Basin and the Aral Sea. Currently, 80% of clay deserts, 95% of river floods, 20% of sand deserts and 40% of mountainous areas have been transformed in Uzbekistan.

Habitat degradation and direct extermination affected, first of all, the large raptorial animals and hoofed animals. Turan tiger and cheetah became extinct, striped hyena, caracal, Peri-Asian leopard are endangered. Habitats of many species reduced and their population dramatically decreased.

Aquatic and semi-aquatic ecosystems experienced serious changes due to salinity and contamination increase, cardinal change of hydrological mode as well. Species diversity, for instance, of the Aral Sea catastrophically reduced. Currently, there is no fish in the Great Aral Sea, and zooplankton is mainly represented by Artemia crayfish – typical inhabitant of hypeghalina reservoirs.

Artemia – practically single inhabitant of the Great Aral Sea

Agricultural biodiversity has seriously suffered as well. Uzbekistan is a motherland of many wild ancestries of cultivated plants and has a high potential in conventional forms of cultivated plants and animals. Past underestimation of their importance led to exotic species prevalence and reduction of traditional ones.

Ecosystems are affected by many anthropogenic factors, including their fragmentation. Climate Change is an additional stress factor able to change them or create threat in terms of biodiversity degradation or loss.

Biodiversity vulnerability. Climate Change has already provided impact on aquatic and land ecosystems. Common types of land and aquatic ecosystems' response to Climate Change and some examples for Uzbekistan are shown in Table 5.7.1.

Climate Change affects all biodiversity types, but information available on the issue is limited since monitoring studies of biodiversity in the context of regional Climate Change have not been conducted. In view of this, regular general system monitoring has to be developed.

Analysis of changes in species distribution and population, their habitats and responses to Climate Change can be based upon the study of indicator groups of animals and plants. Use of birds as bio-indicators is the most promising one, since they are applicable almost for all types of ecosystems. For aquatic ecosystems, observations of the biohydrocenosis are most promising (periphyton, zoobenthos, zooplankton, macrophyte, fish) that have proven to be a reliable reference points of environmental conditions and indicators of aquatic ecosystem vulnerability in arid years.

Table 5.7.1 General types of the land and aquatic ecosystem response on Climate Change

General types of ecosystem response on Climate Change (MGEIC)	Examples for Uzbekistan Impact/vulnerability
Land ecosystems	
Increase of vegetation period in the mid- and high latitudes	Transfer of the desert ecosystems to vegetation winter mode in the Central Kyzyl Kums
Earlier bird arrival and occurrence of their mating season as well as earlier appearance of the insects in the northern hemisphere	Trend of transfer to habitancy by some nest-birds (white stork – Ciconia ciconia asiatica); trend of establishment of new wintering for some pre-aquatic birds from the sandpiper group (avocet – Recurvirostra avosetta, ruff – Philomaxis pugnax, wood sandpiper – Tringa glareola, redshank – Tringa totanus) and earlier spring arrival (plover – Vanelus vanelus)
Shift of the growing lines for some plant species and animal habitats	Extension of the growing lines of the arch key species in mountainous woods and trend of the habitat expansion towards the north for some bird and mammal (coursers – Cursorius cursor, waxbird shrike – Hypocolius ampelinus, little cormorant– Phalacrocorax pygmaeus, white eye – Aythya nyroca, thread swallow – Hirundo smithii, myna – Acridoteres tristis, collared turtledove – Streptopelia decaocto, Indian honey badger– Mellivora indica,etc.)
Increase of the cases of ecosystem disturbance due to the fires and insects outbreak	Increase of the fires in the arid and low water years in the low mountain (adyr) area and reeds, surrounding the plain aquatic-mash ecosystems in South Aral Sea area, where in the areas of ephemeral lakes the outburst of grasshopper populations has been recorded (Sulochie wetland), and, according to the expert assessments, in the settlements of Karakalpakstan the cases of termite outbreak became more frequent.
Extinct of some endangered species.	Climate aridization in combination with anthropogenic fragmentation of the mid-mountain and, especially, low mountain areas of savanna forests of Western Tien Shan led to extinct of such species as Persian gazelle – Gazella subguttarosa, bustard endemic subspecies – Otis tarda, demoiselle - Anthropoides virgo are. Population of the other species, such as monitor lizard – Varanus griseus, steppe tortoise – Agriocnemis horsfieldi, corsac – Vulpes corsac, steppe polecat – Mustella eversmanni, jerboa - Allactaga (big – A.jaculus, Severs – A.severtzovii, Vinogradov – A.vinogradovi) is extremely low and keeps on reducing. In the plain regions of Central Asia replacement of ancient autochtonous jerboa fauna with younger dominating rodent group – sand eel
Many of the other species are endangered to a greater extent.	
Extinct of unique habitats and their endemic species	
Intensification of invasive (alien) species impact	Settlement and impact of alien colonizers on indigenous species: myna - Acridoteres tristis and colored turtledove - Streptopelia decaocto (in anthropogenic plain and piedmont landscapes), American maple – Acer negundo (in mountainous forest ecosystems of Western Tien Shan), etc.
Intensification of the ecosystem fragmentation processes	Universal progressing trend of transformation and fragmentation the desert, river flood and mountainous ecosystems (excluding reserves)
Loss of many species or reduction of their population will decrease their role as the pest population controllers, and reduce recreation potential and landscape aesthetic characteristics of many ecosystems.	Similar developments are possible for Central Asia and, in particular for Uzbekistan, however, this issue has not been studied due to Climate Change.
In the arid and semi-arid areas is expected reduction of the range and dry forest productive capacity due to potential reduction of the soil moisture content.	This trend is observed in the arid years, especially, in Central and Northern-Western Kyzyl Kum
Aquatic ecosystems	
Reduction of water quality due to its temperature increase	Eutrophication and reduction of water quality is evident in small rivers draining the low mountain ridges (Karjantau, Nuratau). In the river mid and outlet sections the courses intensively overgrow with filamentous alga. Change of water quality is specifically evident in the lakes of delta and downstream of Amudarya River in the low water and arid years and accompanied with reduction of dissolved oxygen, hydrogen sulfide contamination, increase of the mineral salt concentration, nitrogen compounds with organic substances, abnormal growth of population and biomass of phytoplankton and periphyton.
Change of water quality due to the change of water flow mode and increase of chemicals ecological consistency with reduction of the flow volume	
Growth of the drought frequency and degradation of aquatic and related offshore ecosystems, loss of their biodiversity and productive capacity	Lake ecosystem and related offshore ecosystem degradation, loss of their biodiversity and productive capacity in delta and downstream of Amudarya River in low water and arid years
Irrigation water demand increase and exhaustion of water sources up to ecologically inadmissible level	Irrigation water demand increase and, as a consequence, progressive exhaustion of all water sources up to ecologically inadmissible level in the are of intensive flow consumption, specifically, in Amudarya River downstream and delta. и

Climate Change consequences for biodiversity and ecosystems. In Uzbekistan, Climate Change affects the biodiversity conditions and intensifies the processes of desertification, provides adverse effect on the flow formation. Increase of rain precipitation share causes increase in mudflow activity in mountainous and foot-hill areas and, as a consequence, soil erosion and habitat deterioration. Anthropogenic desertification (soil irrigation erosion, salinization, range degradation) caused by irrational management leads to forest and other ground vegetation reduction, which, along with loss of habitats, reduces the potential of carbon dioxide binding.

In the course of development of national communication, changes of bird and mammal habitats in Uzbekistan have been analyzed, caused by warming and desertification of some territories. It was found that the species of steppe and semi-desert fauna systems that used to prevail in the Southern limits of our territory moved significantly to the North, right up to the point of phasing out from the fauna composition.Climate Change affects the boundaries and structure of habitats, species phenology and demography, as well as the structure of multi-species communities. The habitat changing processes of three fauna systems species are the most demonstrative ones:

- recession of Southern boundary of prevalence of steppe fauna complex towards North;
- expansion of habitats of South-Asian, thermophilic species to the North-east along the Northern mountainous margin of Pamir–Alay and Tien Shan;
- expansion towards the North of habitats of some Southern species along the natural and anthropogenic ecosystems of Central Asia.

Adaptation measures. Climate Change, reduction of biodiversity and desertification are closely interrelated, and so are their consequences; this determines the response/adaptation measures and common priorities: afforestation, rational water and land use, education of all population strata, public involvement in decision making process.

Efforts for desertification control and biodiversity protection supplement the measures on Climate Change and drought adaptation, require multidisciplinary approach and coordinated actions in many adjacent spheres, such as:

- implementation of the National strategy of biodiversity conservation;
- nature conservation policy and legislative framework (development of ecosystem of protected natural areas, legislation improvement, including enhancement of legal safety of preserved ecosystems).
- institutional development and national, regional and local relations (transboundary cooperation development along with inter-agency coordination of activities);
- ecological monitoring and information (research programs on monitoring, inventory and indicators of Climate Change impact on biodiversity);
- introduction of economic mechanisms of nature management and environment protection;
- awareness raising and ecological education.

5.7.2. Aquatic Ecosystems

Biodiversity of aquatic ecosystems and general situation. Hydrographic network of the primary Basins of Syrdarya and Amudarya rivers, especially, in the flow consumption area, is supplemented with numerous hydrotechnical installations and transformed in water economy systems comprising interrelated natural and artificial watercourses and reservoirs. They are represented with the following key type of aquatic ecosystems:

- *natural ecosystems* – rivers, lakes, Aral Sea;
- *artificial freshwater ecosystems* – irrigation channels, reservoirs; ponds; *artificial salinated ecosystems* – drainage channel (collectors); irrigation effluent lakes.

Universal quantitative and qualitative change of the natural surface water in the flow consumption area due to their regulation and contamination determined anthropogenic metamorphosis or degradation of majority of aquatic and connected land ecosystems. Ongoing Climate Change in combination with anthropogenic stress cause additional negative trends in aquatic ecosystems, and lead to disturbance of established instable ecological equilibrium, reduction or loss of their biosphere and social functions. High vulnerability of aquatic ecosystems is already obvious in the low water and arid years that could be considered as the analogues of future climate warming and aridization. This methodological approach appeared to be the only possible one for assessment of vulnerability due to the lack of data for river ecosystems or a complete absence of that for irrigation and drainage network, as well as for the ecosystems of lakes and reservoirs where the regular ecological monitoring is not conducted.

Transboundary nature of the key rivers predetermined inconsistence of their flow utilization in the Aral Sea Basin. Moreover, the previous water apportioning concept practically excluded the nature protection transit flow of transboundary rivers, providing

ecological equilibrium in the lower courses and lake system preservation.

Lake and delta ecosystems similar to the very Aral Seam are actually excluded from water users' list which has led to the drying and degradation of the Aral Sea ecosystem and environmental instability in Amudarya delta and downstream, as well as in the mid and downstream of the key inflows of the Amudarya and Syrdarya rivers.

Aquatic-march ecosystem in Amudarya downstream

Fishery resource situation. Uzbekistan possesses significant areas of the hunting and fishing areas – up to 38 million ha, including 1.0 million ha of water pool – lakes, rivers, reservoirs. Totally 86 fish species and subspecies inhabit the various reservoirs of the Republic. Number of the fish commercial species in reservoirs varies. Generally, there are more commercial species in plain reservoirs compared to the piedmont and mountainous lakes and reservoirs. The key commercial species: carp (Cyprinus carpio), Aral bream (Abramis brama), silver carp (Hypophtalmichtys molitrix), zander (Stizostedion lucioperca), Chinese carp (Ctenopharingodon idella), asp (Aspius aspius), Turkestan Capricorn (Barbus capito), crucian carp (Carassius auratus), catfish (Silurus glanis).

Commercial fish species

In general, among the fishing areas 3 key sites are conventionally distinguished from the natural reservoirs of the Republic: *1 site* – Karakalpakstan with the fish output of 2 336.9 ton in 1991 году, to 329 ton in 2004; *2 site* – Aydar-Arnasay lake system located on the territory of Djizak and Navoi provinces. On this site the fish output amounted from 2 430.5 ton in 1991 to 737.6 ton in 2004; *3 site* – Samarkand, Navoi, Djizak, Bukhara, Kashkadarya, Surkhandarya and Khorezm provinces with the commercial fishing from the natural reservoirs. On this site the fish output was equal from 1299.6 ton in 1991 to 260.8 ton in 2004.

These data prove significant reduction of the fish output, which yield for the period concerned decreased by 7.1 times on the 1 site, by 3.2 times on the site, and by 4.9 times for the 3 site. In Andijan, Namangan and Fergana provinces commercial fishing from the natural reservoirs has not been carried out during over decade.

Development of fishery from the natural reservoirs is a promising field, virtually representing resource saving technology enabling with the large-scale approach producing significant commercial fish output on the basis of the natural fodder basis utilization. Currently, over 800 thousand ha of the natural reservoirs with the fishery economic value are available on the territory of Uzbekistan, which are the centres of biodiversity concentration. The estimates show that annual profit per each soum invested in the natural reservoir fishery development may achieve around seven soum, on the average. However, the lack of integrated scientifically and economically grounded system of water site management and the fishery of the Republic are even more vulnerable to Climate Change which was obvious in the low water "crisis" years of 2000-2001 on the *site 1* (in Karakalpakstan), where the lake ecosystems degraded during this period and lost their initial commercial fishery capacity for uncertain time.

Adaptation strategy. Pursuant to the above, aquatic ecosystems and their fish resources experiencing anthropogenic stress are the most vulnerable ones to Climate Change. The key strategic adaptation measures need to focus on establishment of favourable hydrological conditions for ensuring the natural biological cycles, reproduction of commercial capacity of the key components of aquatic ecosystem biodiversity. It can be achieved the following way:

- development of interstate collaboration in water resource management for ensuring ecological and social safety in transboudary rivers downstream;
- development of integrated ecological monitoring and inventory of aquatic and related offshore ecosystems;
- design of integrated territorial management schemes for the river Basins and specific aquatic ecosystems providing favourable hydrological conditions and protection of their environmental and socially useful functions;
- development of the fishery development strategy given the global experience and FAO recommendations (Responsible Fishing Code).

5.7.3. Forests and Forestry

General area of the State forest pool amounts 19.2% of the land pool of the country. Forests of Uzbekistan play tremendous protective role.

For Climate Change impact assessment on the forest ecosystems the empiric biophysical model was applied, evaluating the natural habitat conditions of analyzed tree or shrub species on the basis of changes of agricultural climatic indicators of habitats (sum of the positive mean-monthly temperatures and precipitation during the warm season of the year) under the current and future climate. Agricultural climatic data for the reference period (1961 – 1990) and for Climate Scenarios A2 and B2 served as the background information for assessment. Climate Change impact on the habitats of the key forest forming trees – mountainous (juniper), plain-flood and desert ones (saxaul) was assessed.

Desert forests. White and black saxaul were studied generalized since are growing on adjacent areas but different soils. According to the estimate, saxaul formations are tolerant to Climate Changes and fluctuations. Even in the long-term (by 2080) conservation of the current habitats is expected. However more dry and arid conditions may cause reduction of saxaul productive capacity along with the other tree species growing in Uzbekistan deserts.

Mountainous forests. Existing species of juniper were considered individually (Zeravshan, Coptosomatidae and Turkestan) in six forest regions. According to the estimate, the arch formations are sensible to Climate Change. The areas of the combination of climatic factors favourable for the arch growing will significantly shift upwards along the mountain slopes. When implementation of scenario A2 by 2080, elevation of the lower margin of Zeravshan arch is possible by 1050-1000 m, and upper one – by 900-800 m. Correspondingly, the upper arch Coptosomatidae margin will elevate (by 750-650 m) and Turkestan arch (by 650-500 m). It will result in narrowing of the altitudinal belt of the arch formation prevalence. With the altitude elevation the soil properties dramatically deteriorate, since their major part is represented with the rocks, stony rockslides and shallow soils. This will significantly reduce productive capacity of the juniper stands on the new habitats.

The tree form of Turkestan arch is the most vulnerable one to Climate Change. In line with scenario, this form may extinct in the long-term, and unfavourable climatic conditions will become the cause of weakening, diseases and even early collapse of the plants. Dramatic reduction of Coptosomatidae juniper and extinct of Turkestan juniper is possible in Gissar-Darvaz forest region. Types of responses of the forest species of Uzbekistan on Climate Change and its consequences are shown in the table 5.7.2.

Factors deteriorating the forests and forestry vulnerability to Climate Change in adaptation measures absence:

- High anthropogenic stress (uncontrolled grazing, unauthorized forest cut-off, fires);
- Lack of material and financial resources (application of limited technologies, pests and diseases, etc.) and, as a sequence, deterioration of survival rate of established and condition of existing plantations;
- Climate warming and aridization already leads to the spatial movement and habitat reduction of the tree and shrub species;
- Lack of the adequate monitoring does not allow scientifically grounded planning of the forestry development.

Coptosomatidae juniper

After-effects of all factors' operation for the Uzbekistan forests:

- reduction of the area covered with the forest, degradation of the species composition, decrease of the forest reserves and productive capacity;
- deterioration of the forest age composition due to intensification of anthropogenic stress;
- riparian woodlands, specifically, turanga ones, will become endangered since climate warming will inevitable cause water use increase for domestic and agricultural needs, and these unique forests completely depend on conservation of the natural hydrological mode;
- field protective forest plantation will extinct, excluding the linear plantations of the mulberry and osier which are not able to efficiently protect the fields.

Strategy on the forestry adaptation to Climate Change includes the following activities.

- Legislative initiatives and institutional reforms (Forest Code, National forest program).
- Improvement of the forestry management system (forest inventory, long-term plans of the forestry development, monitoring, database).
- Improvement of the efficiency of the forestry activities (feasible work scheduling, grazing control along with the other anthropogenic stress).

- Human resource development of the sector (training manuals, considering peculiarities of the forestry of the country; capacity building).
- Development of applied scientific research, application of the stored knowledge and link of the science and production process.

Table 5.7.2 Climate Change impact on the key forest forming species of Uzbekistan

Forest types	Key forest forming species	Impact and vulnerability
Desert forests – 78% of entire forest covered area of the country	White saxaul – Haloxylon persicum Black saxaul – Haloxylon aphyllin Cherkez – Eriopodum Candym and others	Habitats inside the country preserve. The habitat climate inside the country is getting hotter and dryer leading to productive capacity reduction of both saxauls and the other desert species
Plain-flood 1) riparian woodlands – around 5 % of entire forest covered area of the country	Asiatic poplar – Populus evfratica Osier – Salix Oleaster – Elaeagnus	Vulnerability depends on uncontrolled cutting and uprooting for the flood land development, due to the flood runoff lack in the natural periods as well as water table decline due to water intake. Water consumption increase due to Climate Change makes the riparian woodlands specifically vulnerable
2)Plantation field protecting planting – around 2% of entire forest covered area of the country	Elm – Ulmus plane-tree –Platanus Locust – Robinia Water locust – Gleditchia and others	These planting species are artificially established. Under Uzbekistan conditions they may exist only on irrigated lands. The condition depends on irrigation and maintenance
Mountainous forests – around 15% of entire forest covered area of the country	Pistachio – Pistakia Walnut – Juglans Almond – Amigdalus Apple-tree – Malus Junipers – Juniperus: Zeravshan – J. seravschanica Kom, Coptosomatidae – J. semiglobosa Rgl. Turkestan – J. turkestanica Kom and others	Elevation of hypsographic levels of the habitat boundaries and narrowing of altitudinal belt of their prevalence Spread of the arch belt along the altitude will decrease by 350 m (2080, scenario A2), which will reduce its area and deteriorate the soil properties. Similar trends are possible for the other species

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5.8. Sectors of Economy

Climate data are used in construction, design, and planning of municipal economy; in transport sector, oil and gas industry, in hardware facilities operation, planning of the light and food industry production process, etc.

The task of assessment of the economic sectors vulnerability to Climate Change is complicated and complex as the Climate Change leads to a set of both favorable and unfavorable impacts on economic spheres that are frequently interrelated with each other.

Climate Change impact on economic sectors is considered by the normative documents that define standard climate parameters or various types of zoning. By evaluating how Climate Change impacts these parameters, it is possible to identify Climate Change related trends in economic sectors.

Construction and communal economy design and planning use such data as duration of the cold (heating) and hot seasons, temperature of the coldest and hottest days, number of days with the temperature over and below a specified criteria etc. In the oil and gas industry and transportation sector climatic zones as well as actual temperatures are applied for recording of climatic factor.

Analysis of the trends in rows of standard climate parameters proves those are changing against the background of global warming.

For assessment of Climate Change impact on economic sectors that considers regional Climate Scenarios based on GHG emission scenarios A2 and B2, the standard climate parameters were calculated for the prospects till 2030 and 2080 and their changes were evaluated as compared with the modern period (1971-2000).

Average duration of the heating (cold) season in Uzbekistan will be 8-9% shorter by the year 2030 as compared with the reference period, and by 2080 this period will be 25% shorter.

The Figure 5.8.1 demonstrates the decrease in power consumption for heating in conditions of warming with consideration given to the mean temperature and heating season duration. According to the estimate, by the year 2030 energy saved on heating as compared with the baseline period by scenario A2 amounts to 12%, and by scenario B2 – 16%, saving by 2080 will reach 35% by scenario B2 and 41% for scenario A2.

The estimates show that the mean temperature of the coldest days for the two scenarios will grow 3°C higher by 2030 and 6.6°C higher by 2080.

Consequently, warming up of winter season on the territory of Uzbekistan will lead to reduction of energy consumption for heating as well as to decrease of building materials inputs in some types of construction works.

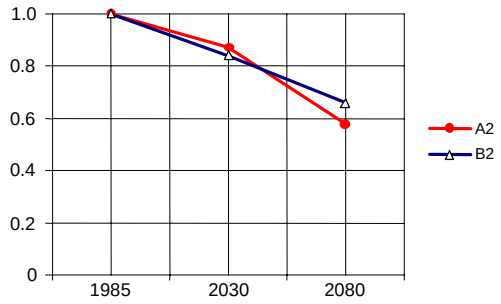

Figure 5.8.1 *Trends of energy resource consumption for heating*

According to the estimate, hot period duration will increase comparative to reference period - 16% according to scenario A2 and 20% according to scenario B2 by the year 2030, and 43% by scenario B2 and 49% by scenario A2 by the year 2080, which will significantly impact energy consumption for air conditioning (Figure 5.8.2).

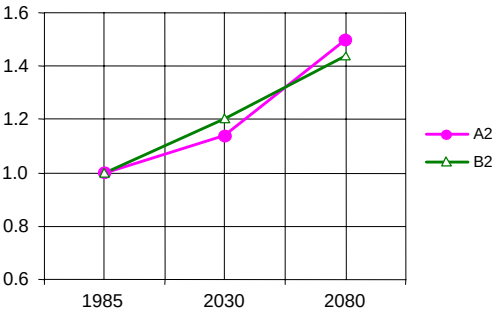

Figure 5.8.2 *Trends in energy consumption for air conditioning*

Specified temperature of the hottest days in the South of Uzbekistan will exceed 40°C by 2080 for scenario A2. According to the data for the province centres of Uzbekistan, the mean temperature of the hottest days for two scenarios will grow 1.3° C higher by 2030 and 3.7° C higher by 2080.

Growth of summer temperatures caused by Climate Change may cause:

- increase of energy consumption for premises ventilation and air conditioning;
- increase in material costs for new residential, agricultural and industrial projects design development for extremely hot and arid conditions,

as well as for manufacturing of new building materials;

- intake of additional resources for cooling of equipment to maintain it in operational condition;
- growth of energy and other material costs to maintain optimal pressure in cold water supply system.

Moreover, climate warming will require re-planning of **light and food industry** as well as retail trade commodity circulation as relates to and its annual rhythm and allocation of goods on the territory of the country which will lead to additional material costs.

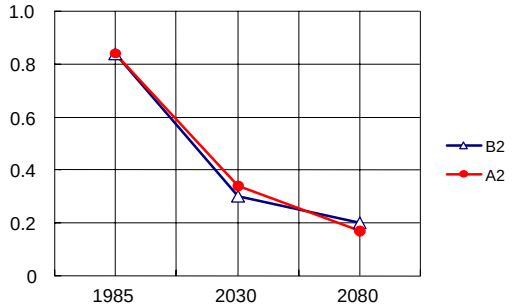

Figure 5.8.3 *Tendency of diminishing of the territory with a stable mean temperature below 0°C in Uzbekistan*

According to the estimates (Figure 5.8.3), by 2080 sustainable periods with the mean daily temperature below 0°C will occur on 18-20% of the territory of Uzbekistan (in its Northern part and in the highlands) which will lead to reduction of additional rates of fuel and lubrication materials consumption in winter season for the ***motor transport sector***. Intensification of extreme summer season will cause expansion of the areas where increased rates of fuel consumption are introduced.

The upsurge of mean monthly air temperature peaks, and hot period duration will lead to the increase in natural loss of ***mineral oil***. Improper use of climate zoning, outdated climate information may lead to notable errors (up to 8%) when considering natural loss of mineral oil.

The key adaptation measures identified to provide for a rational use of energy and material resources, ensure reliability and sustainability of economic sectors in Climate Change condition, as well as for development of certain projects, are to:

- Update normative documents comprising climatic data for design and construction every 10 years.
- Develop differentiated climate based zoning according to the economic sectors specificity.
- Develop new approaches to consideration of climate factors in oil and gas industry, transportation sector and the other industries.
- Consider Climate Change when revising the energy consumption rates.
- Manufacture and import machinery, equipment, and materials appropriate for hot climate conditions in Uzbekistan.
- Consider scenario assessments of climate parameters for long-term planning in various economic sectors.

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5.9. Priority Measures of Adaptation in Uzbekistan

The assessment of the vulnerability and consequences of Climate Change for the environment, resources and socio-economic living conditions has revealed the necessity to take adequate action to reduce the negative consequences and adapt to new conditions.

The analysis of adaptation needs and current measures has shown that Uzbekistan is implementing a number of national and sectoral programs, measures and actions, which directly and indirectly contribute to adaptation.

This is explained by the fact that the primary negative consequences of Climate Change in Uzbekistan are linked with the increase in water resources deficiency. Water deficiency has become a factor that limits the opportunities of the country's economic development, particularly, agriculture, which plays a pivotal role in economy and population employment. The extensive use of water and land resources has led to the large-scale salinization of irrigated lands, degradation of natural pastures, drying up of the Aral Sea, and a large ecological crisis.

The problem of water resources deficiency is directly linked with the increasing desertification in the region, loss of biodiversity and growth of risks for food supplies. Therefore, measures that Uzbekistan is taking in an effort to tackle existing urgent problems are in synch with the adaptation needs brought about by Climate Change.

The goal of the conducted assessment is to study Uzbekistan's existing practice which may be viewed as adaptation to Climate Change and its changeable nature in the context of the available information on vulnerability and adaptation needs.

Parts 5.2-5.8 provide a description of vulnerability to Climate Change by sectors: agriculture, water resources, population health, hazardous hydrometereological phenomena, water ecosystems and fish resources, forests and forestry, communal household and particular sectors of agriculture (oil, gas, transport, construction, planning, energy, etc.) The vulnerability of the above-mentioned sectors is determined by the current and expected climatic changes:

- increase in the duration of the dry and hot season;
- reduction of water resources and deterioration of water;
- increase in the use of water within all sectors and increase in water deficiency;
- increase in the recurrence of hazardous and extreme hydrometeorological phenomena (high temperatures, heavy precipitation, drought, growth of water deficiency, etc.);
- worsening of all types of land degradation (salinization, erosion, movement of salt and dust from dry parts of the Aral Sea, etc.)
- decline in yields of modern crop cultures, pasture productivity and animal husbandry;
- growth of risks for food supplies and population health.

Experts from diverse sectors analyzed the factual and potential unfavorable consequences of Climate Change and determined possible options for adaptation-related action, including increase of scientific, institutional and legal potential.

The analysis conducted has been used in the preparation of sectoral questionnaires (list of measures classified by sectors). After consultations with interested organizations, five criteria for the assessment of adaptation measures according to a five-point system were adapted, namely: ***need for international aid, the effectiveness of measures, the cost of measures***, ***achievability of goals, and usefulness at the present time***.

The adaptation strategies and measures outlined in the questionnaires were analyzed within interested organizations according to the adopted criteria and five-point scale. The completed questionnaires were then used to extract average points and particular adaptation strategies and measures were prioritized by sectors. Then, based on the rating and average points, the measures most appropriate to each sub-sector, strategy or action were considered.

The drawback to such assessment was the absence of weight quotients for each criterion which were hard to determine numerically. Therefore, the final decision to prioritize particular adaptation measures was made based on expert judgment, that is, experts' opinion was, thus, an additional sixth criterion. In this way, as a result of the multi-criterion analysis which invloved respective ministries, departments, and scientific organizations, the most significant adaptation measures were picked.

Agriculture and water resources sectors underwent broad-based consideration since they are closely interlinked. The vital adaptation needs are reflected by the strategy "Water saving and rational use of irrigated lands". The measures it includes, especially those dealing with the improvement of irrigation infrastructure and drainage, and introduction of such irrigation technologies as drop, impulse, and intra-soil, are very costly.

The resolution of issues related to the rational management of water and land resources does not require much investment, but it calls for coordination and adoption of international agreements dealing with the management of transborder water resources.

Regional interaction and international support are necessary for the development and improvement of metereological and hydrological monitoring and creation of posts for the observation of snow and ice resources in mountainous areas where rivers flowing into the Aral Sea start. Without regional interaction it

will not be possible to implement adaptation measures revealed in "water ecosystems and fish resources" sector because the implementation of these measures requires, first of all, setting the quota for water resources.

"Water saving in industrial and communal household water use" also requires sizeable investments, but compared with "water saving in irrigation", it saves a lot less water. However, measures for water saving in the household sector have the most priority from the point of view of providing the population with clean drinking water and raising their awareness of the problem.

Table 5.9.2 below provides prioritized strategies and measures of adaptation to Climate Change in water resources and agriculture sectors which are frequently undertaken in Uzbekistan with the active support of the government and international community.

The following strategies are deemed the most promising adaptation-wise for ***population health*** sector: organization of prophylaxis; increasing public awareness; conservation of the environment and providing safe drinking water for the population; introduction of new and improvement of the existing water treatment technologies, maintenance of heating facilities in rooms and reduction of heat islands in towns. The most prioritized measures for ***population health*** sector are illustrated in Table 5.9.2.

For ***hazardous hydrometeorological phenomena*** sector, measures aimed at the improvement of the insurance system and raising public awareness have been found to be the least expensive. Measures aimed at the development of the regional monitoring of lakes prone to bursting, including those outside Uzbekistan, have the most adaptation potential. Just as important are measures dealing with the improvement of hydrometereological monitoring and forecasts as well as measures to protect crucial objects from hazardous hydrometeorological phenomena. The most prioritized measures are illustrated in Table 5.9.3.

For ***water ecosystems and fish resources*** sector, the following strategies have been found to have the most adaptation potential: conservation and increase of fish resources; second, development of political dialog in the management of transboundary water resources; third, development and improvement of the system of complex ecological monitoring of water and respective ecosystems. Priority measures are provided in Table 5.9.4.

For ***forests and forestry*** sector, the following strategies have been determined: the improvement of the forestry management system, including legislative initiatives and institutional changes, increase of the effectiveness of forestry activity, growth of the scientific and personnel potential of the field. Priority measures are illustrated in Table 5.9.5.

For ***gas, oil, transport*** and ***construction, planning and household*** sectors, measures related to applied research for each sector directed at the development of new approaches to the assessment of the impact of climatic factors and renewal of respective normative documents have the most adaptation potential.

Priority measures for the above-mentioned economic sectors are illustrated in Table 5.9.6.

The following bodies participated in the analysis of adaptation measures: Center for Socio-Economic Research of Uzbekistan of Uzbekistan; Ministry of Agriculture and Water Resources and its institutes (Uzbek Scientific-Production Centre for Agriculture; Scientific Research Centre for Pisciculture Development, Uzgipromeliovodhoz, etc.); Ministry of Health and its subdivisions; National University; Scientific Research Hydrometeorologiical Institute, Atmospheric, Surface Water and Soil Pollution Monitoring Service; "Uzkimyosanoat", "Uzqurilishmateriallari", "Uzbek-energo" State Joint Stock Companies; "Tashteploenergo" Production Association under Tashkent Municipality; "Uzkommunxizmat" Uzbek Agency and others.

Besides consultations at the level of organizations directly participating in the assessment, a wide survey was conducted. Respondents included experts from different state organizations, NGOs, industrial enterprises, higher educational establishments, etc., namely: Samarkand Regional Committee for Nature Conservation; Samarkand Agricultural and Technological University; National University, Samarkand University and Bukhara University; Navoi Regional Committee for Nature Protection and Regional Centre of State Sanitary and Epidemiology Observation; "Zarafshan" NGO; Bukhara branch of "Ecosan" Society; Bukhara Regional Agency of Healthcare; Bukhara Regional Scientific Centre of the Academy of Science of Uzbekistan of Uzbekistan.

The multi-criterion and inter-sector analysis has made it possible to map out priority strategies of adaptation to Climate Change. Presently, the implementation of these strategies is vital for Uzbekistan:

1. Water saving and rational water use.
2. Combating land degradation (melioration of irrigated lands and rational use of pastures).
3. Increase of plant growing and cattle breeding productivity.
4. Taking preventive measures in healthcare sector.
5. Reduction or prevention of damage from drought and other hazardous hydrometeorological phenomena.
6. Creation of conditions for the conservation and maintenance of lake and river ecosystems.

Table 5.9.1. The main strategies and measures of adaptation to Climate Change in water resources and agriculture sectors

Sector	Action/ consequences	Adaptation strategies and measures				Obstacles to implementation
Water resources	Reduction in snow and ice resources in mountains and river flow Disturbance in annual river flow distribution Deterioration of water quality Increase in water consumption in all sectors Increase in loss during irrigation Increase in recurrence and depth of hazardous phenomena (extreme floods and drought)	**Improvement of land and water resources management at national and transboundary level** Improvement of legal mechanisms Introduction of IWRM Increase of the role of land users and water consumers Development of programmes and action plans for melioration of irrigated land Complex assessment of changes in land use, salinization and other types of land degradation Optimization of crop zone selection with an account of climatic change Correction of water consumption schemes and norms Development of long-term programmes/plans for agriculture and water management development Improvement of the monitoring of seed beds and pasture conditions Improvement of agrometeorological services (information and forecasts) Increasing awareness of land and water use at all levels (from local communities to decision-making officials)	**Water saving and rational water use in irrigated land** Introduction of economical irrigation methods (short furrows, through furrows, night-time irrigation, field leveling and others). Reconstruction and maintenance of channels and drainage system Restoration of field-shelter belts Broader introduction of irrigation technologies Reutilization of water with low mineral concentration Improvement of methods for return water treatment Pilot projects on water saving and land degradation Artificial selection of high-yield heat- and salinity-resistant crops Teaching farmers modern skills in land use and water consumption, including new crop cultivation technologies	**Improvement of water resources monitoring system** Development of hydro meteorological networks in the region, tool (device) supply Improvement of harvesting, processing and exchange of information among countries in the region Improvement of transboundary monitoring of water resources Organization of the tabbing of water consumption in households	**Water saving in industrial and household water consumption** Introduction of advanced water-saving technologies in industry and households Use of equipment reducing water consumption Record of water consumption and tariff policy	Insufficient regional coordination Insufficient financial resources Poor technical opportunities within Uzbekistan Insufficient investment Insufficient applied research and developments
Agriculture	Increase in deficiency of water for irrigation Increase in land salinization Increase in recurrence of extreme weather conditions Decrease in crop yields and pastures Increase in fodder deficiency, increase in heat stress for animals Decrease in animal husbandry productivity			**Increase in plant growing productivity** Introduction of high-yield and salinity- and drought-resistant crops Introduction of cotton and lucerne crop rotation Programmes to support farmers working on low-yield land Support of fruit and grapes producers Support of businesses involved in fruit and vegetable product recycling Study of profitability of agricultural crops in households	**Increase of animal husbandry productivity** Setting load norms for pastures Rehabilitation of degraded pastures (plant melioration, creation of sown pastures, improvement of water supply) Creation of fodder base for animal husbandry (increase of the share of fodder crops) Stabilizing sands, forest plantation on dried part of the Aral Sea Measures to cut heat and water stress in free-range animal husbandry	Lack of coordination of land use and water consumption Insufficient financial resources Poor technical opportunities within Uzbekistan Insufficient investment Insufficient applied research and developments

Table 5.9.2. Main strategies and measures of adaptation to Climate Change in population health sector

Sector	Action/ consequences	Adaptation strategies and measures				Obstacles to implementation
Population health	Increase in duration of heat wave and heat loads on humans Increase in heat-related and cardiovascular disease Increase in acute intestinal infections Increase in risk of parasitic disease and malaria	**Conservation of environment** Improvement of legislative and normative framework to reduce environment-related risks for health Improvement of material and technical base of sanitary and epidemiological services Increase responsibility of economic entities Improvement of drinking water resources monitoring and protection	**Provision of sufficient drinking water** Construction of new and repair of existing water pipes and drainage Improvement and introduction of water treatment technologies Introduction of polymer and fibre-glass Creation of local sources of water supply for rural population	**Organization of prevention and prophylaxis** Determination of cardiovascular disease risk groups Improvement of the system for the prevention of acute intestinal infections and transmissible diseases: introduction of electronic monitoring Development of action plan against heat wave, including instructions for medical personnel Control over disease carrying breeds and spots with high concentration of infections Maintenance of heating facilities in rooms and reduction of heat islands in towns (landscaping, shading of buildings)	**Research and raising public awareness** Raising population awareness of increase in disease risk Complementing research and educational programmes with sections on climate and health Development of a system warning of a beginning heat wave, including regional criteria Improvement of forms of medical accountability and provision of access to data	Shortage of financial resources Weak technical opportunities within Uzbekistan Insufficient applied research and developments Insufficient data for assessment of climate impact on health

Table 5.9.3. The main strategies and measures of adaptation to Climate Change in hazardous meteorological phenomena sector

Sector	Action/ consequences	Adaptation strategies and measures				Obstacles to implementation
Hazardous phenomena **Heavy precipitation, hail** **Avalanche** **Drought**	Increase in mudflow risk period and mudflow recurrence Growth of risks of mountain lake overflow Persistence of high risk of avalanche Increase in recurrence and depth of drought, recurrence of high temperatures, heavy precipitation, hail	**Insurance system development** Expansion of the spectrum and improvement of the insurance service quality Improvement of the legal framework, increase of transparency Increase of population's financial insurance-related knowledge	**Boosting the potential of quick response and protection** Improvement of notification systems Protection of housing and objects from mudflow and avalanches in high-risk areas Introduction of drought early warning system Active impact on hydrometeorological processes	**Research and developments** Discovery and mapping of maximum risk zones Improvement of methods for hazardous hydrometeorological phenomena forecasts Development of drought early warning system Development of criteria of hazardous phenomena for different economic branches with an account of geographical area peculiarities	**Improvement of hydrometeorological monitoring** Expansion of terrestrial network of hydrometeorological observations, including foreign mountainous territory Development and application of methods of distance monitoring Restoration of top atmospheric layer observations	Insufficient financial resources Insufficient applied research and developments Insufficient regional coordination Weak technical opportunities within Uzbekistan Shortage of specialists

Table 5.9.4. The main strategies and measures of adaptation to Climate Change in biodiversity sector, water ecosystems, and fish resources sub-sectors:

Sector	Action/ consequences	Adaptation strategies and measures				Obstacles to implementation
Biodiversity	Shifting of ranges northwards, threat of alien species Disappearance of endangered species Reduction in ranges and degradation of wild ecosystems outside protected territories	**Development of environmental protection legislation** Setting ecological limits in water legislation Improvement of norms and rules for the use of significant water ecosystems **Development of legislative framework** for setting rights and obligations of users and fish product manufacturers and protection of their interests	**Enhancement of the current measurers' effectiveness** Implementation of the National Strategy for Biodiversity Conservation Introduction of economic mechanisms for the use of nature and environmental protection Development of a strategy for fish industry development with an account of international experience and FAO recommendations Creation of conditions enabling natural reproduction of fish resources in the most vulnerable areas	**Development of ecological monitoring** Organization of Climate Change indicators Restoration of baseline monitoring in water flow formation areas Inventory of water ecosystems, organization of a complex ecological monitoring of significant areas	**Scientific research and education** Improvement of ecological education in schools and higher educational institutions Dissemination of information on the state of environment **Developments** for application of progressive ways and technologies related to fishery and pisciculture	Legislative deficiencies in wild ecosystems protection Shortage of financial resources for natural reserve management National ecological network not created Absence of transboundary biosphere reserves
Water ecosystems fish resources	Water deficiency and deterioration of its quality Increased degradation of water ecosystems, disappearance of particular lake, river and coastal ecosystems					Shortage of financial resources Insufficient regional coordination Aral Sea and Amudarya delta lakes not included in list of water consumers

Table 5.9.5. The main strategies and measures of adaptation to Climate Change in forests and forestry sector

Sector	Action/ consequences	Adaptation strategies and measures				Obstacles to implementation
Forests and forestry	Increased fragmentation of arid forest ecosystems Reduction of juniper ranges Disappearance of *tugai* forests and field-protective forestation Decrease in desert forest productivity	**Improvement of legislation and the system of forestry management** Development and adoption of a Forestry Code Development and adoption of a National Programme and programmes for field-protective forestation Setting quota for forestry	**Enhancement of forestry activity effectiveness** Use of scientific recommendations and international experience Consideration of climatic changes in the planning of new planting areas	**Increase of personnel potential** Obligatory forestry education for supervising officials of the branch System of continuous upgrade of personnel qualifications	**Development of applied research on demand of production and close correlation between forestry and production** Selection of forest trees resistant to pests and disease, heat and drought	Insufficient financial resources Underestimate of Climate Change impact on forest ecosystems Insufficient methods for assessment of impact of climatic parameters on forest ecosystems

Table 5.9.6. The main measures of adaptation to Climate Change in particular economic sectors

Sector	Action/ consequences	Measures	Obstacles to implementation
Oil and gas sector **Transport**	Natural decrease of oil, gas condensate and oil products, miscalculations in assessment of natural decrease of oil products Miscalculations in planning and assessment of use of fuel and lubricating materials	Use of upgraded climatic information in assessment of natural decrease of oil products and natural gas, in assessment of norms of fuel and lubricating material use Development of specialized climatic zoning and new approaches to the register of climatic factors Production and import of equipment and materials in accordance with hot climate	Underestimate of impact of Climate Change on economic sectors Shortage of methods for assessing impact of climatic parameters on economic sectors
Construction, planning , energy supply and household	Overuse of material, technical and energy resources Increase of energy use for ventilation and air-conditioning Emergence of new heat islands in towns Increased frequency of emergency situations in cold water supply systems	Upgrade normative documents including climatic parameters once every 10 years Improve and adapt town planning and architecture with a view to reducing heat load (use new technologies and materials, landscaping, shading of building, etc.) Improve the planning of industrial areas and vehicular communications with a view to reducing heat islands in towns Improve the system of recording cold and hot water consumption in communal household	Absence of necessary statistical data on economic sectors Absence of necessary financial resources

6. Research and Systematic Observations

6.1. Systematic Observations of Climate System and Information Exchange

6.1.1. Historic and Regional Conditions of Observations Network Development

The Observation Network, functioning on the territory of the Central Asia (Uzbekistan, Kyrgyzstan, Tajikistan, and Turkmenistan) has been developed on the basis of climatic characteristic variability and appeals of economic organizations, ignoring the borders of the country.

First meteorological observations were commenced in 1867 (Tashkent station). Observations and processing had been carried out using common methods, developed in the Main Geophysical Observatory (Russia).

First hydrological posts were organized in the middle of the 70-s of XIX century on Amudarya (Turtkul and Nukus) and Syrdarya (Kazalinsk). Systematic observations over the level of the Aral Sea started in 1911.

In 1920-s upon the state self-determination of the Central-Asian Republics the united observation system for observations, data distribution and storing was maintained, as well as the system of hydro-meteorological forecasting.

Maximum number of hydro-meteorological stations and posts were established in 1980-s. Subsequently, number of points and observation extent was decreased (Table 6.1). However, even in the period of the most intensive development the observation network of Uzbekistan, like those in other Republics of the region, was not enough dense.

Owing to establishment of the National hydro-meteorological agencies (NHMA) in the Central-Asian states and Kazakhstan, part of hydrological stations and posts, within the jurisdiction of NHMA of Uzbekistan, were transferred to NHMA of Kyrgyzstan, Kazakhstan and Tajikistan. That is why for the period 1991-1998 the observation network of Uzbekistan was decreased. Thus, compared to the middle of 1980-s the number of hydrological and meteorological points of observation decreased up to 16%. To the present moment the situation with hydro-meteorological points of observation in Uzbekistan has become stable, but is still complicated.

NHMA of Uzbekistan faces difficulties in its efforts to solve tasks on provision of state management organs and branches of economy with the information on the state of natural environment and climate, actual and solicited changes of hydro-meteorological conditions and state of the natural environment, causes of these changes, submitting of extraordinary information in force-majeure circumstances.

8 posts in Amudarya upper waters and 9 posts in Amudarya upper water, within the jurisdiction of NHMA of Tajikistan and Kyrgyzstan have ceased supply of operational hydrological information. Some meteorological stations on the Aral Sea and in the mountainous areas of Tajikistan and Kyrgyzstan were closed. The situation with snow-metering observations in the mountains, essential for assessment of water resources of the region, worsened and is poor now and for the future perspective (Table 6.2).

Table 6.1 Change of Number of Hydro-meteorological Observation Points

Country / Region	Number of Observation Points			Data % for 1985	
	1985	1995	2005	1995	2005
Hydrological posts					
Uzbekistan	155	128	130	83	84
Central Asia	559	399	277	72	50
Meteorological Stations					
Uzbekistan	93	76	78	82	84
Central Asia	361	282	272	78	75

Table 6.2 Change of Number of Specialized Observation Points in Uzbekistan

Years	Actinometric Stations	Agro-meteorological		Evaporation from water surface	Observation over snow cover		
		stations	posts		on river basins	ground points	aero-visual points
1975	7	68	10	22	13	161	141
1980	7	74	17	22	11	121	244
1985	7	77	28	23	5	41	282
1990	7	66	32	25	3	31	302
1995	6	60	26	20	3	22	233
2000	6	62	26	16	2	12	153
2005	6	61	30	10	2	12	138

Almost in all the Central-Asian NHMA the observations by avia-distance laths over the height of snow cover have been ceased. In NHMA of Uzbekistan the observation on avia-distance laths since 1992 are carried only in three basins once per winter season instead of four times. Aviation gamma-surveys of snow water content are ceased, avia-landing and ground snow-surveys in the mountains are ceased. Route snow-metering surveys in Uzbekistan earlier were carried out in 13 basins in 161 points. At present these works are carried only in the Chirchik-Akhangaran basin. The quality of hydrological forecasts is remarkably decreasing without this information, and, respectively, quality of consumer servicing.

On the lakes and reservoirs separate, not always representative posts are left. Karakum observatory ceased its functioning as scientific and methodological center upon transference to NHMA of Tajikistan, and its role is restricted by the level of a common lake station. Water-balance stations stopped their activity, excepting the station of Fedchenko in Ferghana Valley. As a result, the basins of separate rivers stayed without any meteorological, hydrological and snow-metering observations.

Especially disastrous situation occurred regarding the observations on small rivers. Observations over the regime of dried rivers in low mountain zones are not carried out, and such a situation is observed in the majority of small rivers. At the same time, these rivers are good indicators of climatic and anthropogenic changes.

The amount of probing stations has become disastrously low both in NHMA of Uzbekistan, and in the whole region. If earlier for the aims of the regional hydro-dynamic forecast the data from 49 probing stations were delivered, then at present such information is coming from 8 stations. Two aerologic stations of Uzgidromet were laid up, and Tashkent aerologic station operates practically twice-thrice a year.

Transference of the Weather Modification Agency from Uzhydromet to the Ministry of Defense complicated development of methods of active impact to the cloudy systems, their implementation into the practice and disturbed the united system of forecasting of hail processes and impact on them.

Owing to economic reasons the network of observation stations of NHMA of the Central Asia was decreased, which was negatively reflected to provision of the hydro-meteorological network of Uzbekistan by devices, equipment, spare parts and materials. Many used devices have become obsolete, having worked their resource completely. In the recent fifteen years new modern hydro-meteorological devices are not bought (electronic thermometers, different recorders, hydro-meteorological impellers and winches etc.). Meteorological and actinometric stations lack standard (non-automated) hygrometers, self-recording rain gauge, maximum and minimum thermometers, galvanometers, balance-meters, action-meters. To carry out water-balance observations evaporators ГИ-3000 are needed, accessories, cabins for self-recording devices.

NHMA of Uzbekistan does not have enough funds for construction and repairing of post devices on hydrometric posts and for maintaining them in a due working state. Annually only part of posts are repaired, which demand capital or preventive repair. Therefore, in result, there is urgent need in undertaking measures directed to improving the situation, and this is out of power of any state of the Central-Asian region. So, it is necessary to unite the efforts and power, supported by the international community aid.

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6.1.2. Observations Data Collection, Processing and Distribution

Long-term practice of the Central-Asian countries has formed stable system of collection and distribution of operative hydro-meteorological information, adapted to the current technical level, which considers geographic peculiarities of the region. The scheme provides reliable data collection up to 99%.

To transfer hydro-meteorological information stations and posts of NHMA of Uzbekistan, depending of the local realities, are equipped by phone, cable apparatus and transceiver. Phone and cable channels are leased for information sharing.

Tashkent regional node of tele-communication carries out collection of operational information and its transmission to the channels of global tele-communication (GTC). The responsible zone includes the territory of Uzbekistan, Kazakhstan, Turkmenistan, Kyrgyzstan, Tajikistan. The national duty of NHMA of Uzbekistan within the frame work of the Global System of Observation is provision with functioning of 62 observation stations, covered by the regional basic synoptic network.

Data Processing. Practically all initial materials of meteorological observations, coming from the stations of NHMA of Uzbekistan, are processed in the automated regime. For processing PERSONA-mis program complexes are used (developments of All-Russia SRIHMI – WDC, NHMA of Uzbekistan) and PERSONA-IB (development of NHMA of Uzbekistan).

Every month data from meteorological monthly are delivered to All-Russia SRIHMI – WDC, (part 1) through19 exchange stations. Since 2000 “Resources of surface and underground waters, their use and quality” inter-departmental cadastral register issue is published with participation of Uzgidromet,

Goskomgeology and Ministry of Agriculture and Water Economy.

Participation of Uzbekistan in distribution of climatic data. On the inter-state level there occurs sharing by hydro-meteorological information between NHMA of the region. 75 hydrological stations and posts and 280 meteorological stations are included into the process of inter-state operational exchange by information. Information sharing between NHMA is carried using the leased phone communication channels, operational data, received from the adjacent countries, are used for short-term hydro-meteorological forecasts of NHMA of Uzbekistan.

3 meteorological stations (Tashkent, Tamdy and Chimbay) are included into the Global Observation network, the data being transmitted using CLIMAT cable on monthly basis to the Global System. Beginning from January 1, 2001 NHMA of Uzbekistan is transmitting additionally to the Global System channels the data coming from 9 more stations, by the request of WMO. At present the data from 12 stations have become available not only for WMO, but for all the world information centers. This information is transmitted to West-Siberian Regional Center of NHMA of Russia.

CLIMAT information through 12 stations and DECADA through 9 stations is transmitted to GMC of NHMA of Russian Federation (decade data, received up to 1, 11 and 21 days of month). Moreover, on monthly basis through three GSN meteorological stations since May 2005 the data on daily sums of atmosphere precipitation, maximum and minimum air temperature per day and night are transmitted to the World data Center (Ashvil, USA).

6.1.3. Receipt and Use of Satellite Data

Uagidromet is getting satellite data of METEOSAT series agreed with the European Organization on exploiting of meteorological satellites of the earth EUMETSAT. The data are received through EUMETCAST system of satellite data distribution. Moreover, Uzgidromet, being a member of WMO, has a free access to NOAA AVHRR satellite information, transmitted from meteorological polar-orbital satellites of US National Organization on Oceanography and Atmosphere (NOOA). Complex information on the state of atmosphere and earth surface is coming from the satellite every day. Receiving and processing of satellite information is carried out in the special organization of Uzgidromet ATV "METEOINFOSYSTEM".

The information, received from two types of meteorological satellites, is used in operational practice for solving the tasks of meteorological and hydrological forecasting. Operational satellite information, used for forecasts (maps of cloud formations and nephanalysis), is processed in the real-time.

Satellite data use expanding assumes elaboration of joint developments together with the Ministry of Agriculture and Water Economy, State Committee on Environment protection, being aimed to the following: establishment of the operational observation system over snow coverage in the mountain regions, state of pastures and processes of desertification; development of methods for assessment of the state of agricultural crops on the irrigated lands; development of researches on effective management by water resources on the irrigated massifs; research of dynamics of watering in the zone of ecological calamity (Aral Sea region); revealing of centers of salting and assessment of salt-dust-transfer from the dried bottom of the Aral Sea.

6.1.4. Support of the International Community in the Area of Observations Network Development

Support of international community for development of observations network in the Central Asia was focused on improvement of water resource monitoring in the Aral Sea basin.

UNDP, UNEP and the World Bank have supported the Aral Sea Basin Programme (ASBP). This programme is being implemented by the International Fund for Saving the Aral Sea (IFAS). The Programme objective is improved management of the international waters of the Aral Sea basin. GEF, Swiss Government and EU are implementing projects under ASBP for modernization of the network, improvement of data bases and monitoring of transboundary water resources.

Out of many international projects aimed at strengthening of Uzhydromet network we would like to note activity of Swiss Mission for the Aral Sea, GEF and USAID, who ensured supply of computers and software, installation of NOAA receiving stations for forecasting and capacity building of all National Hydrometeorological Services (NHMSs) in Central Asia. In addition, Swiss Mission on request of Uzhydromet has replaced SEBA loggers at three transboundary stations by the most recent version of SEBA loggers and ensures conditions for automatic data transfer.

6.1.5. Means of Improving the Data Observation, Collection and Processing Systems

There is a need to develop and approve a special program for optimization of observations network of all NHMSs in Central Asia to keep the most important observation points, minimize maintenance costs and bring the network in compliance with contemporary requirements both in terms of manageability and equipment and hydrometeorological services to the users. This would require good will of leaders of NHMSs in Central Asia and approval of the respective governments.

Plan of Regional Hydrological Network Modernization developed in 1996 with financial assistance of the Swiss Mission on the Aral Sea Problems under Project 2.1 "Hydrometeorological Services" of the World Bank could become a basis of the above program.

According to preliminary estimates, the optimal network for the entire Central Asia should consist of 960 hydroposts, at least 400 meteostations and 1600 precipitation observation points. Achieving of such level of the network was envisaged by 2010. Implementation of this network development plan would need equipping of all hydrometeo observation points with standard devices and instruments which will be safely operating in conditions of Central Asia.

Implementation of the above plan is impeded by the number of causes. The major cause is inadequate funding, mainly by governments of Central Asian countries and by international donors. As a result it has become possible to cease reduction of the network, although snow-measuring surveys in the planned 16 basins have failed. Only 6 automatic hydro posts, one standard meteo station and one automatic were established in Uzbekistan. Basically the above plan will be implemented to a very limited extent.

At present meteorological and aerological observation networks need better equipment and measuring devices. It is necessary to restore observations at closed stations, introduce automatic stations in remote hard-to-reach areas (deserts and mountains).

Flow meters

Analysis of current system of data gathering and processing and the relevant equipment demonstrates that the following is needed for ensuring its robust operations:

- Maintain the existing system of data gathering. All NHMSs of the region have high quality trunk channels, ensuring round the clock two-way communications of Center of Exchange and Messages – Tashkent with centers of exchange and messages of Moscow, Novosibirsk, Almaty, Bishkek, Ashgabat as well as all avia-meteorological stations and regional divisions of NHMS of Uzbekistan.
- Equip automatic stations with communication and telemechanical devices enabling information transfer to data gathering centers by land lines.
- Replace existing system of communication between Central Hub of Information Gathering from NMHS and Central Telecommunication Node of the Agency of Post and Telecommunications (Ministry of Communications) for state-of-the-art digital multi-channel system of data transfer.

Tasks which could be handled using internal resources of the country:

- Develop hydrometeorological device manufacturing facility to satisfy demand from the hydromet service and cooperate this plant with instrument engineering facilities of NHMSs – members of Intergovernmental Council for Hydrometeorology of the CIS;
- Gradually restore all meteorological and hydrological observation network and further develop them;
- Organize publication of meteorological yearbook;
- Restore publication of observation materials on snow cover, evaporation from water surface and solar radiation.

Hydrological equipment, the Arnasay Lake

Tasks which need international assistance:

- Equip several meteorological and actinometric stations with state-of-the-art equipment and devices;
- Equip radio probing stations for their systematic operations;

- Create glacier experimental base;
- Build rectilinear rating tank for calibration of propeller flow-meters. The tank would be able to serve all Hydromet services of the Central Asia.

It is envisaged to establish a component of the World System of Observation over Hydrological Cycle (WSOHC) in the Aral Sea Basin. The Aral-WSOHC Project would enable to create technical and research structures for future information system on regional water resources.

6.2. Climate Change Research in Uzbekistan

Articles 4.1 (g and h) and 5 of UNFCCC determine necessity of undertaking and expansion of research studies in all areas, related to Climate Change, systematic observations and information sharing.

Overall, scientific and research activities in Uzbekistan are conducted under national science and research programs funded by the public budget. Applied research and design project proposals contest is organized every three years in Uzbekistan and contests for fundamental research – every 4.5 years.

The programmes potentially support research related to Climate Change mitigation measures, adaptation to possible adverse impacts, monitoring of regional climate and development of forecasts for different advanced time.

6.2.1. Research in the Area of GHG Emissions Reduction Technologies

Under *Development of Resource-Saving Environmentally Safe Production, Processing and Storage Technologies Program* research in the following areas could be performed:

- Technologies of chemical and physical processing of mineral resources (oil, gas condensate, coal, shale, natural gas);
- Technologies for disposal and processing of residential, industrial and agricultural waste;
- Technologies for production, processing and storage of agricultural and food products.

Development of Highly Efficient Technologies and Technical Means for Energy and Resource Saving, Use of Renewable and Non-traditional Energy Sources, Rational Production and Consumption of Fuel and Power Resources Program supports research in the following areas:

- Improving legal and regulatory framework in power sector of Uzbekistan;
- Energy saving in production, transportation, distribution and consumption of electric and heat energy in energy system, industry, cities and agricultural facilities;
- Efficient and rational use of fuel and power resources in transportation and sectors of the economy;
- Development of methods for reduction of power and gas losses in main and distribution systems;
- Development and launching of state-of-the-art methods based on renewable energy sources for energy and heat supply to commercial and residential sectors in urban and rural areas.

At the same time, research related to reduction of GHG emissions have not been adequately supported yet in the country and lack systematic and targeted character. Major areas of research in energy at present are the following:

- Improving energy efficiency in production and transportation of power;
- Improving power use efficiency in selected sectors of the economy;
- Enhancing efficiency of fuel use in vehicle transportation;
- Expanding of resource and power saving materials; and
- Using solar and wind energy.

In addition, there are also applied projects aimed at creation of autonomous solar, photo-electric and bio-gas installations, systems of solar hot water supply, decentralized power supply and efficient burning equipment.

Facilities of Solar Physics Research Association

The above research are mainly conducted by Research Associations of the Academy of Science (Physics-Sun, Academpribor and other) and agency-level institutions and centers (Uzlitineftegas, Hydroproject, Energosetproject, Tashteploenergoproject, Neftegasnauka, Ecoenergya and other) and are funded by the public budget and interested companies.

6.2.2. Research in the Area of Adaptation Technologies and Measures Development

Under *Rational Use and Preservation of Land and Water Resources, Creation of Highly Efficient and Environmentally Sound Technologies in Irrigated Land Improvement, Environment Protection, Nature Use, Environmental Safety and Protection from Stress Factors* Program the following research could be conducted:

- Genesis of soil cover and its preservation, desertification in irrigated area; development of fertility restoration technologies;
- Improving water resource management system for sustainable development in conditions of water resources shortage and deterioration of their quality;
- Development and introduction of resource saving technologies, ensuring better efficiency of water use;
- Assessment of land quality, creation of automated information system of the state land cadastre;
- Improving agricultural methods ensuring water saving and efficiency of fertilizers;
- Improving maintenance of hydro conservation systems and water sharing principles;
- Assessment of environmental and toxicological situation and development of acceptable standards of environmental burden for ecosystems;
- Development of measures for improving quality of surface and ground waters, ensuring conditions for maintaining environmental equilibrium;
- Monitoring of hazardous meteorological and hydrological processes, development of the respective forecasting system;
- Forecast of geological and ecological state of the environment, assessment of risk and possible damage in case of natural disasters and development of mitigation measures.

This program includes research related to monitoring of climate system, assessment of changes and changeability of regional climate, development and introduction of weather forecasts of various advance time as well as forecasts of dangerous hydrometeorological phenomena.

Creation of Resource Saving and Highly Efficient Production Methods for Grain, Oil, Vegetable and other Crops Program supports developments in the following areas:

- Agromethods of agricultural production taking into account maintaining and improving soil fertility;
- Cotton, wheat and other crops cultivating methods envisaging minimum tillage;
- Method of growing crops resistant to diseases, pests and extreme impacts;
- Plant protection methods, as well as storage of grain, vegetables and melons;
- Improving methods for environment improving forests cultivation.

Development of New Methods for Prevention, Diagnostics, Treatment and Rehabilitation of Human Diseases Program includes the following areas:

- Development of diagnostics, treatment and rehabilitation methods for cardiovascular diseases and other;
- Development of methods for prevention, early diagnostics and treatment of human tumors;
- Development of measures for combating contagious parasitical diseases and improving their diagnostics, treatment and prevention;
- Optimization and standardization of emergency medical assistance; and
- Development of resort and recreation facilities in the country.

Creation of High Yield Cotton, Grain and other Crop Varieties, Productive Cattle and Poultry Breeds Based on Widely Use of Genetic Resources, Biotechnologies and Modern Disease and Pest Control Methods Program includes the following:

- Creation of data bank on gene pool of plants; genetic, biotechnological and other selection methods;
- Creation of highly productive, precocious varieties of cotton complying with international standards for fiber and seed quality, resistant to diseases, pests and external stress;
- Nurturing of high quality new varieties and hybrids of grain, legume, oil, forage, vegetable and other crops as well as potatoes;
- Reproduction of genetically homogenous seed material of new promising varieties of cotton, grain, rice and other;
- Creation of varieties of fruit and berries, grapes, flowers and mushrooms;
- Development of environmentally clean methods of disease and pest control;
- Development of new method for prevention, diagnostics and treatment of cattle and poultry diseases;
- Monitoring of epizootological situations, etiology of origin, regional specifics of contagious and parasitic diseases of animals, development of protection and control methods;
- Methods of sustainable reproduction of cattle population and preservation of gene pool of agricultural animals and poultry;
- Creation of highly productive lines and hybrids of animals, birds and fish.

Research under the above programs which are basically of adaptive nature are conducted by the

Academy of Science organizations such as Institute of Microbiology, Institute of Physiology and Biophysics, Institute of Genetics and Experimental Biology of Plants, Research Center *Botanika* and others.

Academy of Science of the Republic of Uzbekistan

Institute of Water Issues, Institute of Irrigation and research organizations of the Ministry of Agriculture and Water Resources (MAWR) conduct research in the following areas: hydroecology and water treatment methods; methods of integrated use of water resources, water saving irrigation methods, hydrology and hydraulic engineering for irrigated land, water resource management and etc.

Activities of specialized research organizations on nature conservation and selected universities is aimed at development of territorial comprehensive systems of nature protection, industrial impact assessment on nature, development of standards for emissions, assessment of environment impact on human health.

Climatic system related researches are performed by Uzhydromet and its Hydrometeorological Research Institute (NIGMI). The Institute is involved in improving monitoring systems (climatic, hydrological, including snow cover and glaciation monitoring), agrometeorology, assessment of weather and climatic factors impact on agricultural crops, water resources, hazardous hydrometeorological phenomena. NIGMI develops methods of short-term and long-term forecasts, conducts research in applied climatology. Agroclimatic zoning has been accomplished recently, as well as helio- and wind-energy cadastres, climatic atlases and reference books.

Research related to Climate Change impact assessment were mainly launched under the UNFCCC: *Uzbekistan – Climate Change Country Study* Project (First National Communication), and continued under preparation of the Second National Communication which enabled to involve wide academic circles in this new problem and ensure an impetus to development of research in the following areas:

- Climate Change impact assessment on water resources of the region;
- Climate Change impact assessment on water use and productivity of various crops;
- Building and using of climatic scenarios;
- Studying of dynamics of various climate parameters of the region under the influence of global warming.

However, full-fledged research in Climate Change issues still face organizational, methodological, information and other restrictions.

6.2.3. Major Constraints and Needs in Research Development

Organizational restrictions. Despite the fact that existing programs enable to conduct research within the wide range of areas related to Climate Change, there are no targeted programs in this field in the country. Existing programs should be amended by two targeted areas: 1) development and introduction of methods and measures for GHG emissions reduction and increase in runoff; and 2) development and introduction of measures for adaptation and mitigation of adverse impacts of Climate Change.

Another impediment is ***shortage of financial resources*** for implementation of government R&D programs. Even those research institutions which have obtained funding for their projects face problems with procurement, organization of field trips, participation in national and international seminars and conferences. Overheads (maintenance of premises etc) are also a burden.

There is a ***shortage of skilled specialists and capacity*** which to certain extent is linked with inadequate funding. Level of wages in research institutes is lower that in many other sectors which is not attractive for young specialists. Project leaders may not reallocate grant funds for wages. In some cases the level of submitted projects is not eligible for funding which is also a result of poor capacity.

Methodological restrictions. These mainly refer to lack of specialist trained in contemporary analysis methods and tools, as well as knowledge in specific, non-traditional areas, namely Climate Change impact assessment, development and implementation of mitigation and adaptation measures. Major challenges and gaps are related to use of proved and recommended methods and tools necessary for the following:

- Assessment of Climate Change impact on various social and economy sectors;
- Building of social and economic scenarios;
- Assessment of environment and social and economic risks;

- Quantitative assessment of reduction of emissions and costs for introduction of methods and measures for mitigation and adaptation; and
- Analysis of proposed measures, alternative development solutions and policy development.

The existing recommended models are not applied in the most cases due to shortage of skilled staff, experience and data.

Shortage of data various social and economic sectors, ecosystems and etc., considerably impedes Climate Change impact research and adaptation measures analysis. Data gathering across Uzbekistan is very difficult and access to some data is limited. For instance, in health sector current report forms are not meeting requirements of the assessment, while certain data are confidential.

Lack of adequate monitoring of land quality and agricultural cropping pattern, as well as insufficient testing studies of crops impede use of state-of-the-art models.

Inadequate monitoring of natural pastures using satellite data hinders online and historic assessment of pastures productivity dynamics.

Lack of water consumption metering in entities, insufficient metering on the stage of transboundary water sharing and water use impedes use of balance models like WEAP.

Insufficient hydrometeorological and glaciological observations data in the Aral Sea basin rivers runoff forming zone (largely Kyrgyzstan and Tajikistan) impedes assessment of water resources and application of hydrological models of mountainous rivers runoff forming. In fact, at present only modeling of selected indicator rivers (with sufficient observation networks) is possible.

Underestimating of Climate Change importance both by decision makers and academics. Erroneously Climate Change research are substituted by research of climate system only and its impact on natural resources, while proper Climate Change research should include vulnerability of social and economic sectors, development and assessment of adaptation and mitigation measures in various sectors of the economy, regions or ecosystems.

Needs for research development. Knowledge enhancement in and awareness of Climate Change issues is crucial at all levels, including decision makers.

Various research institutions, agencies and economy sectors should participate in addressing Climate Change issues, especially vulnerability assessment, development and introduction of mitigation and adaptation measures.

It would be necessary to secure earmarked funding for Climate Change research and develop research programs linked with UNFCCC and other conventions (study interrelation between Climate Change and desertification processes, ecosystem productivity and biodiversity to develop comprehensive response measures). Priority activities should include the following:

- Mobilization of sufficient finding and technical support for implementation of research related to various aspects of Climate Change;
- Inclusion of "Climate Change" agenda to government research and development programs;
- Organization of national experts training in using state-of-the-art methods and models for Climate Change impact assessment, analysis of adaptation and mitigation measures.

The most efficient approach would be active participation in international research programs and project which allows coordination of activities both at the national and international level. Likewise, Uzbekistan is participating in implementation of Long-Term Plan of WMO (2004-2011), and Uzhydromet has developed a plan envisaging Climate Change related research. This plan could be viewed as input to the research in accordance with the World Climate Programme.

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7. Mitigation, Adaptation, and National Development Plans

The main conditions for mainstreaming Climate Change into national development planning are as follows:

1. to prioritize needs so that adaptation and mitigation measures are comparable with national development priorities,
2. to consider risks associated with Climate Change.

According to the implemented assessment, the first condition is in place in Uzbekistan; the second condition is so far implemented 'unconsciously' through a 'forced' adaptation to water and land resources deficits, irrigated lands and natural pasture degradation, and high rates of population growth.

The urgent undertaking of mitigation measures is a vital necessity given that currently generation of the GDP is a high energy consuming process.

Despite being an energy self-sufficient country, Uzbekistan still has many problems that impact (directly or indirectly) the energy self-sufficiency and entail an increase in greenhouse gases emissions. More than 30% of equipment in the energy sector is out-of-date and of low efficiency. The high losses in current systems of energy production, transportation, transmission and distribution to consumers result in high levels of fuel cost per unit and greenhouse gases emissions.

Therefore, the goal of intensive industrial development can be achieved only by improving the current situation in the energy sector. Reconstruction and modernization of the existing energy production facilities, introduction of new technologies are to be the principal measures that will allow more effective fuel utilization. That is why, ***a new technological need assessment*** should be implemented with employment of the state-of-the-art approaches and detailed economic analysis of costs and benefits of the new technology introduction in connection with the national sustainable development policy.

A new technological need assessment will facilitate making appropriate decisions with respect to the mitigation measures and policy, accelerate technology transfer and proper legislation development in the energy and non-energy sectors and will serve as a basis for renovation of the National Strategy of Greenhouse Gases Emissions.

Overall energy saving capacity in the Republic is estimated to be 23 million tons of reference fuel per year, realization of which will enable the reduction of greenhouse gas emissions more than by 40 million tons in CO_2-equivalent every year. This has allowed Uzbekistan as a Party not included in Annex I, to use the Clean Development Mechanism to support own efforts to increase fuel consumption efficiency and undertake Climate Change mitigation activity.

Launching the activities under the CDM, namely, the establishment of the Interdepartmental Council and CDM Designated National Authority (DNA), conduction of several training programmes were a powerful incentive for the development of the mitigation measures. The projects containing mitigation measures that were submitted for funding under the CDM have been already developed within the sectoral programs in the Republic. CDM has mainstreamed Climate Change mitigation activity in Uzbekistan.

Therefore, to stimulate activity on adaptation to Climate Change, similar efforts should be undertaken, especially on strengthening capacity. At present, the main barriers to commencing this activity are the fragmented actions, lack of coordination at the national level, lack of funding and the fact, that many decision makers are unfamiliar with Climate Change problem and the methods of adaptation to its negative consequences.

To start the mainstreaming process, that is, to create a united flow of actions on Climate Change adaptation in the country, it is necessary to build capacity at all levels:

- by increasing awareness of Climate Change issues amongst decision makers and in the agencies directly related to socio-economic development, environment protection, health etc.;
- by creating a non-departmental coordination body charged with the responsibility for addressing adaptation issues in order to strengthen coordination and work out joint strategies and measures;
- by involving the agencies/organizations as well private business;
- by improving the legislative-regulatory process to support adaptation measures, especially in respect of effective land and water consumption;
- by increasing public awareness on the vital necessity of undertaking adaptation measures, rational land and water resources usage by waging public awareness campaigns on a continuous basis.

The main barriers and constraints to the above activities are as follows:

- all adaptation measures implemented in the country are economically forced as so far Climate Change problem has a low priority;
- lack of financial assistance/support from donors for strengthening the institutional structure for better impact assessment, analysis of adaptation measures and support of adaptation actions;
- lack of expertise working in the adaptation area and insufficient awareness at all levels;
- uncertainty of the climate predictions in time and space – the assessments differentiated by territory and time are required for economic evaluation of

adaptation measures and making appropriate decisions;

- lack of differentiated social and economic data, methods for assessing the impact and developing and undertaking the relevant measures at local levels; these measures being successful would show the public the benefits of adaptation measures and encourage the introduction of the adaptation technologies, thereby, attracting small business.

To summarize the above, there is a necessity for designing a ***project on adaptation capacity building*** with final/fundamental goal being to establish the Expert Unit for development of adaptation measures. There is also a necessity to design and implement the ***project on assessment of Climate Change impact on social and economic situation*** in the country with a focus on the most vulnerable social and economic sectors.

At the international level, it is necessary to establish the leverages for "encouraging" adaptation activities in the developing countries, possibly through training programmes on adaptation projects development with inclusion of the economic effectiveness issues and the methods of economic evaluation; ad hoc workshops for decision makers; demonstration projects on adaptation technologies introduction, etc.

Major prerequisites for mainstreaming in Uzbekistan

1. A peculiarity of the country is the absence of trade-offs between development priorities and the actions required to deal with Climate Change . The assessment implemented within the framework of the Second National Communication has shown that the adaptation priorities including management of risks associated with Climate Change are overlapped with the national development priorities including the policy and actions on increasing living standards of population and sectoral development programmes.

2. In the water recourses, agricultural, ecosystems and public health sectors the necessity of undertaking urgent measures is obvious, as anthropogenic impact on these sectors has reached a critical point.

3. The Government of Uzbekistan has passed new decrees and regulations including urgent measures on stabilization of ecological situation and line agencies have prepared the sectoral, inter-sectoral and national development programmes and plans.

The national strategy of sustainable development includes the goals of social, economic and environmental policy, the gradual achievement of which will facilitate sustainable development, namely:

- ensuring high living standards of the population under the conditions of sustainable social and economic growth based on the structural and institutional reforms;
- creation of a socially-oriented market economy in the constitutional state, that is integrated in the world economic system;
- overcoming the consequences of the Aral Sea crisis and improvement of strained ecological situation in other territories of the Republic;
- conservation and improvement of the environment; and
- rationalization of land use and water consumption and effective utilization of other natural resources with the purpose of their conservation for future generations.

The measures of forced adaptation and mitigation developed and implemented in Uzbekistan are of a multilateral nature – relevant technological application, enhancement of management system and increased public awareness.

All of them promote sustainable development, increased resilience to negative Climate Change consequences, contribute to reduction of greenhouse gases emissions and facilitate implementation of the National programmes. ***However, the majority of them remain at the stage of planning and only a few of them have come to the stage of implementation.***

For mainstreaming all Climate Change related activities undertaken or planned in the country should be identified and coordinated. The projects containing these activities, which have not been adopted by the Government should be comprehensively analyzed and revised if necessary, and then submitted for approval.

The programmes that are being implemented and developed should be ***reinforced and/or revised*** in order to be in line with the National strategy of sustainable development.

The revision of the programmes, their integration or abolishment should be implemented regularly taking into consideration new possibilities, which arise and the priority needs of the country. All of this can be addressed within the project ***"Integration of vulnerability and adaptation to Climate Change into sustainable development policy planning and implementation."***

Mitigation programmes. In the *National Strategy on Greenhouse Gas Emissions Reduction* approved in 2000 the general statements and requirements towards the current national policy containing mitigation measures are presented. The strategy should be updated taking into account new needs, priorities, level of technology development and effectiveness of the measures aimed at reduction of the GHG emissions that enable the reduction of emissions at a lower cost.

The need for an *energy efficiency and conservation strategy* is an acknowledgement of both the high levels of waste in current systems of energy distribution and consumption and the need to place the sector on a more market-based footing. In Uzbekistan the "*National Programme on Renewable Energy Sources Use"* has been developed. The Republic possesses a significant potential for renewables and the programme recommends designing the projects on utilization of solar power

energy, small hydro power energy, use of wind and biomass energy. Solar energy use for supplying households and Governmental agencies with hot water and electricity is considered as the most realistic.

The National Energy Programme and National Energy Saving Programme (developed but not adopted) are to be revised taking into account modern opportunities and needs in the following directions:

- enhancement of the legislative and regulatory basis for rational energy and natural resources use;
- preservation of energy self-sufficiency through developing domestic energy resources;
- partial decentralization of energy production sector;
- mitigation of unfavorable energy sector impact on environment through increases in performance index and the ratio of renewable energy sources to total energy use;
- increase in efficiency of oil processing and quality of oil products;
- persistent development of coal industry and the attraction of investments to increase effectiveness of coal production; and
- restructuring of the public electricity and heat production sector; modernization of central heating infrastructure and development of renewables for the purposes of heating and hot water supply.

At the present time the *Integrated Programme of Technical Modernization and Development of Leading Industries* is under way, and contains the specific measures for development, technical re-equipment and modernization of the key industries (energy, oil and gas industry, gold production and chemical industry, ferrous and non-ferrous metallurgy, construction materials) and attraction of foreign funds to these industries.

The programmes promoting adaptation. *Strategy for Improvement of Living Standards of the People of Uzbekistan (Living Standards Strategy, or LSS) for 2005-2010* plays an important role in increasing adaptation capacity.

The key problems brought about by Climate Change in Uzbekistan are as follows: salinization and degradation of agricultural lands; scarcity and pollution of water resources, insufficient supply of safe drinking water, loss in biodiversity of all ecosystems, desertification, contamination of food, air contamination in big cities and industrial centers. The programmes and projects aimed at addressing above-mentioned problems ***are being developed*** in Uzbekistan.

Land Reclamation Programme for 2008-2012 poses a problem of construction and reconstruction of main, inter-district and on-farm collectors with the total length of more than 3.5 thousand km and more than one thousand of ameliorative wells, reconstruction of the drainage system with total length of 7.6 thousand km, provision of modern equipment to firms of contractors and water management organizations via leasing. Budget of this programme is supposed to be more than 75 billion soums (national currency). However, taking scale of work into consideration, allocation of additional funds will be required.

The projects on rational water consumption and increase in water supply are included in the *Programme of Action on Environmental Protection (2008-2012) and in the Composite List of Priority Investment Projects,* which also require additional funds for implementation.

Programme of Action on Environmental Protection includes the measures on implementation of the National Strategy and Action Plan for Conservation of Biodiversity and envisages creation of a number of protected natural territories and the centers on breeding animals and plants that are about to become extinct.

Programme of Action on Improvement of Ecological and Socio-Economic Situation in the Aral Sea Basin (2003-2010) anticipates such measures as: development of a legislative base to support water supply, improvement of monitoring system, scientific research, implementation of the adaptation related projects (reconstruction of irrigation and drainage systems, creation of managed lake systems, expanding access of the population living on the vulnerable territories to clean potable water etc). However, as previous experience has shown, not all measures come to stage of implementation. The pure success rate of regional programmes stems from insufficient coordination and conflict of interests between the countries at the very early stages of the regional programmes development.

Within the framework of the national capacity building for implementation of three global environmental conventions (UNFCCC, CCD and CBD), the project proposals were prepared on development of the programme of sustainable development and rational use of deserted pastures and on development of desertification and drought monitoring system and computer information system for early warning against drought. However, these project proposals remain just proposals so far.

National Strategy and Action Plan for Conservation of Biodiversity. The commitments of Uzbekistan on the fulfillment of the Convention on Biological Diversity include development of measures stimulating protection and sustainable development of the components of biodiversity. The most important task for the future is identification and monitoring of the most important components of biodiversity – species and ecosystems under a threat of extinction as a result of severe anthropogenic impact.

Regional Environmental Action Plan for Central Asia (REAPCA). The priority problems of the REAPCA are air and water pollution; land degradation; waste

management and degradation of mountain ecosystems.

Undoubtedly, an important effort towards conservation of mountain ecosystems is a strategy on "*Regional Cooperation for Sustainable Mountain Development in Central Asia*", main priority of which is the organization and coordination of integrated research of the mountain territories based on the monitoring system data. For this purpose a *Regional Mountain Center in Central Asia* was established.

The main adaptation activities include development of the measures to combat desertification and melioration of the dried area of the Aral Sea; afforestation and conservation of forests. To support these efforts, the national programme on afforestation is required. The project ***"Restoring and creating of forests on the Jambay and Zaamin forest farms"*** prepared within the framework of the Second National Communication, can serve as a demonstration project in forestry.

In the health sector a number of programmes are underway, in particular, the *Programme on public heath protection and prevention for 2004-2008.* With the assistance of donor community, the investment programmes and projects aimed at preventing dangerous diseases (HIV, tuberculosis, malaria), improvement of nutrition and provision of modern medical equipment as well as medical and sanitary care to rural population are being implemented.

Access of urban and rural population to clean potable water supplies and sanitation is being expanded, the measures are being undertaken on reconstruction and expanding water supply systems in many settlements in the Republic of Karakalpakstan, Khorezm, Samarkand, Navoi and Bukhara provinces and in Tashkent City.

The rise in occurrence of mudflows and avalanche risks as well as an increase in potential flood risks from mountain lakes pose a threat to life for a part of the population. The *Programme of Action on Environmental Protection (2008-2012)* envisages resettlement of the people living in the landslide, mudflow and flood prone areas. Currently it is necessary to prepare the recommendations on risk reduction for planning organizations and decision makers, to expand the specialized monitoring of snow avalanches, mudflows and high mountain lakes prone to bursting and also to improve the methods of hazardous phenomena forecasting.

Such economic sectors as oil and gas sector, transport, construction and municipal service being the sources of greenhouse gases, in their turn, are affected by Climate Change impact and also need adaptation measures. For instance, the rise in temperature leads to an increase in natural losses and making errors during the receipt, transportation, storage and distribution of oil products. The other implications of the rise in temperature are as follows: energy consumption increases due to air-conditioning; new urban islands of heat can possibly appear; emergency situations become more frequent. Developing and undertaking adaptation measures in the oil and gas sector, transport, construction and municipal sector can be considered as ideas for project proposals but nothing is being done.

Analysis of the implementation of many national programmes and plans has shown that many financial and organizational barriers emerge to integration of adaptation measures into national development planning, namely:

- incomplete realization of developed and approved national development plans;
- lack of long-term targeted development programmes in the agricultural sector;
- weak regional cooperation in transboundary water use;
- absence of the indicators of the national strategy of sustainable development for long-term prospect (main indicators have been developed up to 2010); and
- lack of targeted research in adaptation and mitigation, especially in terms of economic aspects, hampers decision making and attraction of investments.

At the present time, the programmes and plans promoting adaptation and mitigation, are fragmentary and therefore, experience the lack of financial support. Attraction of the international adaptation funds will be a serious, additional and necessary support.

Implementation of the national development plans can be supported by the resources and leverages that are anticipated for realization of the adaptation and mitigation measures within the framework of UNFCCC, other environmental conventions and international financial institutions.

All the above listed activities (under implementation or prepared for implementation) will not solve all existing problems. An integrated approach and consolidation of efforts is required to resolve all of the issues.

In this connection, there is a need for preparation of a special project on the development of the ***National Action Plan on Climate Change,*** which would include both adaptation to Climate Change and mitigation of its adverse consequences. It would help to join all efforts undertaken by the country to achieve the general goal – mitigate Climate Change and reduce the risk of negative consequences for different socio-economic sectors.

While preparing the sustainable development programmes, it is necessary to take into consideration possible Climate Change impact (according to the short-term and long-term predictions) on all aspects of development.

In order to persuade politicians to take all above indicated factors into account in the long-term planning, these factors should be scientifically substantiated.

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8. Technology Transfer Activities

8.1. Technological Need for Environmentally Friendly Technologies and its Assessment

Currently the increase in total greenhouse gas emissions in Uzbekistan (by 9.3% in 1990-2005) results from increased consumption of fuel, which is related with application of outdated technologies, obsolete equipment and inefficient utilization of fuel and power resources.

In the short term, technical and technological renewal of the following sectors of strategic importance is the priority direction of development of the Uzbek economy: fuel and power sector, metallurgy, construction sector, car manufacturing industry, agriculture, etc.

In order to meet these objectives Uzbekistan government pursues a policy of attracting foreign investments to implement new highly efficient power- and resource-saving technologies, which facilitates promotion of Environmentally Friendly Technologies (EFT) from developed countries-investors.

In realization of such policy Uzbekistan, as a transition country, considers this path as most optimal to ensure a sustainable economic growth. In addition, as Uzbekistan has no quantitative commitments to reduce emissions of GHG under the Kyoto Protocol such policy creates a favorable environment to use the Clean Development Mechanism which facilitates a significant drop in greenhouse gas emissions and reduction in power intensity of the national economy and opens up new financial and technological opportunities to promote the process of EFT transfer.

In assessment of the technological necessity to reduce greenhouse gas emissions in Uzbekistan undertaken in 2001 during the II Phase of the First National Communication on Climate Change, sectoral plans for development of power industry, thermal power industry, oil and gas sector, chemical industry, construction sector, transport, waste management and forestry were reviewed and the following priority sectors were identified to implement measures to reduce GHG emissions:

- production of electric and thermal power – 25.7%;
- extraction, processing and transportation of natural gas and oil – 22.2%;
- population and domestic household – 25.8%;
- transport – 6.7%;
- agricultural soils – 5.4%.

In 2001, 40 project proposals were developed of which: 7 in power industry, 13 in oil and gas sector, 7 in thermal power sector, 11 in industrial processes, 1 in renewable energy sources and 1 in forest planting. Reduction of greenhouse gas emissions resulting from implementation of these projects was assessed to be 9 million 446 thousand tons of CO_2-equivalent a year and unit costs – from 0.15 to 27.9 US$/t. Total amount of investments needed accounts for US$2556.8, of which 98% is the share of power industry. However, only one of the projects proposed has been implemented. Major reasons are: lack of domestic and foreign investment capital in the country to realize such projects, lack of industrial production of modern equipment, insufficient technical capacity to implement new technologies.

On findings of National Inventory of GHG Emissions, in the period of 1990-2005, GHG emissions increased in power industry and waste management by 12% an 15.2% accordingly (Figure 8.1). At the same time, emissions in transport sector dropped by 43% due to reduction in transportation of goods. In the sector of industrial processes the emissions reduced by 21% due to a fall in the industrial production. In agriculture the emissions lowered by 4% due to the decreased use of mineral fertilizers and reforms undertaken in this sector.

Thus, ***"Power Industry"*** in the following sub-sectors has the largest potential for reduction of GHG emissions:

- production of electric and thermal power;
- extraction, processing and transportation of natural gas;
- fuel combustion in motor vehicles and domestic household;

and ***"Waste Management"***, in particular solid household waste, emissions from which are soaring due to a swell in population and its needs. Waste from livestock farming is increasing as well due to growth in livestock population.

Analysis of demographic and economic situation in Uzbekistan in the last 10 years shows that population swell and development of economy are accompanied by an increase in total GHG emissions (Figure 8.2).

The period of 1995-2005 was characterized by positive changes in demographic and economic growth of Uzbekistan as both population and GDP per capita grew.

However during the same period a considerable increase in GHG emissions was registered. In the period under review, GHG emissions grew faster than per-capita GDP and growth of economy was accompanied by an increased power intensity of industry and other sectors. In the period from 2000 to 2005 GHG emissions per GDP unit decreased. However this trend was not the result of special steps taken to mitigate Climate Change.

Restructuring of economy, expansion of services sector with lesser consumption of power, increase in the share of natural gas plays a significant role in these changes. Nonetheless, power intensity of production in Uzbekistan is high. Both the reduction in power intensity of the economy and

implementation of power-saving and power-efficient technologies are priority direction to ensure a sustainable development of the country.

Analysis of current and projected national sectoral programs shows that development of industrial sectors is oriented to an increased power efficiency and power saving contributing to reduction in GHG emissions.

Steps planned to save power in power industry include designs for large power plants to reduce emissions by 1.4 million tons of CO_2 by 2010. There are projects to raise efficiency of production in oil and gas sector, which should result in reduction of emissions by 1.4 million tons of CO_2 by 2010. Projects on raising efficiency and modernization in industry have been put forward, including development of technologies (4 million CO_2), technical re-equipment and power saving in commercial and housing sector (4 million CO_2), in agriculture (3 million CO_2), and transport (0.75 million CO_2).

Steps planned to save power and raise power efficiency do not include use of renewable sources of power due to their high cost. However demand for RES-technologies in Uzbekistan is high due to the need to satisfy the increasing demand for energy.

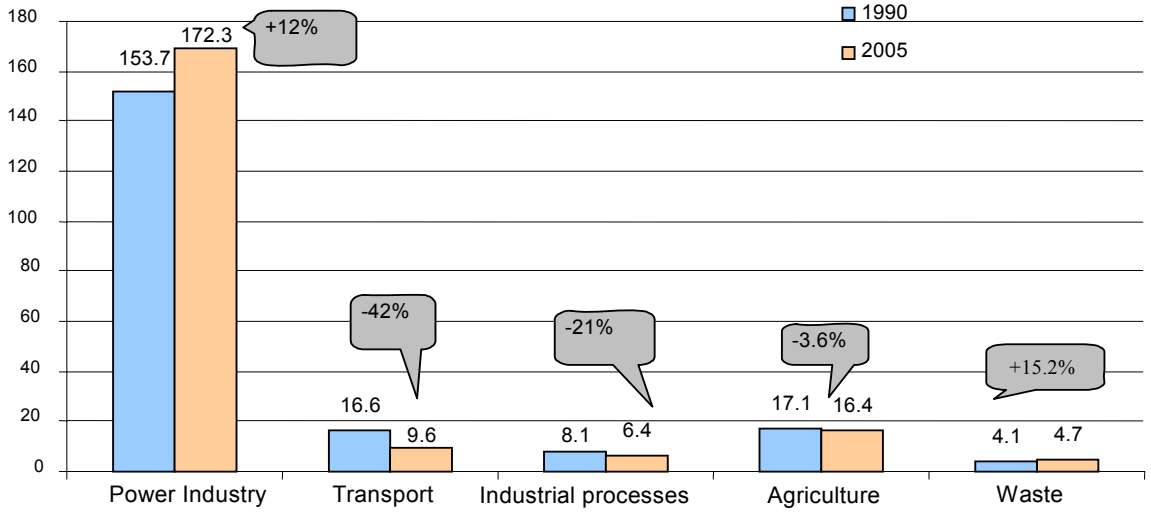

Figure 8.1 *Change in GHG emissions in 1990-2005 by sectors, million CO_2-equivelent*

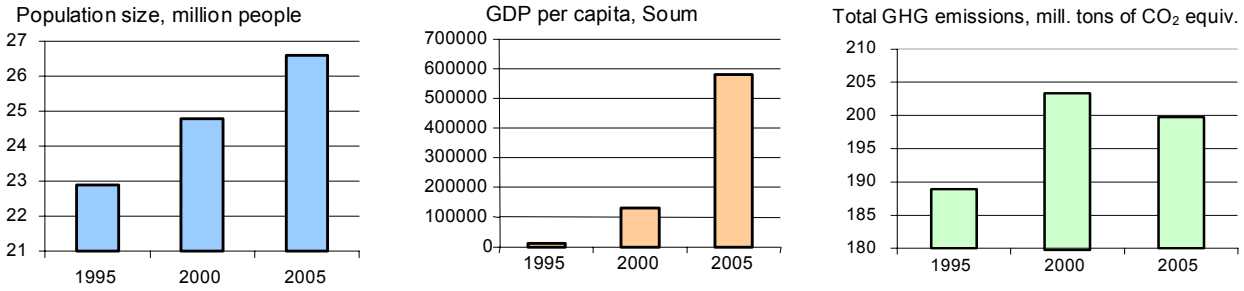

Figure 8.2 *Change in population, GDP per capita and total emissions of GHG in 1995-2005*

8.2. Information on Environmentally Friendly Technologies

As a result of conducting a consistent energy policy Uzbekistan has gained energy independence over a relatively short timeframe. However to maintain energy independence of the country it is critically important to raise the efficiency of utilizing the energy sources and establish conditions to implement power-saving environmentally friendly technologies.
As mineral fuel and traditional technologies based on fuel combustion will retain their leading role in development of Uzbek economy for the foreseeable future, efforts are needed on energy saving and raising energy efficiency in fuel and power industry, agriculture, chemical industry, housing and utilities, and waste management sector that have the highest potential for reduction of GHG emissions.

To meet these objectives environmentally friendly technologies can be used on a broad basis to raise the efficiency output of generating installations in power sector and industry, use of biomass in agriculture from waste to generate power, compost waste, utilize associated gas in oil and gas sector, reduce emission of nitrous oxide in chemical industry, use of RES, etc.

8.2.1. Energy Sector

Combined production of heat and power (cogeneration). It is planned to build a gas-turbine installation (GTI) at Tashkent TPP, which will allow reducing of emissions by 224.3 thousand tons of CO2 a year.

Figure 8.3. *TPP in Tashkent region.*

Gas-turbine installations help produce electric and thermal power. Energy efficiency is increased thanks to thermal pumps that utilize the low-temperature heat and thus additionally increase the efficiency output as well as addition of a heating cycle and transition to a combined production of electric and thermal power. Such technology can be replicated at Navoi, Tashkent, Novo-Angren, Talimandjar TPP, Mubarek CHPP, Bukhara and Fergana district boiler rooms.

Gas Technologies. *Steam-gas installations (SGI), generating electric power by a steam turbine which is activated by steam produced by gases generated in fuel combustion, improve the power efficiency at the existing thermal power plants.* Efficiency output can be increased by up to 58% by increasing the temperature of the flame and steam pressure. Currently modernization of Tashkent TPP where a steam-gas installation of 370 MB is installed has been carried out. Planned reduction of emissions resulting from implementation of this project will amount for 427.3 thousand CO2 a year.

Implementation of gas-turbine installations (Gas-turbine TPP) for an autonomous generation of electric power with use of gases of degassing of oil and condensate of low pressure, burnt off at flares of oil an gas enterprises of Uzbekistan will allow reducing of emissions by up to 200 thousand tons of CO2 a year.

Gas-expansion generating unit (GGU) intended for generation of electric power without fuel combustion by utilization of excess pressure of natural gas at gas distribution points, is a most efficient power-saving complex to improve efficiency of power plants.

In addition, efficiency of power plants can be improved by applying modern automated systems of energy control and accounting in transmission and distribution, use of frequency regulated electric drive at boiler houses and water heating installations. Such technologies can be applied at all large SDPP, TPP, CHPP and district boiler houses of Uzbekistan and are easy to replicate.

Application of modern locking equipment and sealants at compressor stations of the system of natural gas transportation will allow reducing leakage of methane on trunk gas pipelines of Uztransgas JSC. It is planned to implement the project on reducing the natural gas leakage applying this technology at compressor stations CS-2 and CS-3 which will reduce emissions of GHG by up to 57.9 thousand tons of CO2 a year.

Coal Technologies. New modern coal installations using the technology of recycling boiling layer with a steaming cycle with above-critical steam parameters can increase efficiency output of any CHPP running on coal combustion by more than 50%.

Installations with preliminary coal gasification (the syngas is produced which is a mixture of hydrogen and carbon oxide) and conversion cycle similar to SGI-GTI can produce a considerable effect – increase in efficiency output by up to 50 %.

Low-temperature tornado technology of coal combustion based on aerodynamic properties of flows in combustor (direction of large masses of coarse-grained fuel to the lower part of the combustor, and direction of air to its upper part) allows reducing the maximal temperature in the combustor by 100-300°C and burn off not powdered coal but coarse-grained coal.

By way *preliminary preparation of coal* (drying, cleaning from tailings, crushing, increasing homogeneity, etc.) fuel efficiency output can be increased by 2-5%.

In the near term, in the light of realization of the Program for Development of Coal Industry for 2002-2010 it is planned to increase the share of coal in the structure of fuel resources used in generation of electric power by up to 15%. Environmentally friendly coal technologies will be in particular demand of large and small heat supply boiler houses and CHPP of Uzbekistan.

Mini- and micro-CHPP. Using the autonomous systems for combined production of heat and electric power based on *mini- and micro-power installations/CHPP* running on natural gas or biofuel for individual households, remote rural settlements, small residential areas or at industrial enterprises is more efficient from economic and practical viewpoint than a centralized heat- and power supply applied in Uzbekistan to date.

At present, almost 1.5 thousand remote and difficult to access rural settlements in Uzbekistan are not connected to the national centralized power supply

network. Such connection to the general network is not planned for the near future due to economic inexpediency of such connection of remote areas and relatively small number of their residents. In these cases application of mini-power-installations/CHPP by resident of remote settlements will allow improving their living standard.

Pilot project "Transition from the centralized heat supply system to close-type water intake and independent connection to the heating systems of residential buildings in Sergeli district of Tashkent" is planned to be implemented to test the mini-CHPP in housing and utilities sector of Uzbekistan. The estimated reduction of emissions accounts for 50 thousand CO_2 a year.

Utilization of associated gases burnt off at flares to generate secondary electric and thermal power. This technology is based on use of extracted associated gas which after purification is delivered to a compressor to be brought to the appropriate pressure and further on to a gas turbine of a thermal power plant of a gas-turbine TPP type to generate secondary electric and thermal power. Currently the associated gas is burnt off in flares, emissions of which lead to considerable pollution of environment. *Utilization of flare gas* will allow reducing its emissions and additionally receiving energy for power and heat supply of an industrial oil and gas extracting enterprise and neighboring populated areas, save fuel and energy resources and generate additional profits.

This technology is applicable at many enterprises of oil and gas refinery plants of Uzbekneftegas NHC. Four project proposals have been submitted on utilization of associated gases in various minefields with total reduction of emissions by 290.5 thousand tons of CO_2 a year.

Renewable Energy Sources. Uzbekistan has a great potential of renewable energy including hydropower, solar and wind power, biomasses, although development of renewable energy economy is minimal.

Gross potential accounts for about 51 billion tons of oil equivalent; however the level of modern technologies allows using about 179 tons of oil equivalent. This exceeds more than 3 times the current annual production volume of mineral fuel. At present, used RES account for just 0.6 million tons of oil equivalent (0.3%).

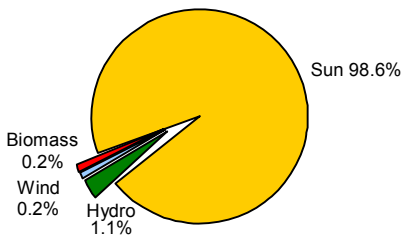

Figure 8.4 *Technical potential of RES in Uzbekistan*

Of all renewable energy sources in energy balance of Uzbekistan only hydropower of natural and artificial water streams is used. *Small hydropower industry* is a dominating type of RES for Uzbekistan, although at the same time its share in current energy supply is negligent.

Potential of hydropower resources is assessed to account for 88.5 billion kWh or 9.2 million tons of oil equivalent, including technical potential of 27.4 billion kWh, or 1.8 million tons of oil equivalent, of which only 30% is used (Table 8.1). The Program for development of small hydropower industry for 2005-2010 envisages construction of 15 small HPP with a total set capacity of 420 kWh and an average annual electric power generation of 1.3 billion kWh.

Table 8.1 Potential of renewable energy sources in Uzbekistan

Indicator	Total, millionn tons of oi equivalent	Including: millionn tons of oil equivalent			
		Hydro-power	Solar power	Power of wind	Biomass
gross	50984.6	9.2	50973	2.2	-
technical	179	1.8	176.8	0.4	0.3
used	0.6	0.6	-	-	-

There more than 60 natural water streams in Uzbekistan, on which construction of great number of *small HPP* from 1 to 10 MW is possible. Small HPP are most profitable as they are built on existing hydro technical facilities.

At present six HPP are built under the Program of small hydropower industry development: under Tupolang water reservoir with capacity of 175 MW, under Gissaarak water reservoir – 45 MW, HPP-Andijan-2 under Andijan water reservoir – 40 MW, HPP under akhangarang water reservoir – 21 MW, HPP Gulba on Dargom channel in Samarkand region – 5 MW, and Shakhimardan mini HPP in Fergana valley – 1.3 MW. It is planned to build also Bagishamal-2 small HPP (SHPP) and Shaudar SHPP in Samarkand region, HPP on Karkidon water reservoir in Fergana valley. Development of small HPP will allow reducing GHG emissions by 474.2 thousand tons of CO_2 a year and solve the issue of power supply for agricultural needs.

Uzbekistan has a considerable *geothermal power* potential, however the temperature of this source of energy is usually below 50°C, which makes it difficult to use it. Geothermal sources can be used for heating houses and greenhouses if the thermal well is in close proximity. Currently there are none examples of application of geothermal sources.

Taking into account that in Uzbekistan there are up to 270 sunny days a year another most promising source is *solar energy,* gross potential of which is assessed at more than 50 billion tons of oil equivalent, and technical potential – 176.8 million tons of oil

equivalent (Table 8.1). Solar energy is available on all of the country's territory and its involvement in energy balance can facilitate the fastest solution of the issue of access by population of electric and thermal power. This is particularly attractive in remote areas, although areal distribution of solar energy on the territory of the country is uneven. The problem of energy supply of remote settlements is most critical in Aral Sea area, where delivery of energy and drinking water by traditional methods is complicated. In such situation the only alternative method of improving the people's living conditions is to implement solar installations.

It is intended to expand the use of renewable energy sources to 1-2.5% by 2010, however current, relatively low prices for energy carriers especially for natural gas make the renewable energy expensive and therefore there is virtually no advance in this direction.

The most applicable in Uzbekistan RES technologies are:

- Solar photoelectric systems for an autonomous energy production.
- Solar water heating installations of hot water supply for urban household consumers substituting gas boilers or thermal electric heaters.
- Solar water heating installations for hot water supply of rural household consumers (baths, shower cabins) substituting combustion of wood fuel.
- Small HPP working for national energy system.
- Biogas installations for heat generation running on utilization of vegetative waste from agricultural produce (stems of cotton, straw) and organic waste (droppings of cattle) substituting boilers running on natural gas and mazut.
- Biogas installations for heat and power generation running on collection of methane at installations on cleaning of waste water and at dumps of solid household waste.
- Wind generators working for national energy system.

Uzbekistan possesses sufficient experience on production and use of *solar water heaters and photoelectric systems.* Major local producers of solar installations are OOO "Kurilishgelioservis", NPP "ENKOM", OAO "FOTON", and Physicotechnical Institute. The cost of solar installations from local producers are below the average international prices, however to date high price of such technologies put a significant obstacle. Under international pilot projects solar photoelectric systems were installed in remote rural areas of the country in order to supply them with the electric power. Such solar installations have proved to be efficient and beneficial to improve living standards.

Biogas installations to generate heat by utilizing waste from agricultural crops and animals to apply in farms having sufficient livestock population. This will allow to ensure reliable supply small greenhouses and livestock farms with heat and hot water as well as fertilizers for own agricultural needs and for sale. Currently the PROON project "Facilitation of development of biogas installations in Uzbekistan" is implemented. In 2006, under this project a pilot demonstration installation of biogas system at a farm in Tashkent region was conducted. During 2007-2008, in the Center "Eco-Energy" of State Committee for Environment Protection biogas installations were produced and put into operation in Andijan, Jizzakh, and Kashkadarya regions. Projects of local installations to satisfy needs of three to four farms have been developed and it is planned to implement them in 2009-2010.

Development of *wind energy industry* in Uzbekistan has its special features. On data from Uzbgydromet on a larger part of the country low average annual wind speed at the height of 10 m is registered. In some parts of the country, in the Aral Sea area and Bakabad district of Tashkent regions the speed of wind is sufficient to use *wind generators*. To perform an accurate assessment of wind speed conditions to apply large wind generators further studies of winds at the height of 100 m are required. In this connection, wind generators of larger capacities above several MW have not been installed. The country has a limited experience of applying wind installations from hundreds of Watts to a MW. An experimental photo-wind-electric installation is mounted on a TV and radio transmission station located in a mountainous area in Charvak settlement. Wind installation of small capacity is mounted on a poultry farm in Kazakhdarya district of Karakalpakstan. Structurally wind generators of small capacity do not differ from wind generators of high capacity. It is planned to realize a project on installation of wind power plant with capacity of 5 MW and estimated reduction of emissions by 8.2 thousand tons of CO2 a year.

Under technical assistance program PROON and ADB have completed several research projects that analyze the current state of RES development in the country with specifying the following gaps and barriers:

- large amounts of initial capital investments;
- insufficiency of financial resources and insufficient development of RES market;
- lack of local suppliers of RES equipment and relevant service;
- current legal framework does not cover all areas of RES development and use as well as efficiency of energy consumption;
- poor awareness of potential consumers of RES;
- current government policy is oriented to a larger extent on use of traditional sources of energy on hydrocarbon material;
- absence of national strategy in the area of renewable energy industry
- lack of state funding of projects on use of RES due to their high cost, high risk level and time-consuming implementation.

8.2.2. Chemical Industry

Technology of reduction of GHG emissions in chemical industry. Quite a range of new technologies on reduction of emissions of nitrous oxide (N_2O) in production on nitric acid in chemical industry is proposed for implementation using the c*atalytic decomposition* of N_2O. Such catalytic agent is installed right behind the thin platinum grid in the existing reactor of oxidation of ammonia (in working gas) or in a separate reactor on the way of the tailing gas. Successful tests have shown high economic efficiency of both solutions under considerable reduction of GHG emissions.

Six projects employing such technology are implemented at chemical enterprises of "Uzkimyosanoat" NHC: "Navoiazot" OAO, "Ferganaazot" OAO, "Maksam-Chirchik" plant, which will reduce emissions of GHG by 1 106.2 thousand tons of CO_2 a year.

Another project foresees *technological improvement of carbamide production* by way of reconstruction of the existing scheme of production and application of utilized CO_2 from ammonia production as a raw material. This technology allows increasing carbamide production capacity and reducing emissions of carbon dioxide by 270.8 tons of CO_2 a year.

8.2.3. Solid Household Waste (SHW)

Technologies of Solid Household Waste Utilization Solid household waste contributes considerably to GHG emissions. *Technology of burning off the household waste* on broad scale is well known and can be applied to produce heat for urban systems of centralized heat supply in such cities as Tashkent, Samarkand, Fergana, Andijan, etc. Construction of waste burning plants requires large investments lack of which is a main obstacle for application of such technology in Uzbekistan.

Technology of utilization of biogas on dumps of solid household waste to produce electric power is another promising prospect. This technology f renewable energy is based on *collection of dumping gas (methane)* from soil on landfills of solid household waste and its burning off.

Experimental measurements on Akhangaran landfills of SHW showed that efficiency of biogas collection makes 60% and higher. Efficiency output is a gas engine is 30%-40% which corresponds to efficiency output of existing steam turbines in Uzbekistan. Such technology is quite profitable and will allow to obtain great social and economic benefits and can be replicated on a broad scale on dumps of solid household waste that are in close proximity from large cities of Uzbekistan, e.g. on Akhangaran, Samarkand and Bukhara dumps. However due to lack of funding this technology has not been implemented in Uzbekistan.

8.2.4. Motor Transport

Use of Compressed Natural and Liquid Oil Gas instead of Petrol *Technology of transition of urban motor transport from petrol to compressed natural gas or liquid oil gas* is fairly simple in technological execution and does not require considerable expenses.

There are several difficulties in its broad-scale implementation on motor transport in Uzbekistan. Technical level of motor transport development in Uzbekistan has fallen behind on its technical and economic and environmental parameters from international standards and does not meet the needs of the growing population. Urban passenger transport is not sufficiently adjusted for hot climate conditions. The structure of fleet of cargo vehicles due to their narrow specialization prevents from implementation of modern efficient technologies of automated systems of transport process management that are based on use of progressive container shipments in high-speed transport connections.

In the structure of motor transport passenger cars make 81%, cargo transport 16%, buses 3% (2005), at the same time 78% of motor transport are privately owned. It is forecasted that in 2010 motor transport will use more diesel fuel (by 24%) and gas (by 10%) compared with 2005, which will allow improving the quality of open air, reducing pressure on environment and improving living standard of population.

8.2.5. Forestry

Technology of Forest Recreation and Forest Planting Each year forests are planted on more than 42 thousand ha of lands of forest fund of Uzbekistan, of which on the area of up to 20 thousand ha – on the dried bed of the Aral sea to protect crop lands from salt and dust relocation on large spaces which leads to land degradation and desertification. At present 1.5 million ha of bed silt have cropped up Uzbekistan, of which 600 thousand ha call for top priority

forestation efforts. About 1/4 of forest lands are suitable for further forest recreation.

Planting specially bred forestation species that are mot adjusted to local climate conditions, drought-resistant and are a natural component of natural ecosystems is most appropriate approach to solve the environmental problems in Uzbekistan.

In a desert zone saksaul that is used on widespread basis for drift-sand works is major forestation specie. In addition, desert forests are valuable pastures. In mountainous areas forestlands are comprised of juniper stands and nut-trees. Local specie of juniper is extremely valuable and long-lived. At the same time, it is protection from water and wind erosion.

Figure 8.5. *Forest plants on wind-blown sand.*

Tugai forests of the country represent plants of wood species of tugai: Asiatic poplar, oleaster, and several species of willow. All inundable tugai forests are of important bank protection importance.

Considering the low percentage of forest lands on the country, widespread application of local tree species for land recreation exercised for environment protection purposes, help adapt to Climate Change, rehabilitate of natural environment and maintain biodiversity as well as increase potential discharge of GHG.

Another efficient technology for Uzbekistan in conditions of arid crop farming is *field-protective forestation in irrigated and dry zone*. Technology for creating forest strips and plantation crops of quick-growing hybrid poplars for protection on irrigated lands and obtaining industrial wood has been developed by the Republican scientific and production center for decorative horticulture and forestry.

The range of species of hybrid poplars grown in Uzbekistan and used for field-protective forest planting on irrigated lands are highly productive and grow fast. As result, agrarian landscape of arid zone prone to degradation is transformed into a more sustainable forest-and-agrarian landscape enjoying higher self-regulation. At the same time, in 3-4 years after planting the stocks, discharge of carbon dioxide to perennial forest ranges occurs. Conduct of a demonstration project on field-protective forest planting in Jizzakh in 2003-2006 showed that from 1 ha of protective forest ranges it is possible to gain discharge of carbon dioxide sequestering 15 tons of CO_2 equivalent a year.

As virtually all irrigated arable land of the country needs, to varying degree, protective ranges, the *technology of field-protective forest planting* can be used on a broad scale on all of the country. This will allow strengthening adaptive capacity of irrigated lands, increasing productivity of agricultural crops, reducing soil degradation and wind erosion thanks to phytoncids and salt and dust containment ability of forest ranges, will create local source of commercial wood.

8.3. Creating Enabling Environment for Technology Development and Transfer

Availability of great RES potential and use of local technologies in Uzbekistan form a sound basis for development and transfer of environmentally friendly technologies which should be accompanied by stimulating political and economic environment to ensure that at least a fraction of this potential is realized.

Investment climate is a determinative mechanism to access environmentally friendly technologies both at local and international levels. Efforts of the government of Uzbekistan to improve investment funding are aimed at innovative methods of raising direct foreign investments and mobilization of local financial resources to carry out technological modernization of key industries of the economy with application of modern energy-efficient and resource-saving technologies.

Private sector of the economy plays an important role in technology development and transfer. The government of Uzbekistan continues to play an important role in intensification of reforms to strengthen small entrepreneurship and private business.

The Investment Program has been developed and approved annually. Under this Program national laws provide various fiscal and other stimuli.

In 2007, total investments in Uzbek economy grew by 23% compared with 2006 and amounted to US$4.3 billion, of which direct foreign investments make 76%. Roughly 50% of total investments were directed at technical and technological modernization.

State Investment Program for 2008 foresees investments for the amount of US$5.4 billion, of which direct foreign investments make US$1.5 billion. Fund for Reconstruction and Development established in 2006 in Uzbekistan and accumulating foreign currency resources in the amount of US$1.2 billion plays an important role in implementation of the annual investment program .

It is planned to implement in 2008 more than 80 investment projects on modernization of production, raising energy efficiency, an energy saving in fuel and power complex, housing and utilities, chemical industry, agriculture at the expense of investment attracted.

In spite of the fact that currently national fuel and energy complex of Uzbekistan is developing sustainably, the energy saving policy aimed at establishing regulatory framework that facilitates raising of efficiency and energy saving and broad-scale application of renewable energy sources is implemented.

The Law of the Republic of Uzbekistan "On rational Use of Energy" passed on 25 April 1997 represents a major legislative act defining the issues related with use of renewable energy, preservation of national fuel and energy resources, efficient use of energy and production potential. This Law contains a separate article regulating the issues of use of RES and stimulation of development and implementation of energy efficient technologies and foresees subsidizing of RES users from the Fund for Energy Saving. This Law requires to secure an accelerated payback of capital investments in construction of RES installations when setting a price for energy generated by RES. The Law provides for stimulating price policy, which guarantees quite attractive selling price for electric power generated by RES for development of RE.

8.4. Barriers and Gaps

In spite of available stimulating economic, legal and favorable political conditions, there are barriers in Uzbekistan that prevent broad-scale implementation and transfer of environmentally friendly technologies that exist virtually in all sectors:

- lack of information on modern EFT;
- insufficient human skills to implement technologies;
- economic barriers such as lack of adequate capital, high transactional costs of purchasing technologies, no full technology cost calculation;
- lack of knowledge on local technological needs;
- commercial barriers such as practice of non-acceptance of risks, followed by local banks and international financial institutions;
- inadequate legal norms in the area of environment protection that do not provide for stimuli and benefits to take steps on reduction of emissions of GHG;
- poor development of modern sci-tech and research base to develop local EFT;
- undeveloped state of local market of modern energy saving technologies;
- insufficient financial support from the government to promote environmentally friendly technologies on local and international markets.

To ensure economic growth the government has defined solving the problems of energy saving, reducing power intensity of the economy and broad-scale use of expensive renewable energy sources as priority direction.

In order to work out efficient mechanisms and specific steps on further energy saving policy it is necessary to stimulate attraction of foreign investments aimed at broad implementation of RES, expand knowledge on technologies and create a EFT market. In this context, insufficient human skills and experience, trade and political barriers and non-acceptance of risks are constraining factors that are impossible to overcome quickly when doing business as usual. In this area the efforts of the government to ensure stimulating conditions for successful technology development and transfer, its direct participation in this process plats an important role in elimination of arising barriers.

8.5. Capacity Building for Technology Transfer and Development

Development and strengthening potential for widespread expansion and application of environmentally friendly technologies and know-how to a larger extent is ensured by various bilateral and multilateral programs with the assistance of international organizations. Under such programs and projects training and workshops, sharing of experience, pilot projects on implementation and application of EFT are conducted. Demonstration projects have become efficient means of strengthening potential in Uzbekistan.

Under financial assistance of PROON several pilot demonstration projects on implementation and application of RES-technologies to use solar energy which are a good example of technology transfer have already been realized.

For instance, realization of the GEF/PROON project "Elimination of barriers to energy efficiency in communal heating and hot water supply" (1999) was aimed at study of situation in housing sector and working out recommendations on energy saving in hot water and heat supply of Uzbek cities including expanded use of solar energy. As a result of project

implementation, experts have gained valuable experience on implementation of energy efficient technologies in utilities sector.

The PROON/Uzbekistan project "Transfer of technology for local production of solar panels to heat water" (2004-2005) aimed at raising awareness of population, state organizations, private companies and financial structures on technologies and advantages of renewable power economy, has successfully arranged demonstration of local production of solar collectors based on European technology thus contributing to further development of national production capacities, development of market of technologies and equipment of renewable power economy in Uzbekistan.

Under another project of PROON/Uzbekistan "Clean water for rural communities in Karakalpakstan" (2005-2006), 13 shepherd families in a remote rural settlement of Kostruba were provided with photoelectric systems and two such systems were installed in a school and a local council. Shepherd farms in another rural district – Karauzyak – have been equipped with nine water-lifting photoelectric systems. The population of the settlements has gained knowledge and skills to use the technology of renewable power economy and appreciated the advantages of using solar installations in the daily lives.

In order to develop potential on legal and economic aspects the Asian Development Bank project "Stimulation of use of RES, energy efficiency and reduction of emissions of greenhouse gas" (2001) has assessed the existing legal framework, institutional structures for creating the RES market and reviewed international experience on development of sector of renewable energy in developing countries with similar market conditions in order to determine the capacity of government funding and donor co-financing of renewable energy economy in Uzbekistan.

"Training Program on GHG emission reduction in Caspian Region" (2003-2006) implemented by the Canadian Agency for International Development (CIDA) serves an efficient example of strengthening potential in Uzbekistan. Under this program, 3 demonstration projects on reduction of GHG emissions with use of renewable power technologies have been developed and implemented.

Another PROON/Uzbekistan project "Development of national strategy on waste management and first five-year action plan" (2005) aimed at improvement of methods of organizing work on solid waste management, has given great attention to the campaign for raising public awareness and understanding by local population of the problems of removing, processing of waste and development of waste utilization technologies.

The Project "Synoptic research for working out the national strategy of development of renewable energy economy in Uzbekistan" (2006) implemented by PROON and the Danish Consulting Services Fund has reviewed the RES resource base and possibilities to apply RES-technologies, given recommendations on possible schemes for stimulation of renewable energy economy development and performed cost efficiency analysis.

Resource potential of solar energy economy, economic expediency of solar energy economy in Uzbekistan has been studied in project "Solar energy – a promising specialization for Uzbekistan" (2006) implemented by PROON and the Center for Economic Research of Uzbekistan.

In 2006-2007, the project "Facilitation of development of biogas technologies in Uzbekistan" under financial assistance of GEF/PROON has been implemented which strengthened the capacity of local administration on management of environment and development of clean energy. Under this project a pilot demonstration installation of biogas system in a farm is completed. The project is aimed at raising the public awareness about biogas technologies and advantages of their application for agricultural needs.

Since 2007 the PROON/Uzbekistan project "Strengthening potential on Clean Development Mechanism in Uzbekistan" has been implemented. Under this project training of experts of the National Body of CDM and prospective developers of project proposals-experts from various industries in development of relevant CDM projects is undertaken.

Evidently the international organizations have made a considerable contribution on capacity building on transfer of EFT in Uzbekistan. However successful implementation of new technologies to a large extent depends on human factor. One of weak elements of capacity building and strengthening is staff turnover. With the lapse of time a part of trained experts change their jobs; therefore in spite of the fact that Uzbekistan has quite considerable capacity of skilled workforce both at the place of production and in science, the problem of lack of workforce skilled in the issues of Climate Change, transfer of EFT, use of Clean Development Mechanism remains topical.

The need in capacity building and strengthening on a regular basis is critical. Availability of developed scientific and technical capacity, strengthening of national institutions and skills development of experts in all areas of the economy are key components of the Uzbekistan sustainable development policy.

8.6. Technology Transfer Mechanisms

The process of transfer of environmentally friendly technologies includes many mechanisms: direct supplies of technologies and equipment, gaining of knowledge and experience, establishing joint ventures in production or purchase of technologies, commercial deals, government and foreign investments, exchange of technological information, etc.

Sectoral programs of Uzbekistan aimed at raising energy efficiency/energy saving and this reduction in emissions of greenhouse gas employ these mechanisms when implementing projects. However implementation of projects facilitating realization of sectoral program requires considerable initial investments.

As transfer and development of environmentally clean technologies are one of components of sustainable development of a country, adequate funding of the process is a determining factor of any mechanism of technology transfer. For Uzbekistan, where wear and tear of equipment used and obsolete technologies slowdown the rates and efficiency of economic development, solution of the problem, Government believes, is in expansion of foreign economic cooperation both in the area of attracting direct foreign investments to the economy and establishing joint ventures opening up the access to new technologies.

Legal basis for attraction of foreign investments regulating and stimulating the activities of foreign investors has been established. Particularly favorable conditions for investing are provided to foreign partners investing in development of strategic industries of the economy thus ensuring the industries with new management methods, new investments, modern technologies. The Law "On Product Sharing Agreements" passed in 2001 provides significant benefits and guarantees to foreign investors implementing investment projects on the territory of Uzbekistan.

Uzbekistan actively employs the innovative financial mechanism of the Kyoto Protocol, ***Clean Development Mechanism***. This economic tool allowing to attract investment resources in national economy and advanced environmentally friendly technologies aimed at reduction of greenhouse gas emissions, especially in power industry responsible for the most of emissions, which in turn will help Uzbekistan to reform its economy in accordance with the requirements of sustainable development.

Profits of foreign partners making direct investments in CDM projects are exempted from payment of taxes on the territory of the Republic of Uzbekistan. In addition, implementation of sectoral investment projects to raise energy efficiency and energy saving under Clean Development Mechanism reduces the cost of projects at the expense of selling reduced emissions of greenhouse gas making the, economically appealing to foreign investors.

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9. Education and Public Awareness

9.1. Education, Capacity Building and Public Awareness on Climate Change Issues in Uzbekistan

The Republic of Uzbekistan, in accordance with Articles 4 and 6 of the Convention and the New-Delhi Program of Action, actively participates in education, capacity building and public awareness regarding Climate Change and promotes this issue at the national, regional and sub-regional levels.

The activities related to increase of understanding and training public on Climate Change issues in Uzbekistan are coordinated by the Centre of Hydrometeorological Service under the Cabinet of Ministers of the Republic of Uzbekistan (Uzhydromet) – a body responsible for implementation of the UNFCCC in Uzbekistan. The Secretariat on the UNFCCC Implementation and Information Centre for public awareness, conducting media campaigns and training, and distribution of the information concerning Climate Change and the Kiyoto Protocol has been created in Uzhydromet.

Various target groups of population take part in the activities on capacity building and raising public awareness on Climate Change issues: scientists, teachers, schoolchildren, university students, managers and experts of the ministries and agencies of key sectors of economy, industrial enterprises, representatives of business and private sector, newspaper, radio and TV journalists, active members of the ecological Non-government organizations and public.

Primary activities are focused on:

- Conducting educational seminars and conferences for various target groups of the population at national level;
- Participation in the regional and international meetings on Climate Change and questions of the Kiyoto Protocol;
- Release of special bulletins on Climate Change;
- Development of methodical manuals and guidelines for schoolchildren, students and teachers;
- Publication of information booklets and posters for wide audience;
- Distribution of information and expansion of access to the information on Climate Change by means of monthly dissemination of press releases and news through a specialized website on Climate Change and national information network;
- Conducting ecological campaigns and the days of ecology devoted to the World Day of Environmental Protection and other significant ecological dates; and
- Ensuring TV and radio broadcasts, preparation of articles and regular publications in the local press about Climate Change and its negative influence.

Large-scale information and educational campaigns conducted in Uzbekistan for the last 5 years have allowed for raising significant interest and call for action among population at all levels. However, it is necessary to note, that coverage of the public by these activities is still insufficient and increasing public understanding of Climate Change issues and public participation in this area is a long and gradual process, and success is being achieved year by year.

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9.2. Education System in Uzbekistan and Environmental Education

From the moment of declaring its independence, the Republic of Uzbekistan has reorganized the structure of the educational system and preparation of professionals. The Law “On education" was passed in 1992. New curricula and textbooks were introduced, and new types of educational institutions in form of professional colleges and the academic lyceums were created. In 1997, the National Program on professional training, aimed at gradual reforming of the whole education system was introduced. The new education system, which provides obligatory 9-year secondary education at school and 3-year vocational education in a professional college or academic lyceum, was introduced. “Bachelor" and "Masters" degrees were introduced into the higher education system. For the purpose of improvement of material base of schools and colleges in 2004 the State national program on development of school education was accepted.

All secondary schools are supervised by the Ministry of Public Education of the Republic Uzbekistan. Higher education institutions are managed by the Ministry of Higher and Secondary Special Education of the Republic of Uzbekistan. There is a Centre of secondary special vocational training functioning as part of the ministry, which manages activities of professional colleges and academic lyceums. There also “branch institutes” related to the Ministry of Health, the State Railway Company, Uzbek Agency for Communication and Information, etc.

According to the statistical data of 2006, 9 926 secondary schools function in the Republic with 6 million schoolchildren studying and over 475 thousand teachers (73% of whom have higher education degree) working in them.

Vocational training system includes 955 specialized professional colleges with more than 890 thousand students and about 20 thousand qualified teachers.

The system of higher education of Uzbekistan includes 62 higher educational institutions, including 20 universities and 42 educational institutes, in which

more than 278 thousand students study and 18 thousand teachers (52% of who have doctorate degree) work.

Top skills professional training is carried out in postgraduate study and doctoral studies. About 4 thousand post-graduate students (69% – in the system of higher education and 31% – in scientific research institutes) are trained throughout the country. Doctors and candidates of sciences make up 45% of an aggregated number of scientific and pedagogical professionals. 23 institutes, 16 faculties, 4 centers and 14 courses of improvement of qualification function in the system of improvement of professional skill and retraining of personnel.

Close attention is paid at *environmental education and education for sustainable development* (EE and ESD) in the country. Environmental education in the Republic is coordinated by the Ministries of Education and the state environment protection institutions that serve as an indicator for coordinated approaches and principles in this area.

Priority of environmental education is defined by the «Program of Actions on Environmental Protection in the Republic of Uzbekistan for 2006-2010», which includes actions for development of environmental education with participation of the Ministry of Public Education (MPE), Ministry of Higher and Secondary Special Education (MHSSE) and state organizations, engaged in nature protection activities.

In November 2005, the Coordination Council (CC) on EE and ESD has been established by joint decision of the State Nature Protection Committee, MPE and MHSSE. The program documents in the area of environmental education were accepted.

At the same time, "ecology" as a school subject is not included into the list of obligatory subjects, though bases of environmental knowledge at school are presented in subjects of natural study, biology, botany, chemistry, physics and geography. Manuals on environment and nature protection for schoolchildren were published as part of facultative lessons. There is a network of establishments of an extra-curricular environmental education: ecologic-nature centers and eco-clubs, which hold ecological competitions for schoolchildren, organize summer ecological camps, conduct campaigns in national parks and nature reserves.

Environmental study is included as a compulsory subject into the curriculum of the higher education institutions and is taught in all training courses. Chairs of Environment and established in the majority of the institutions. Annually, about 320 young environmental experts are trained at universities and institutes of Uzbekistan. Training programs on such specialties as environmentalist-technologist, teacher-ecologist, biologist-ecologist, lawyer-ecologist, ecologist-engineer and ecologist-chemist are introduced in the universities and institutes of Uzbekistan. On the Bachelor and Masters level students study “Environment and Law”, "Environmental Protection", “Management and Safety of Environment”, "Geoecology", “Environmental Protection and Rational Use of Natural Resources” and “Natural Resources Management Economy».

Despite the presence of considerable trained and training capacity in the country and transformations made in the education system, concrete issues of Climate Change are not considered within the framework of the general training in such subjects as geography, physics, chemistry, economy although various aspects of Climate Change closely intertwine with these sciences.

9.3. NGO Involvement in Environmental Education

At a regional seminar

Non-Government Organizations (NGOs) of Uzbekistan conduct active work in the sphere of EE and ESD. There is a network of NGOs working in the field of ecological education and making a considerable contribution in its development. The basic target groups of these organizations are children, youth and local population.

NGOs actively participate in the organization of ecological campaigns involving of students and youth, carry out trainings and develop training-methodical materials on environmental issues. A number of print materials on ecological issues have been prepared and published by NGOs during the last years.

Development of ecological education is promoted by cooperation of regional, sub-regional and national NGOs with various international organizations and programs and donor agencies such as UNDP, UNEP, OSCE, USAID, WWF, World Bank and others. In the framework of such cooperation, considerable contribution into EE and ESD issues is being made by the Central Asian Regional Environmental Center in Uzbekistan. The Centre has initiated publishing of a number of manuals on environmental education, conducted a series of training for teachers on use of

thematic posters on Climate Change within the school curriculum.

Nevertheless, the issues of Climate Change in Uzbekistan are not adequately addressed; there are no special training courses and programs on the given issue.

Despite the efforts made by the experts and NGOs, no considerable progress is observed in this area due to insufficient interaction among responsible departments and ministries, as well as weak communication with the scientific, educational, public and international organizations working in the environmental sphere at the national level. Creation of CC on EE and ESD and adoption of program documents on these issues at the national level are positive prerequisites for Climate Change education development in Uzbekistan.

9.4. Public Awareness and Mass Media

Practically all mass-media outlets write and talk about the issues of global warming and environmental protection in the country today. Articles in newspapers and magazines are published and TV and radio broadcasts on environmental issues are aired regularly. However, there are no regular scientific editions, special headings in newspapers and magazines and TV and Radio programs on Climate Change issues in the Republic. Thematic publications on these issues appear as a result of projects implemented within grants.

In order to increase knowledge of population on Climate Change issues, Uzhydromet closely cooperates with leading journalists in the country, participates in Radio and TV programs, publishes articles in local newspapers, holds seminars in various provinces of the Republic with participation of mass-media.

Considering small amount of published editions and irregularity of information campaigns due to lack of funding, it is difficult to fill in gaps in Climate Change knowledge among general public and shape public opinion about necessity of quick and effective actions at the national level on mitigation and adaptation only by efforts of one department of Uzhydromet in the country.

It is required that Climate Change issues are properly reflected within the national political, economic and educational programs.

9.5. Use of Information Technologies and Networks in UNFCCC Implementation

Quick development of Information Communication Technologies (ICT) and electronic mass-media in Uzbekistan create preconditions necessary for improved access to information and increase of knowledge of population, and attracting its attention to Climate Change issues.

The Government of Uzbekistan defines the development of ICT as a strategic priority of economic development and increase of a standard of the population well-being.

One of the priority directions in the development of ICT is equipping educational institutions in the Republic with computers and providing access to the Internet network. According to target indicators, 63% of secondary schools, 92% of academic lyceums, 85% of professional colleges and 100 % of higher education institutions of Republic will have access to the Internet network by 2010.

The legal base defining the basic economic, legal and organizational aspects of ICT functioning is in place including the following:

1. By the decision of the Cabinet of Ministers of the Republic of Uzbekistan as of 10.04.1998 № 150 "*About creation of an interdepartmental information computer network"* interdepartmental information computer networks allowing for improved information exchange processes between the ministries and national institutions; creating databases and gradual transfer of document circulation into an electronic form have been established;
2. By the decision of the Cabinet of Ministers of the Republic of Uzbekistan as of 23.05.2001 № 230 *"About measures on the development of computer and information technologies for 2001-2005 and maintenance of wide access to international information system "Internet"* conditions for wide integration of Uzbekistan into a world information field have been created;
3. By the decision of the Cabinet of Ministers of the Republic of Uzbekistan as of 06.06.2002 № 200 "About measures on further development of a computerization and introduction of ICT" the process of development of applied and adapted software, information databases and other software products, development of websites of industrial branches of economy, the ministries, departments, business, public health services, science and education institutions has been accelerated. Releases of specialized Internet magazines and newspapers have been put in place.

With prompt development of ICT in Uzbekistan, environmental NGOs in Uzbekistan have created their own websites and information networks (http:/www. ecoforum.sarkor.uz, www.ngo.uz, www.ecoinform.freenet.uz, www.armon.freenet.com, www.logos.uzsci.net), which promote expansion of

access to information on ecological issues, including Climate Change.

Despite all measures taken for advancement of ICT development in Uzbekistan, there is a number of issues and barriers complicating wide access and use of information technologies, namely:

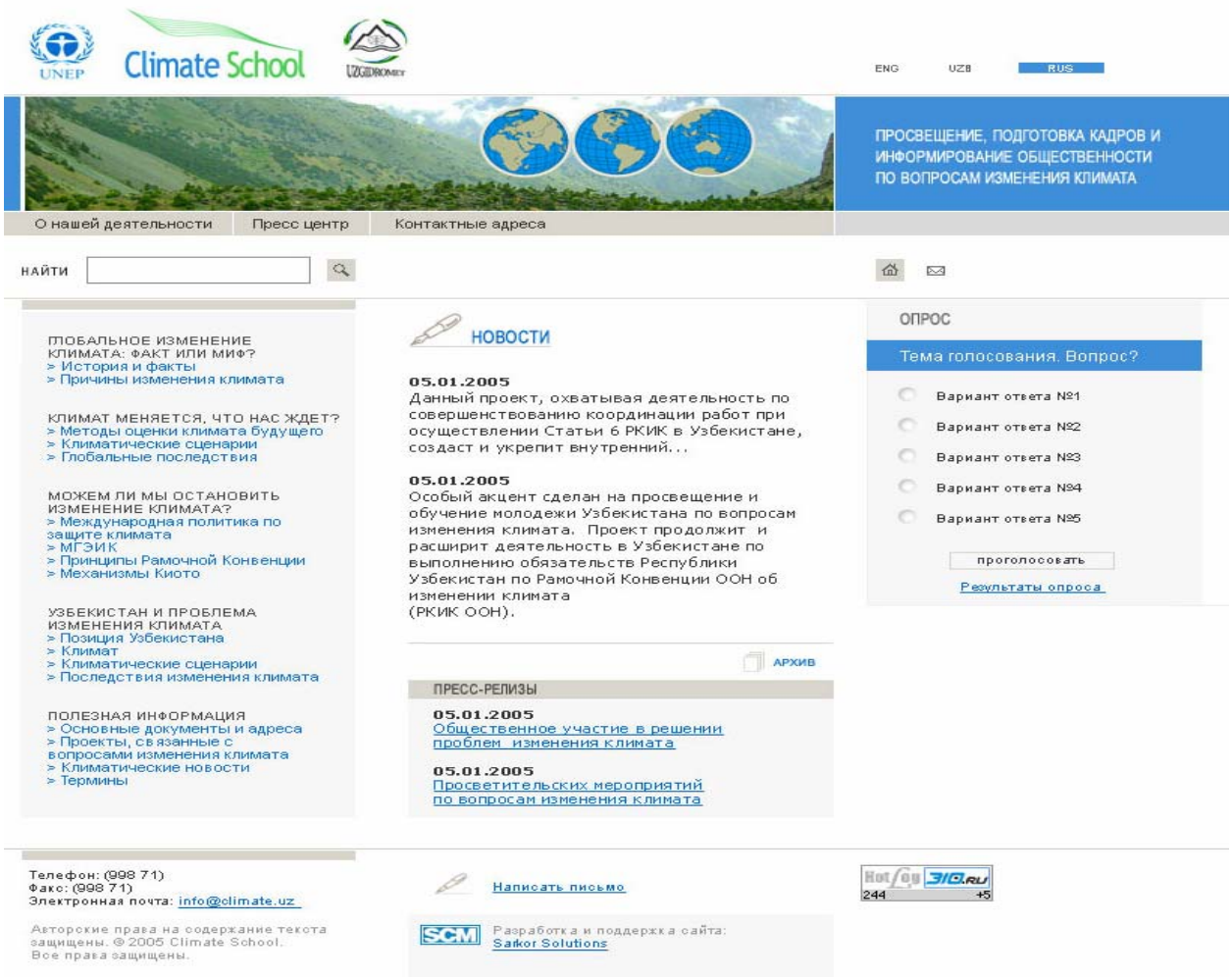
- The rural population has weak skills of use of information technologies and is insufficiently equipped by computer equipment that limits access to Internet. The main part of Internet users lives in the capital and large cities.
- There are no specialized information networks on exchange of the information and data used for preparation of GHG inventory, vulnerability and adaptation assessment and the analysis of GHG emissions reduction capacity on the national and regional levels; and
- There us an in insufficient involvement of national and regional electronic mass media, Internet resources of the state nature protection bodies, Ecoforum of Uzbekistan and local NGOs in covering Climate Change issue.

9.6. Implemented Initiatives

Activities on education, capacity building and public awareness on Climate Change issues are mainly conducted in the framework of bilateral and multilateral programs and projects with financial assistance of the international organizations.

1. UNDP/Uzbekistan Project "Uzbekistan – the Country Study on Climate Change" on preparation of the Initial Communication (1997-1999) has become the first information-educational activity on Climate Change issue:

- 14 seminars on impact on natural resources, measures of GHG emissions reduction and adaptation to Climate Change were conducted;
- 5 newsletters, in Uzbek, Russian and English languages disseminated among stakeholders, governmental bodies, NGOs and private sector entities were published;
- A series of special programs for local TV and radio as well as number of print articles on Climate Change were developed.




ИҚЛИМ
ЎЗГАРИШИ
ИҚЛИМ
ЎЗГАРИШИ
УСЛУБИЙ ҚЎЛЛАНМА
Ob-havo, iqlim, suv
O'zbekistonda
iqlim o'zgarishi
Suv Ekkori bilan bog'liq bo'lgan suv
Kelajakda Orol nima qilmoqda?
Ob-havo, iqlim, suv
SUV VA QISHLOQ XO'JALIGI
RESURSLARI
ИЗМЕНЕНИЕ
КЛИМАТА
Иқлим ўзгариши ўзи нима:
Иқлим ўзгариши ҳақида
БМТ доиравий конвенцияси
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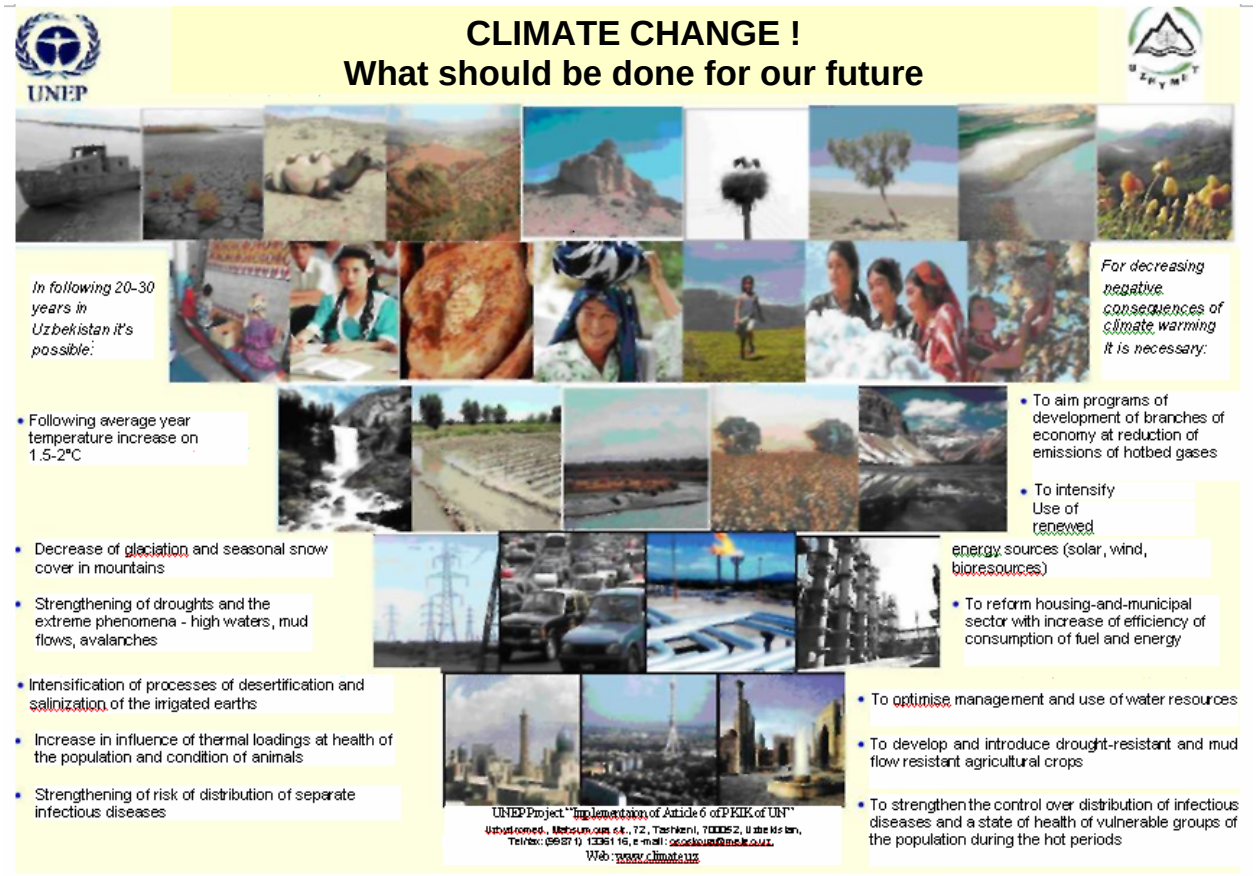

2. The considerable contribution has been made by the UNEP/Uzbekistan Project on Implementation of the UNFCCC Article 6 (2004-2006), which has taken concrete actions for youth training, capacity building and public awareness:

- The national information network of various state departments, educational institutions, mass media, NGO, private sector entities, offices of ecological projects (more than 100 entries) was created;
- The specialized website on Climate Change was developed http://www.climate.uz;
- Monthly information press releases and news on Climate Change are being issued;
- The assessment of the national capacity in the area of education, capacity building and shaping public awareness on Climate Change issues was conducted;
- The national program on public information on Climate Change was prepared;
- The following information products were developed in Uzbek and widely disseminated:
  - The manual on Climate Change for teachers, schoolchildren college students;
  - Training course on Climate Change for students of higher education system;
  - Methodical guidelines for teachers of higher educational institutions;
  - Brochures the UNFCCC "What is Climate Change: the guidelines for beginners on the UNFCCC and Kiyoto Protocol" in Uzbek;
  - A series of booklets "Weather, water, and climate" and "20 advice: how to do the small daily contribution into the Environmental Protection»;
- The information poster "Climate Changes! What is necessary to do for our future?" A series of training seminars on Climate Change were conducted in various cities of Uzbekistan (Namangan, Andijan, Fergana and Nukus);
- Reports were presented at international and regional seminars and conferences;

3. The experts of Uzhydromet who deal with Climate Change issues regularly participate in conferences of the UNFCCC Parties and sessions of Subsidiary organs of the Convention, take active part in international expert meetings of IPCC and annual seminars of the Asian-Pacific region. As selected members, experts from Uzbekistan work in the UNFCCC Expert Working Group on technology transfer and regularly participate in review of the IPCC reports. Currently, they work in the Council of Bureau of the UNFCCC Adaptation Fund.

4. Significant contribution into activities on public awareness on Climate Change in Uzbekistan has been made during the preparation of the Second

National Communication of the Republic of Uzbekistan under the UNFCCC (2005-2008):

- 13 training seminars were conducted (7 of them aimed at increasing the level of public awareness, 2 on GHG inventory 2 – on vulnerability and adaptation, 1 – on Climate Change mitigation and 1 – an reporting seminar based on the results of vulnerability of natural resources and key sectors, GHG inventory and emissions reduction measures assessment. Over 100 representatives of various organizations took part in each seminar. Training was conducted in all regions of the country with focus on youth education (many seminars were conducted at the country universities in Uzbek language);
- In October 2006, the international seminar on Vulnerability and adaptation assessment was held with participation of 13 countries of the Central Asia, Caucasus, Moldova and the Eastern Europe working on the preparation of the Second National Communication with the assistance of the United Nations Support;
- Four national experts of the project participated in the international training seminars: in 2005 – on preparation of National Communications, in 2006 – on application of LEAP and PRECIS models; in 2008 – on methods, tools, data and supervision under the Nairobi Program of action.
- In 2007, special edition of an international "Newsletter" of the National Communications Support Program was prepared highlighting the achievements of Uzbekistan in the preparation of the Second National Communication;
- In 2007, the reporting seminar on the results of research under the Second National Communication was conducted with participation of UNEP;
- TV and Radio programs on Climate Change issues were prepared and broadcast;
- Articles on Climate Change issues are being regularly published;
- 2 newsletters based on the results of the project research were published;

On 10-12 March 2008 the report non findings of the research conducted in under preparation of the Second National Communication was presented at the international conference on the Aral Issues, their Impact on Population Gene Pool, Flora and Fauna and Measures of the International Cooperation on their Consequences Mitigation.

The Second National Communication of the Republic of Uzbekistan under the UNFCCC published in three languages is disseminated among the interested organizations, NGO, industrial enterprises, representatives of business, private sector and the public.

9.7. Barriers and Priority Needs

Despite obvious progress and increase of information-educational activities on Climate Change issues, national experience and lessons learnt show that *the general level of understanding* of Climate Change issues in Uzbekistan *remains insufficient*, especially among politicians and decision-makers.

Due to shortage of funds and technical resources, the activities on shaping public awareness are undertaken mainly in the framework of international projects and this is not enough. Achieving steady progress in increase and maintenance of necessary level of knowledge requires applying the regular approach and constant funding.

The following ***gaps*** were revealed in the area of public information in Uzbekistan:

- Absence of the corresponding status of Climate Change problem in the national economic development plans and educational programs;
- Insufficient knowledge of journalists of Climate Change issues and weak participation of mass media in shaping public awareness on the issue;
- Weak interaction between the Ministries of Education, the state departments working in the area of environmental protection, and NGOs concerning Climate Change;
- Regional cooperation on Climate Change issues between the interested state and non-government organizations of Central Asia is insufficiently developed;
- There is no regional specialized Climate Change information networks between the countries of Central Asia.
- Lack of educational, scientific-popular and information materials and methodical guidelines on Climate Change in Uzbek language.

Given the above mentioned constraints, the following *priority requirements* enabling better implementation of the Article 6 of the Convention and the New-Delhi program of works in Uzbekistan are defined:

- The state support is necessary for implementing the activities on public awareness on Climate Change issues with due account of national circumstances and opportunities;
- Increased understanding of policies and measures of mitigation and adaptation by decisions-makers of different levels needs to be achieved;
- Inclusion of Climate Changes issues in curriculums of schools, colleges and higher education institutions needs to be facilitated;

- Regular training of target population groups on adaptation to Climate Change in the most vulnerable sectors needs to be conducted;
- Strengthening and expansion of sub-regional, regional and international cooperation should be achieved.

The following actions need to be ***immediately*** taken to improve public information sector:

- To develop and conduct training courses on Climate Change for mass media representatives;
- To prepare the briefing note on Climate Change issues in Uzbek language for politicians and decision-makers;
- To develop training programs on Climate Change mitigation and adaptation measures for various target groups of the public and experts of key economy sectors;
- To develop a video film on Climate Change in Uzbekistan for a wide range of public.

In a long-term prospect, the priority actions include:

- Integrating Climate Change issues into national development programs and plans;
- Updating educational programs of schools, colleges and higher education institutions with inclusion of Climate Change issue;
- Publishing specialized editions of newspapers and magazines, developing regular special TV and Radio programs on Climate Change issues;
- Creation of a regional Climate Change information network of the Central Asian countries.

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10. Constraints, Gaps and Capacity Building Needs

10.1. National Circumstances

Information concerning national circumstances serve basis for research works and vulnerability assessment, analysis of potential adaptation steps for Climate Change, and measures for decrease of GHG emission.

Geterogeneity of huge amount of information and diversity of interrelations between scientific, economic, social and political issues determine challenges and gaps in process of receiving of exact and internationally comparable data.

In Uzbekistan, the basic source of indices is official state statistics, the area facing hindrances as to providing time continuity and stability of key indices statistical data. There occurs an urgent need in improving and expanding of statistical account of such indices as GDP in internationally comparable prices, GPD by the parity of purchasing power; population mortality from deceases, which directly or indirectly relate to climatic factors etc.

It is necessary that statistics register annual data on damage caused to agricultural production by negative affect of extreme weather conditions; statistical reporting should be provided on tourist sector development; access should be granted to data on registration of individual vehicles etc.

10.2. Greenhouse Gas Inventory

Despite obvious achievements, in Uzbekistan there are still some gaps and challenges that are merely obstacles for preparation, collection and quality checking of data for assessment of greenhouse gas emissions, and elimination of those shortcomings is taking a lot of time and resources. It is often impossible to retain stable national groups of experts for separate categories of sources to collect complete data on energetic balance, to get assessment of emission coefficients specific for each particular category.

National GHG Inventory in Uzbekistan is carried out within the framework of preparation of National Communication. For regular GHG Inventory in long-term perspective it is necessary to develop a stable infrastructure and financial support on the part of the Government, which is the main obstacle at the present moment owing to lack of the national funding. Concrete gaps and requirements of capacity building are indicated in Table 10.1.

Table 10.1 Constraints, Gaps and Needs for Capacity Building on GHG Inventory

Constraints and Gaps	Description	Requirements
No data	No data concerning consumption of biomass as a fuel in private households	Research activity on assessment of biomass consumption as a fuel in private households.
	No data of age structure of total number and other detailed data	Research activity on determination of age and other characteristics of head of cattle
Non-completeness of Data	Lack of data on input HFC for calculation of potential emissions	Organization of HFC statistic registration system
	Absence of detailed data on change of areas between different categories of land use	Change or detailing of data registration by areas of used lands
	Not all the forest lands are included into the state forest fund	Organization of forest registration on the lands, not possessed by the State forest fund
Development of the National Emission Factors	Small value of selection for emission factors in gaseous systems, and as consequence – high uncertainty	Cooperation with the companies directed to getting essential data for development and verification of national emission factors and decrease of their uncertainty
	Absence of national emission factors from ventilation, burning in torches of gaseous systems	
	Obsolete generation coefficient of solid domestic wastes and their morphological composition (determined using methods of direct measurement by The Institute of Sanitary and Hygiene in 1989)	Carrying of new special research works in the field of solid domestic wastes on dust-heaps
Technical and Institutional capacity requirements	Preparation of fuel balance by source categories is carried out only within the Project framework	Government's permission for preparation of fuel balance on annual basis for the body, which is to prepare inventory
	Absence of statistic registration of HFC, imported into the country	Organization of HFC statistic registration system
	Absence of a state program for land use categories areas registration using land use methods	Registration system organization
	Absence of s state program for forest lands state registration using distance methods	Registration system organization
	Insufficient expert capacity on inventory for separate categories of sources (Land Use Change, agriculture)	Training

10.3. Mitigation of Climate Change including Projects

Obstacles of normative, economic, technical, organization and personnel kind, which occur in implementation of mitigation policy, some sector programs, and separate steps for GHG emission reduction, are described in detail in Section 4. However, there are some gaps and challenges in collection and analysis of essential data and their usage in process of assessment of GHG emission reduction capacity and development of forecast mitigation scenarios. Complete and reliable data on energetic balance of each sector of economy, current and forecasted cost of fuel resources, and complete set of macroeconomic development indices are of urgent need.

Owing to shortage of data, experts and experience some obstacles are faced in application of such methods, like LEAP, MARKAL-MACRO, ENPEP, STAIR, GACMO, EM, ETO. It is necessary to organize training on the models application, new approaches and methods for carrying out analyses of GHG emission decrease capacity. Not all the similar modern approaches are applicable in Uzbekistan, taking into account specificity the economic development of the country. Owing to this, there is a need for development of GHG emission decrease assessment methods and approaches, which would take into account peculiarities of the country development in a more complete way for their application in process of prepration of subsequent National Communications.

Detailed assessment of priority technological requirements in GHG emission decrease in key economic sectors of Uzbekistan was carried out in 2001. For the past years some changes took place in Uzbekistan in the structure of economy, a significant progress of industry, agriculture was observed, policy of energy consumption changed towards power intensity decrease in all the sectors of economy.

Taking into account these changes, it is necessary to carry out a new assessment of technological requirements using new methods and a detailed cost analysis related to the steps directed to gas emission decrease, development, implementation and transfer of technologies and assessment of economic efficiency of the above-listed steps in the context of the National policy of stable development for short-, middle- and long-term perspectives.

New researches on assessment of technological requirements are to serve a basis for renewal of the National Strategy for GHG emission reduction, as the current strategy of GHG emission decrease fails to reflect the current mitigation needs, lacks complex and systemic approach, and offers a highly limited set of economic and technical levers, mainly, in the Energy Sector.. Assessment of technological requirements is to help to take adequate decisions regarding mitigation steps and policy, to accelerate implementation and transfer of technologies and urgent legislative tools in Energy Sector and other sectors, as well as, to improve subsequent National Communications.

In Uzbekistan, an active work is done in the field of project development under the Clean Development Mechanism (CDM), over 60 draft emission reduction project offers were completed, however up to today not a single CDM project has been registered with the Executive Council. Lack of capacity in rendering consulting services in support of such projects development hinders their promotion. Despite of implementation of diverse international programs and workshops in the field of training of local experts, preparation and implementation of CDM projects, skills of local project developers are not on a sufficiently high level for quality drafting of CDM projects documentation. It is necessary to continue implementing training programs related to CDM projects, paying special attention to the practice of financial analysis, issues of validation and certification of decreased emission units.

List of challenges, gaps and capacity building needs, relative to mitigation of Climate Change, are indicated in Table 10.2.

10.4. Vulnerability and Adaptation

What would be the affect of Climate Change in the nearest future to the environment and economy, infrastructure, and health in Uzbekistan? What adaptation measures are to be taken first of all upon occurrence of dangerous changes in the environment? This depends on the scale of impact and the adaptation capacity of the environment, socio-economic sectors and population of the country. Answers to these questions depend on the degree of elaboration of knowledge of all socio-economic sectors.

The basis for examination and scientifically substantiated assessment of Climate Change impact is represented, first of all, by the adequacy of the system of climate observation (correspondence to principles of climate monitoring) and second, by presence of “non-climatic” socio-economic data, upon which any sectoral assessment and analysis of adaptation measures are based. Often impact of Climate Change is not unequivocal, that is why before undertaking an adaptation measure it is necessary to assess potential damage from Climate Change and to correlate it to the cost of development and implementation of such a measure. So, submission of data on the current and future damages from Climate Change in diverse socio-economic sectors is an obligatory condition for approving a strategy of adaptation to Climate Change.

Table 10.2 Constraints, gaps and requirements of capacity building on mitigation of climate change

Gaps and Challenges	Description	Requirements
Informational	Restricted access to statistic information, related activity of branches and enterprises directed to mitigation Lack of information on results of carried actions related to mitigation Lack of information on consulting, draft and production companies, related to the work of mitigation projects Lack of information for investors on potential market of technologies in Uzbekistan and on local enterprises, producing equipment for mitigation technologies	Development of statistic accountability related to gas emission decrease Organization of a registration system of actions directed to mitigation Establishment of local consulting firms related to CDM projects
Technical, Technological	Centralized control of majority of branches, which hinders the process of decision taking in process of prepration of any step Technical state of enterprises of power sector, use of power high capacity installations, centralized supplies of fuel, heat and electrical energy Lack of adequate long-term National Mitigation Strategy and Road map for its implementation Lack of a long-term forecast of gas emission for diverse scenarios of development of Uzbek economy, complex scientific researches on mitigation issues	Modernization and technological renewal of the current power sector Carrying of a new assessment of technological requirements on mitigation, development of a long-term gas emissions forecast and appropriate National Strategy on their decrease for perspective development up to 2030
Legislative	Lack of the appropriate regulatory legal base for effective implementation of mitigation policy and steps Inappropriate stimulation system – that one who pays for implementation of steps directed to mitigation is not to derive any benefit or profit Lack of a privileged taxation system for importing of mitigation technologies and their accessories Current regulatory documents, stimulating energy saving and use of Renewable Energy Sources are of a framework character Lack of legislation, stimulating and/or obliging implementation of mitigation technologies into non-power sectors of economy.	Improvement of the National legislation in technical adjustment, appropriate standards, principles and regulations on technical adjustment, which are adequate to standards, principles and regulations in mitigation field.
Financial	Pricing for fuel and energy not encouraging increase of power efficiency Significant amount of non-payments for used resources Lack of financial funds in the majority of enterprises and among the population for implementation of mitigation projects Lack of financial support in a kind of grants, subsidies, credits for establishment of mitigation technologies market Restricted participation of the national financial organizations in transfer of technologies High cost of separate mitigation technologies, for instance, technologies of renewed power sources Export/import prices for natural gas and electrical power are much lower than the world export/import prices for energy sources	Government subsiding and project support on use of renewal power sources, on increase of power efficiency and energy saving Financial encouragement (benefits, subsidies) for private sector and population in the filed of mitigation steps implementation Involvement of banks into privileged crediting for purchasing of ecologically pure technologies
Bring of Information to Publicity	Insufficient understanding of problems and threats, related to Climate Change for the economy and population, and, as a consequence, lack of attention on the part of persons, taking decisions in regard to the issues on decrease of GHG emissions and run-off increase Insufficient public information concerning necessity of energy and resources saving	Promotion of Climate Change mitigation importance Informing on technologies and measures decreasing GHG emissions

10.4.1. Systematic Observations

Systematic Climate Observations. To receive reliable data on climate it is necessary to create an adequate system of observation and data collection. In Uzbekistan, there is the basis for performing the Convention obligations related to systematic observation (Section 6.2), however, supplementary development of capacity (materials and technical support, improvement of management, in-service training of experts) is needed.

Gaps and Needs. Economic reasons, that caused shrinking of the observation network, affected provision of the hydro-meteorological network with devices, gauges and equipment while Uzbekistan lacks sufficient funds for re-organization and development of the network. First of all, it is necessary to restore observations in aerologic stations, to improve technologies of information collection and storing, and in separate cases – to save data, and to establish data bases, appropriate to the modern requirements, including easing of access to information.

It is necessary to synchronize diverse international initiatives on strengthening of observation networks and on developing of interrelation between the states of the region. The developed Regional Plan of Action on Global System of Climate Observation (GSCO) for Central Asia regarding restoration of the work of high-mountain stations in the Aral Sea basin actually still remains only written on paper. Efficient forecasting of run-off of Syrdarya and Amudarya rivers lacks hydro-meteorological information from formation zone, as well an adequate long-term assessment of water resources considering Climate Change. Exchange of regional data and historical observation series between the neighboring countries faces some difficulties.

It is necessary to establish regional climatic database, including long-term (not less than 30 years) homogeneous series of observation of different parameters (meteorological, hydrological, and glaciological) for the whole basin of the Aral Sea. The objective for establishment of such database is revealing of climatic changes, profound assessments of impacts for both, the whole region, and for separate states, provinces, geographic districts, river basins.

Table 10.3 describes the capacity building needs in the field of developing of systematic climate observations.

«Non-climatic Data" (socio-economic data, data on the state of environment). Shortage and inaccessibility of authentic socio-economic data from diverse sectors made it difficult to make an assessment on vulnerability to Climate Change and analysis of adaptation measures (Table 10.4).

In process of vulnerability assessment, difficulties were faced relating to the socio-economic data in the following sectors/spheres: development of socio-economic scenarios, water resources in the zone of run-off distribution, agriculture, eco-systems, population health, dangerous and extreme phenomena related to the climate.

Table 10.3 Capacity building needs for the system of climate observation

Meteorological and Hydrological Observations
Improving of interaction on regional level Making Development Plans for Observation networks Improving of network providing with gauges and equipment Technical modernization of observation production, initial data processing and communications Installation of automated stations in remote areas Organization of supplementary hydrological posts on trans-border rivers Resumption of water-balance stations operation Improving of operation of specialized meteorological stations (agro-meteorological, actinometric etc.) Improving of data processing, archiving and storing Organization of operation directed to data saving and recovery (re-analysis on national level) Improving of current data base and making modern open-source data bases
Aerologic Observations
Recovery of aerologic observations Funding of station networks (equipment and consumables) Technical modernization and provision of long-term functioning of stations Carrying out of calibration of observations for distance flexing data application (in future perspective)

Table 10.4 Basic capacity building needs for organization of collecting of socio-economic data

Requirements	Obstacles	Ways of Solving/Capacity Building
Development / choice of sectoral and integrated indices and criteria of vulnerability	Lack / shortage of sectoral data Lack of experience Probable change of indices and criteria in process of examination and assessment	Examination of international and regional experience Sectoral expert assessments
Development of national mechanism of data collection and submission within the framework of UNFCCC	Lack of regulatory documents and persons, responsible for implementation of UNFCCC in different establishments	Development of regulatory documents, accounting form with participation of international coordinating organizations Appointment of persons, responsible for implementation of UNFCCC in different

Practically in every sector information was deficient, data on economic damage was actually absent. Moreover, vulnerability indices and criteria have not been sufficiently developed, both, sector based and integrated ones, which did not permit to perform a complete analysis and assessment of adaptation measures.

Examination and assessment of "impact-reaction-damage-selection of measures" sequence should be based upon factual data, differentiated by the sectors, territories, and separate natural and anthropogenic objects. In view of this, it is necessary to develop recommendations, schemes and mechanisms of submission of socio-economic data, essential for assessment of Climate Change impact, including information on economic damages from dangerous natural calamities to Uzhydromet, an organization responsible for fulfilling of commitments under the Framework Convention,.

Development and introduction of international standards for statistical reports taking into account assessment requirements will allow to assess vulnerability of Uzbek economic sectors to Climate Change in a more reliable and authentic way and to develop more convincing adaptation measures.

10.4.2. Research

In Uzbekistan, internal sources for research funding are insufficient, and implementation of majority of international projects do not imply long-term support of research activities.

However, research works on issues of Climate Change are essential to solve a lot of tasks:

- analysis of social, ecological, and economic consequences of Climate Change; risks assessment;
- distribution of continuously updated information on issues of Climate Change;
- development and introduction of early warning on hazardous phenomena related to climate (draughts, heat waves etc.);
- development of ecological education programs to involve people in solving of the problems of Climate Change, and development of appropriate social behavior;
- maintaining of specialized training on he appropriate level (ecological, hydro-meteorological, agro-climatic etc.);
- determination of costs and benefits of potential measures, development of adaptation projects, and involvement of additional resources through international cooperation.

10.4.3. Climatic and Socio-Economic Scenarios

Climatic scenarios. Regional climatic system observation data is the basis for making assessment of occurred changes of climate, scale of potential climatic changes in the future, assessment of impact extent and damage sizes. Regional Climate Scenarios were built using MAGICC/SCENGEN system Global Climatic Models (GCM) method of statistic data interpretation. A number of gaps and capacity building needs were discovered as to development of Regional Climate Scenarios (Table 10.6).

Observation outputs are not sufficient to interpret the results of GCM on mountainous territory. Statistic interpretation with data lacking did not allow developing detailed scenarios for run-off formation in mountainous zone, which indicates the need for additional observation data from adjacent countries or use of re-analysis data in the network nodes.

Not all climatic parameters, essential for assessment of impact on productivity of agricultural crops, pastures, human health etc., could be calculated using AGICC/SCENGEN and statistic interpretation, which indicates the necessity of involving direct outputs of modern models with more dense mapping and greater amount of output parameters.

It is necessary to regularly update the analysis of accessible GCM outputs, in order to discover which models describe the Central-Asian region's climate in the most adequate way. Developing of GCM output statistic interpretation (downscaling) with review of greater amount of parameters required for assessment of Climate Change impact by sectors and quantitative analysis of essential sectoral indices and criteria is necessary.

In compliance with the requirements of sectors assessment, different periods of time and spatial scaling should be reviewed, as well as, in addition to the emissions scenarios according to the main Climate Scenarios (A1, B1 etc.), the scenarios considering emission mitigation and stabilization measures should be reviewed to determine the level of GHG concentration, dangerous for the region.

Capacity for using Regional Climatic Model (the appropriate software, high-speed Internet, expert training) needs to be developed.

It is necessary to expand spatial coverage for building regional scenarios, for instance, when assessing water resources, the scenarios for the entire Aral Sea basin need to be developed.

Examination of the current climatic variability and vulnerability to climatic fluctuations is an important stage for making assessment and choice of adaptation

measures. Therefore, research activities using climatic indices – extremity, variability, agro-climatic indices of comfort etc. are to be developed and strengthened as they would be indicative for sectors assessments. Development of the appropriate integrated indices – climatic vulnerability index in conditions of Uzbekistan – is a separate objective. It is necessary also to expand the work on visualization and distribution of the received climatic materials in a form of charts, monitoring bulletins *etc.*

Table 10.5 Basic capacity building needs as to climate scenarios creation

Requirements	Obstacles	Ways of Solving / Capacity Building
Development of the regional scenarios of higher resolving capacity not only for the territory of Uzbekistan, but also for discharge forming mountainous zone	Insufficient territory interpretation by observation data Insufficient technical capacity Lack of skilled experts	Collection/exchange by historical series of observations, involvement of re-analysis data in the network nodes Analysis of the available outputs (IPCC DDC) renewed GCM aimed to choice of more adequate models for the Central-Asian region Development/use of GCM statistic interpretation methods
Development/choice of specialized or composite indices in compliance with the requirements of different sectors and inter-sectoral assessment	Lack of data. Methods and experience for developing of indices and criteria, especially, composite ones	Profound analysis of vulnerability and adaptation in the country, study of international experience, development of own indices considering data deficiency Improving of accessibility and collection of socio-economic data Attending training workshops
Building of scenarios of specialized or composite indices in compliance with the requirements of different sectors and inter-sectoral integral assessment	Lack of criteria and indices for separate sectors	Assessment of essential sectoral indices using a digital method on the base of climatic scenarios data Improving of accessibility and collection of socio-economic data
Plotting/mapping of the built scenarios by the territory of Uzbekistan	Insufficient information base for detailing indices by the regions of the Republic Insufficient methodological base for territorial extrapolation	Application of GIS technologies, study of international methods and experience Development of research activity inside the country
Assessment of the current climatic variability, replication of extreme values	Lack of accessibility to electronic base of meteorological data of daily or urgent solving capacity by Uzbekistan and adjacent territories	Analysis and control of available daily data, development of data base of daily solving capacity, regular replenishment Development of research activity and assessments using climate extremity indices
Development of capacity for using a regional climatic model	Lack of technical capacity Lack of experts, both for climate modeling and for using modeling outputs	Technical support Experts training

Table 10.6 Capacity building needs as to socio-economic scenarios development

Requirements	Obstacles	Ways of Solving / Capacity Building
Making of scenarios of socio-economic development for countries with transient economy	Lack of methods and experience Absence of authentic data and economically substantiated plans of long-term socio-economic development	Making of socio-economic models of future development Study and use of international experience Attending training workshops
Development/choice of specialized or composite indices in compliance with the requirements of different sectors and inter-sectoral assessment	Lack of data, methods and experience for developing indices and criteria, especially composite ones	Profound analysis of vulnerability and adaptation in the country, study of international experience, development of own indices considering data deficiency Improving of accessibility and collection of socio-economic data Joint research activity of climatologists and experts from different sectors Attending training workshops
Assessment of expenses and benefits related to adaptation measures	Lack of approved sectoral development plans Lack of methods and experience	Study of use of international experience Attending training workshops Joint research activity of experts from different sectors in the filed of Climate Change

Socio-Economic Scenarios are essential to carry out research of future options on qualitative or, if possible, on quantitative basis to access possible consequences of Climate Change. Methodological basis in building the scenarios for Uzbekistan was represented by NCSP Manual (Developing Socio-economic Scenarios for use in Vulnerability and Adaptation Assessment, 2004) and experts' assessments. Assumptions, expressed in the scenarios, were used for vulnerability assessment of two interrelated sectors: water resources and agriculture with application of WEAP model.

Composite vulnerability indices, recommended by Adaptation Policy Frameworks for Climate Change were not developed due to data, methods, and lack of internal experience.

The needs for strengthening of methodological capacity in socio-economic assessment in Uzbekistan are rather significant (Table 10.5-10.6), and this is related not only to building of development scenarios, but to assessment of Climate Change impact, for instance, damages from extreme calamities, for assessment of costs and benefits of alternative adaptation measures.

Choice and assessment of appropriate indicators is a separate problem, as the economy of Uzbekistan is in transition, intense re-construction and forming of market structures are taking place nowadays. Owing to this, it was impossible to calculate generally accepted indicators expressed in comparable units, for instance, GDP, according to PPP. Due to this some indices, represented in Table 1.1 and 1.2, are not indicative because of high level of inflation during 1990-2000.

10.4.4. Water Resources

Runoff Formation Zone. Assessment of accessible water resources both at present and for perspective future, requires using of a regional approach, as about 8% of water resources are formed on the territory of Uzbekistan, the main zone of forming is the territory of adjacent states. To assess accessible water resources huge volume of information is needed from the territories of the neighboring countries – meteorological, hydrological and glaciological data. It is necessary to develop regional cooperation to improve interpretation of observation data concerning the territory (historical series, recovery of series, use of digital models of relief), which would permit to use model assessment methods on more profound basis for each basin. Historical run-off regulation distorts natural regime, preventing use of hydrological models in separate basins, demanding model adaptation to each basin. Assessment uncertainty reduction is possible with greater spatial differentiation, but demands raised to the data will have to be higher. The first priority regional problem is monitoring of snowy-glacial resources of a run-off formation zone. More complete consideration of modern snowy-glacial resources and their trends in the basin of each river would permit to reflect the volume and annual run-off structure on a more adequate basis.

Full-scale assessment of glaciation was carried out in 1980, subsequent assessments were of fragmentary character. Due to climate warming it is necessary to repeat glacier inventory on a new quality level. There is little up to date information available. In 2000 only separate glaciers, located on the territory of Uzbekistan, were estimated using satellite information, and high levels of degradation rates and decrease of mountainous glaciation were observed, but trend values are variable all over the territory.

Assessment of modern glaciation of all he mountainous zone of run-off formation is an essential and very complicated task, demanding involvement of appropriate experts, high resolution satellite data, GIS application.

Zone of Run-off Dissipation. CROPWAT and ISAREG models were used for assessment of water use in the run-off dispersion zone. Completed calculations of irrigation rates for different districts indicated great differences in estimations for each crop, soil peculiarities, and ground water level. This indicates that to decrease uncertainty of the future water demand it is necessary to expand research activity using irrigation models and more differentiated climatic and socio-economic scenarios.

Development of research activity using models of WEAP type is essential. The assessment using WEAP, carried in the Republic, indicated a great uncertainty and shortage of input data. From the methodological point of view, use of dividing of the regions of the country as elements of division instead of separate river basins led to complication of the assessment. Another obstacle was represented by registration of the ramified irrigation network and trans-border character of rivers, as well as, shortage of the required input data by sectors of water use, differentiated by the territory. Gaps and requirements of capacity building for improving the vulnerability assessment and analysis of adaptation measures in water resource sector are represented in Tables 10.7 and 10.8.

Table 10.7 Gaps and needs for improving the assessment of water resources in run-off formation zone

Requirements	Obstacles	Ways of Solving / Capacity Building
Assessment of modern and future state of available water resources	Insufficient monitoring of water resources, especially, in the runoff formation zone	Development of a basin approach in solving river water resource assessment problem Development of regional monitoring over the state of water resources
Increase of models reliability and decrease of river water resource assessment uncertainty	Lack of data of hydrometeoro-logical monitoring restrains development of methodological assessment base and forecasting of water resource state	Development of hydro-meteorological monitoring of the run-off forming zone Improving of data exchange between the states located within the Aral Sea basin Development of the regional hydro-meteorological data base and its replenishment on a regular basis
Development of a regional approach to assessment of water resource change and run-off-forming factors (snow reserves and glaciers) Composite assessment of mountain snowreserves on the basis of diverse kinds of observations (ground and distance ones)	Absence of complete inventory of the modern state of glaciation in the Aral Sea basin Lack or absence of ground and distance observations over the state of snow cover in the mountains	Complete inventory of the state of glaciation in the Aral Sea basin using satellite information of high solving capacity Development of the regional mathematical models of snow cover forming in the mountains and assessment of a glacial discharge Development of the regional modeling of run-off transformation, understanding of the current data and climatic scenarios
Assessment of frequency change regarding draughts and floods	Absence of composite draught monitoring Increase of run-off variability in all the basins for the recent decades	Development of run-off and hazardous phenomena (draught, freshet etc.) variability assessment methods

Table 10.8 Gaps and needs for improving the assessment of water resources in the zone of intense run-off use

Requirements	Obstacles	Ways of Solving / Capacity Building
Assessment of potential water loss increase in the irrigation and reservoir-drainage networking regarding to Climate Change (evaporating capacity, filtration, network state)	Lack of water-balance observations on irrigation massifs Lack of information concerning the state of the irrigation and reservoir-drainage networking and methods of loss control	Organization of systematic water-balance observations Development of methodological base for loss assessment, including modeling Study of potential ways of loss decrease
Assessment of potential increase of water consumption in the fields at the expense of climatic conditions change (water consumption of diverse crops, losses, change of reclamation state of lands)	Lack of detailed observation data concerning the state of drained massifs in the zone with different water supply level and for diverse crops Lack of field observations	Organization of field observations and research activity Continuation of research works on calibration of irrigation models, verification of crop coefficients for diverse types of soils, levels of ground waters Development of experimental base (pilot plots) and methodological approaches for assessment of irrigation dosage change
Assessment of requirements for water and decrease of available water supply in irrigatory agriculture under the conditions of Climate Change	Lack of a composite assessment on all the levels of water consumption in the irrigated zones Lack of socio-economic scenarios and data Absence of long-term plans of agrarian sector development	Organization of water consumption registration in the farms Improving of trans-border monitoring of water resources Development of socio-economic scenarios and long-term plans of agrarian sector development Development of research using models of a WEAP type, both within the Republic in separate local basins and in large river basins
Assessment of hydro-ecological consequences (water quality, level of ground waters, state of drinking water supply sources)	Insufficient methodological base for making assessment Lack of observation data Poor expert capacity	Development of approaches to assessment of hydro-ecological consequences of Climate Change Development of monitoring over water sources state Attending training programs, courses and workshops by experts
In-service training of experts in the filed of hydrological modeling for model adaptation to the regional conditions and use of satellite information	Lack or restricted opportunity of attending training courses , workshops Insufficient access to Internet	Involving funds for experts training Attending training programs, courses and workshops by experts
Assessment of efficiency of measures of rational water use in the irrigated agriculture Development of optimum irrigation technique schemes by zones of diverse water supply, correctness of irrigation dosage and standards	Insufficient methodological base for assessment Obsolete information base for improving hydro-module dividing and irrigation standards considering modern and perspective crop varieties	Development of monitoring over the state of water consumption Development of experimental base (pilot plots) and methodological approaches (well-known before, used and new ones on the regional basis) for assessment of potential change of irrigation standards Probing and improving of measures on the pilot plots

10.4.5. Agricultural production

Assessment of productivity of main agricultural crops was performed through expected deficiency of irrigation water using CROPWAT and ISAREG models. To assess losses of yields owing to irrigation deficiency the information on current irrigation system was used, though perspective water-saving technologies were not considered.

For more authentic vulnerability assessment of agriculture, for instance, supplementary irrigation requirements and yield losses, the data on new varieties of agricultural crops are essential, as well as, their characteristics as to draught- and salt-resistance, more differentiated registration of reclamation state of lands. Till present the plan for improving the reclamation state of land has not been developed, though implementation of the Decree *"On Measures Directed to Radical Improving of the System of Reclamation Land Improvement"* dated October 29, 2007, has been commenced, where development of similar plans has been stipulated.

It essential to indicate the disadvantage of authentic statistic information in the regions of the Republic as relates to crop areas and yield capacity of various agricultural crops based on their varieties. Data on water consumption, use of fertilizers, reclamation state of the irrigated land and natural pastures on the level of separate districts and farms are absent

At present the assessment of Climate Change impact has not been performed on due level, as some hindrances occurred in using models of APSIM, DSSAT types and others due to lack of data and skilled experts with good experience of using such models. Absence of modern agro-climatic division by districts and information on new crop varieties did not permit to develop recommendations on optimization of crops allocation.

For more complete assessment of vulnerability of pasture crops the information of productivity of valuable varieties is essential (satellite data gives assessment of total green mass, which includes non-edible vegetation). Search for new solutions for assessment of pasture vegetation productivity is essential.

Owing to lack of sufficient authentic statistic information on number of cattle and grazing pressure, livestock farming sector vulnerability has not been assessed to the full. Assessment of vulnerability to Climate Change was carried out only for astrakhan sheep (assessment of thermal stress change with change of climate). It is necessary to develop assessment of Climate Change impact to other types of stock-breeding (cattle, poultry, hog-breeding). It is necessary to carry out analysis of Climate Change impact to development of fruit-and-vegetable and grape complex, to study benefits and risks of Climate Change based on separate directions in a more detailed way: cotton-growing, vegetable-growing, grain-growing, vine-growing, production of fruits, stock-breeding. It is necessary to continue monitoring research works on impact of Climate Change to agriculture, aimed to timely revealing and reduction of adverse effects.

In conditions of Climate Change it is necessary to develop agro-climatic expert-consulting system, which would permit to use up to date scientific and practical information in the field of agronomy both, in large and small farms, which would result into increase of agricultural crops productivity.

Study of mechanism of state insurance (one of the main adaptation measures against Climate Change) showed that absence of regional criteria for extreme weather events differentiated for different economic sectors, created significant hindrances in insurance practice. For more complete assessment of agricultural vulnerability from dangerous hydro-meteorological events it is necessary to have authentic information on damages from climatic events.

Development of optimal insurance mechanism in agriculture, transparent and effective, demands more profound study of the available international practice in the field of agricultural insurance.

Implementation of the majority of selected adaptation measures demands additional funding and new technical solutions, that is why they must be examined, and their efficiency and cost are to be assessed.

Analysis of Climate Change impact to economic efficiency of agriculture is a separate large issue, as well as, economic assessment of adaptation in the sector.

The main directions of research and activity in agricultural sector in the context of Climate Change include the following ones:

- improving of monitoring over natural resources using modern tools and methods;
- development of programs of reclamation improvement and increase of land fertility with detailed description of each territory;
- improving of management and control of irrigation water in farms aimed to increase water use efficiency;
- improving and development of system of agro-meteorological service (information and forecasts);
- development of programs of field-protective wood-growing aimed at satisfaction of rural citizens' needs in timber, decrease of evaporation from the fields and increase of GHG emissions.

Table 10.9 The main needs for capacity building in agricultural production

Requirements	Obstacles	Ways of Solving / Capacity Building
Assessment of main crop productivity change affected by Climate Change, including the following: all types of degradation of irrigated lands; decrease of water supply; threats of distribution of deceases and pests	Methodological and information base for usage modern models is practically absent Insufficient expert capacity Restricted opportunity of participation in training courses	Specification of forms of statistic accountability in agricultural sector (for getting information by districts and crops). Carrying of field research works, installation of modern gauges and new methods of research Development of specialized data bases considering data on new varieties of agricultural crops (draught- and salt-resistant). In-service training of experts in the field of agro-climatic modeling aimed to using probed crop models and approaches to yield assessment. Organization of full-bodies monitoring over reclamation state of lands, agricultural crops, including using space information. Coordination of research works by issues of water and agricultural economy between the establishments
Assessment of pasture vegetation productivity change affected by Climate Changes, increase of anthropogenic loading and decrease of water supply	Insufficient methodological information base for assessment using distance methods Restricted access to satellite information of high solving capacity and to Internet	
Development of Climate Change impact to such kinds of stock-breeding, like, cattle, birds, pig-breeding	Lack of authentic statistic information on cattle number and loading of pastures Insufficient methodological base for assessment Insufficient expert capacity	Specification of forms of statistic accountability in agricultural sector (for getting information by types of stock-breeding) Attending of training programs, courses and workshops by experts
Development of recommendations on optimization of crop allotment on the territory considering Climate Change and variety composition	Insufficient methodological and information base (absence of information on new varieties, uncertainty of climatic scenarios, obsolete hydro-module dividing into districts) Insufficient expert capacity	Development of monitoring over the state of crops and reclamation state of lands Development of methodological and experimental base (pilot fields) and methodological approaches Use of GIS technologies Development of interrelation: science - production
Improving of agro-meteorological servicing Improvement and expansion of insurance system	Restriction of access to agro-meteorological information for farmers (lack of communication devices and gauges) Lack of differentiated criteria of dangerous events Poor capacity of associations involving land and water users	Improving of methods of agro-meteorological forecasts and system of operational forecast and information Establishment of agro-climatic expert-consulting system for farms Development of communication systems and information distribution

10.4.6. Population Health

The main outputs, received concerning Health Sector, include the following: assessment of change of period for malaria transmission, assessment of diarrhea incidents increase on the example of Tashkent city and increase of maximum heat loads in provinces in compliance with climatic scenarios. Heatl wave continuity indices trends, extremely high temperatures have been examined, comparison to the mortality index from cerebro-vascular deceases was carried out, and mortality increase in years of greater continuity of heat waves was revealed.

However, assessment of Climate Change impact to population's health encountered great obstacles. Mainly, this is related to lack of experience and problems with data. Multiple essential data for making assessments of impacts in the population health sector are inaccessible or absent. For instance, mortality data from different deceases, access to differentiated data by separate cities districts, daily mortality, hospitalization data, appeals to polyclinics, calls of medical aid. Supervision data over infection deceases, population of decease carriers, their temporary or geographic distribution bear fragmentary character or inaccessible. Forms of statistic accountability in healthcare sector does not comply with the population health vulnerability assessment requirements owing to Climate Change, which indicated to necessity of development of new, maybe international forms of accountability. Here one can see an urgent need for assistance on the part of the World Health Organization (WHO) and Nairobi Work Programme (NWP) for adaptation support.

Within the framework of development of Second National Communication such important aspect like water quality impact to health was not sufficiently examined owing to lack of specific data and time. Mathematical models were not used owing to lack of data and experts, capable of using modern methods and tools. Poor interaction took place between the

establishments inside the country. In the future experts' efforts – medical workers and climatologists – should be united on organizational basis. Continuation of the process of the National Communications and encouragement of complex research activity within "Climate and Health" Project would help.

Requirements of capacity building for healthcare sector aimed to strengthening of vulnerability and adaptation assessment skills are as follows:

- Further study and revealing of diseases that are the most sensitive to the climate;
- Study of interaction between the environmental conditions and health;
- Establishment of health indices database and appropriate meteorological parameters;
- Development of population health vulnerability complex indices and criteria for initiation of medical warnings on upcoming heat;
- Analysis of morbidity on the territory aimed to revealing of the most vulnerable districts;
- Analysis of socio-economic conditions and population structure for revealing vulnerable groups;
- Study of international experience on using of modern methods and tools for vulnerability assessment and evaluation of consequences;
- Territory mapping based on indices of vulnerability and consequences;
- Analysis of adaptation measures efficiency in healthcare sector regarding separate country territories aimed to development of programs and action plans for the most vulnerable districts.

10.4.7. Biodiversity and Ecosystems

Biological diversity in Uzbekistan is subjected to definite threat, specific realms are decreased and changed in the result of high anthropogenic loading including desertification and Climate Change, and ecological systems are degrading.

Ecosystem vulnerability increases when anthropogenic factors are coupled with the impact of unfavorable climatic changes. Therefore, any environment-oriented measures, directed to sustainable management and use of resources of natural eco-systems will promote preserving of their biospheric and socially beneficial functions, i.e., adaptation to Climate Change, and at the same time, increase the potential for UNFCCC implementation in Uzbekistan. Such measures are related to filling the gaps, occurred in "Biological diversity and eco-systems" sector and capacity building, namely:

- Implementation of the National Strategy of saving of biodiversity;
- Improving of environment-oriented legislation aimed to development of ecological network and increase of legislative protection of wild natural eco-systems, which are still preserved over the borders of the protected territories;
- Inventory and monitoring development of heterogeneous natural ecosystems (ground, water) both on the protected territories and in problematic zones (South Aral region, Ustyurt, Kyzylkum and Karakum deserts, in Tyan-Shan foothills and Pamir-Alay);
- Increase of ecological awareness among management structures and population;
- Carrying out of organization and technical measures for maintaining functioning of water and ground eco-systems and for security of biological cycles in them. .

Though Climate Change is an additional pressure and threatening factor for vulnerable ecosystems and is a factor of biodiversity degradation, this issue has not been yet examined completely in the Republic. The latter assumes necessity of strengthening, and in many cases, capacity building both for carrying research works in the field of vulnerability and adaptation assessment in the following directions:

- identification and research of eco-systems, sensitive to Climate Change;
- assessment and research of maintaining mechanisms for ecological services and eco-system vulnerability, sensitive to climatic changes and fluctuations;
- monitoring and research of climate impact to populations of selected species with focus on revealing of Climate Change indicators;
- research and monitoring, aimed at saving of threatened species and their habitat area, as vulnerable components of ecosystems in conditions of changing climate.

The main obstacle on the way of solving the above-described objectives are as follows: practical absence of methodological and informational base for making assessments; insufficient expert capacity; restricted opportunities for participation in the international workshops and training courses, poor inter-departmental interaction inside the country, low level of funding for monitoring related research work in the sector.

10.4.8. Extreme and Hazardous Hydrometeorological Phenomena

Droughts. The assessment of vulnerability and analysis of adaptation measures to such increasingly frequent phenomenon in Uzbekistan as drought have demonstrated that the major gap in this area is lack of information on its impact on socio-economic aspect due to the fact that no large-scale and catastrophic drought have been observed in Uzbekistan. Periodical seasonal drought has been mitigated through regional water resources management in the interest of irrigation in the lower reaches of the rivers. However, increasing range of fluctuation of precipitation during the last decades, intensive warming, increased water consumption and change in the functioning regime of water reservoirs in the riverheads of the Syrdarya and Amudarya Rivers (the priority was given to the Energy Sector), have significantly increased the drought risk, especially in the lower reaches of the Amudarya River Basin. The drought of 2000-2001 became an evident example of the phenomenon.

The main conclusion made as a result of vulnerability assessment is that the phenomena such as drought of 2000-2001 will occur more frequently with prolonged duration. In this regards, the following questions come up: what is the size of the territory that the phenomenon could affect; what would the consequences be; what measures are required for mitigation of consequences? In order to answer these questions, it is required to expand the hydrometeorological monitoring, conduct research in relevant fields and develop organizational measures. The major needs in the capacity building of research that are directly related to impact assessment and adaptation measures include:

- improving hydrometeorological monitoring;
- improving droughts forecast methods;
- conducting socio-economic consequences assessment with differentiated territory information;
- developing programs and plans of action aimed at drought prevention and risk reduction for agricultural sector (ensuring preparedness for extraordinary situations liquidation, mechanisms of information dissemination on drought warning in the provinces, population and administrative organs preparedness); and
- developing the drought early warning system;
- insuring the drought consequences.

There is a need for institutional strengthening – establishment and functioning of the drought monitoring centre; and political measures – identifying the joint transboundary concept of water use in the conditions of the expected drought on the regional level and improving water resources monitoring.

Floods and mudflows. According to conducted assessment, due to the Climate Change, it is expected that the number of floods and mudflows will increase while the duration of hazardous periods will extend. The bottom lands of the river and low river terraces are especially dangerous due to the possibility of shores destruction, rivers beds deformation, mudflow mass deposit and occurring of gorge phenomenon.

Outburst risky lakes. Currently, 271 lakes of various origins threaten the territory of Uzbekistan. The largest out of them is the Sarez Lake. Due to warming, the torrent hazard of the lake outburst in the upper mountainous zones increase.

Avalanches. On the average, according to conducted assessments, the avalanche periodicity in Uzbekistan and avalanche risk period duration due to the Climate Change will have the minor decrease by 2050, which means that the avalanche risk remains.

Risks depend on probability of the hazardous phenomena, their demonstration extent, territories where they are observed, available sites and population size in each hazardous region. When development the mountainous areas the natural risks associated with the mudflows and avalanches increase. Assessment of the location of periodicity and volumes of consequences of the hazardous and extreme phenomena is one of the priority objectives due to the Climate Change.

Since it is not possible to completely avoid the natural risks associated with the floods, mudflows and snow-slides, the needs of capacity building for assessment the vulnerability and adaptation are linked with prevention (non-admission), impact mitigation (protection) and damage division (insurance). The needs of the risk assessment for the floods, mudflows and snow-slides include identification of the hazardous areas, probability of events and duration of the hazardous period. The types of activities requiring the gap filling and capacity building are listed below:

- Analysis of the current variability of extreme hydrometeorological phenomena (probability of occurrence, duration of hazardous period by the territory) and their after-effects for vulnerability assessment.
- Future risk assessment in line with the Climate Scenarios and application of the advanced methods and tools.
- Development of the large-scale maps of the current and future risk for individual phenomena in line with the needs of the sectors (construction, transportation, recreation area, etc.) for identification the high risk areas.

- Assessment of potential of the hazardous phenomena risk reduction via improvement of forecasting and warning.

The goal of vulnerability assessment deepening and adaptation in the sector is to identify potential probability for the risk reduction and elimination; identification of priority activities, implementation of identified measures and mitigation of the natural disaster consequences.

Insurance role. Properly arranged insurance system enables safe damage reimbursement from the hazardous weather phenomena (frosts, heavy precipitation, hail, wind, hot winds, high temperatures, etc.). During the recent years insurance system in Uzbekistan is rapidly developing, however the needs of capacity building still exist.

In case of the growth of periodicity and extremeness of the weather phenomena cooperation of the NHMS of Uzbekistan with the insurance companies of the Republic has to be enhanced. When the insurance cases occur the qualified expertise of the hazardous natural phenomenon occurrence has to be carried out along with the opinion on achievement by the hazardous natural phenomenon of unfavourable or hazardous values for the certain type of activity. However, these criteria have not been properly studied.

The key need is to develop criteria of the hazardous phenomena for the various economic branches based upon the actual information and considering peculiarities of geographic regions. In this context, the guidelines, schemes and mechanisms of providing the NGMS of Uzbekistan with information on economic damages from the hazardous hydrometeorological phenomena need to be developed.

Key restrictions and gaps of the insurance system development are as follows:

- low demand on insurance services among the population due to the lack of insurance market transparency;
- poor infrastructure of insurance market, lack of high efficient agency networks, insufficient level of priority insurance types development;
- lack of legislative base on obligatory insurance types meeting the international practice;
- inadequate professional competence of insurance companies employees.

The Program of insurance market reform and development was adopted in Uzbekistan for the period 2007-2010 in order to overcome existing shortcomings in insurance service system; it meets the requirements of UNFCCC implementation in the Republic.

10.4.9 Economic sectors

Climate Change impact assessment on the various economic sectors was made through the change of rated climatic parameters included in the relevant normative documents.

Lack of methodological guidelines both for the estimates of specialized climatic parameters and for the record of climatic factors in economic sectors became the serious complicating factor for this activity.

The lack of required statistical data on the sectors was the next serious problem. Only indirect estimates of the climate impact on construction and design, oil and gas sector, transportation and light industry were received in the frame of development the Second National Communication.

The following is required for objective assessment of the Climate Change impact on economic sectors: monthly release data on the power consumption, natural actual loss of oil products, additional costs for the fuel and lubricants in winter and summer as well as information on damages from the hazardous weather phenomena.

Development of methodologies of the climatic factors record in various economic sectors along with methodological guides for the estimate of specialized climatic parameters for the normative documentation is required with consideration of international practice.

Economic estimate of the Climate Change impact on economic sectors is an important long-term objective.

10.4.10. Overall Needs for Capacity Building in the Area of Vulnerability and Adaptation Assessment

Various scientific institutions of Uzbekistan have increased interest in the Climate Change and variability problem. Certain research projects are being implemented with support from international organizations, however, they are isolated, and exchange of research findings is insufficient and complicated. There is no task-oriented research program on the Climate Change problem.

The estimates and research mainly relate to analysis of the Climate Change impact. Vulnerability assessment and damage analysis as well as study of

adaptation alternatives with model application have not been developed yet. Therefore, given domestic resource deficiency, the following is necessary:

- development of scientific research program focused on the Climate Change;
- establishment of research networks facilitating interdisciplinary research and information dissemination;
- improvement of coordination among the various sectors and implemented initiatives on Climate Change to facilitate the synergies, their integration in policy and sector-specific programs promoting adaptation.

There is also a need for coordination of research associated with the Climate Change with the needs of decision makers in various sectors as well as necessity of population informing on the future risks, potential ways and certain measures reducing vulnerability, and further introduction of adaptation measures.

We are suggesting the list of the measures which will enable improving the national capacity in the field of vulnerability assessment and adaptation. Substantial assistance can be provided by international agencies (UNFCCC, NWP, NCSP, etc.) through:

- thematic training – application of crop and irrigation patterns, best practices for the models of the WEAP type, models for the impact assessment on ecosystems, integral assessment methodologies, etc.;
- training has to be arranged for the groups of the countries with similar problems and with involvement of several specialists to ensure establishment of expert groups in the countries.

Expansion and deepening of activity will enable improving the knowledge base on the problem and enhance adaptation potential via:

- consideration of the Climate Change in economic sectors through the regular updating of the normative climatic information;
- development of the sector-oriented development programs with consideration of the vulnerability assessment outputs;
- integration of research on the Climate Change in the projects on desertification control and biodiversity conservation;
- study of inter-sectoral relations and integral effects for development of integrated strategies on adaptation actions;
- deepened analysis of adaptation measures and technologies for identification of efficient and acceptable ones under specific conditions of Uzbekistan;
- involvement of funding mechanisms of the market economy for introduction and support of adaptation measures.

10.5. Technology Development and Transfer

A range of barriers and gaps impede wide usage and transfer of technologies aimed to emission reduction:

- Significant amount of initial capital costs for technologies introduction;
- Deficiency of funds for technologies import and underdevelopment of domestic market for power-saving and RES technologies;
- Deficiency of local vendors of up-to-date equipment and appropriate services;
- Existing regulatory and legislative base is incomplete for development of clean technologies market;
- Poor awareness of potential customers about energy and resource saving technologies;
- Current state policy oriented mainly towards conventional types of power based on hydrocarbon raw materials.

The main obstacle for development and proliferation of current mitigation technologies complying with social and economic conditions of Uzbekistan is a lack of regular scientific research and studies on mitigation of Climate Change, development of scientific, technical and human potential in this area.

Strengthening of potential for study of technical, social and economic aspects of Climate Change mitigation is a critical need in Uzbekistan. Special training seminars shall be conducted on methods for use and production capabilities for ecologically safe technologies at a local level.

Potential subjects for training are as follows:

- Methodology for use of new technical products such as carbon capture and storage.
- Methods for costs and profit assessment of mitigation measures in construction, power generation, agriculture and industry.
- Implementation of low-carbon technologies applied in urban planning, transport and power generation.

Exchange of experience on implementation of mitigation measures, relevant costs and positive effects in associated areas, efficient ways for mitigation measures integration into sustainable development within training workshops framework will facilitate capacity building in the area of technologies transfer and strategy for emission reduction.

Requirements for surmounting the barriers in technology transfer capacity building are provided in the Table 10.10.

Table 10.10 Obstacles to capacity building relative to transfer of environmentally safe technologies (EST) and potential ways to overcome those

Constraints and Gaps	Description	Needs
Institutional	Lack of the state support for promotion of ecologically safe technologies Lack of the national strategy in the field of renewable power industry Lack of authorized agency responsible for RES application and introduction of the cutting-edge energy technologies Disinterest of the local self-governance bodies in funding of investment projects on new technologies development, including RES	Involvement of politicians, governmental officers, self-governance bodies and all concerned parties in activity on development and transfer of the new EST for improvement the energy efficiency and energy saving Inclusion of the aspects on technologies development and transfer in the national development plans and sustainable development strategy
Market	Lack of actual potential for the private sector development in the power industry field, including the small-scale power industry Domination of the interests of the large energy producers and consumers and significant cross-subsidy among the groups of the energy consumers State subsidizing of the fuel and power sector does not encourage technologies development and transfer Lack of practice of technologies introduction and transfer	Creation of the friendly environment for the competitive development of the private sector in the power industry field Increase of RES share in the energy consumption structure State support of the small business and private entrepreneurship in the energy saving field Pilot projects
Financial	Lack of domestic and foreign investment capital Lack of domestic and foreign long-terms loans under the reasonable terms Lack of experience of the financial institutions in investments in renewable power industry High cost of the production hardware and ecologically safe technologies Lack of the state funding of RES application projects given their high cost, high risk and long-lasting implementation	Active involvement of domestic and foreign investments for the cutting-edge technologies purchase Creation of financial incentives for commercial banks and conditions for the risk reduction on the long-term credit accommodation Development of domestic technological market State support on establishment the special energy saving funds for RES projects funding
Legislative	Lack of normative documents on renewable power industry and development of domestic energy saving technologies The standards on GHG emissions and their control liabilities have not been anticipated Incentives and privileges for implementation of measures on GHG emission reduction have not been anticipated Inefficient penal sanctions and payments for the harmful substances emissions by enterprises	Development of the normative and legal mechanisms encouraging inflow of new technologies in the domestic market Introduction of privileges for GHG emission reduction and expansion of the low emission technologies application
Capacity building	Lack of competent personnel on the safe technologies introduction Poor development of the modern scientific and technical research base for development of domestic EST Limited access to information on new technologies Poor awareness of the politicians, heads of the ministries, commercial world and society on technologies of the Climate Change impact mitigation, unconventional RES, etc.	Regular training of personnel in the RES application aspects Development of research on domestic technologies elaboration, active involvement of industrial enterprises and private sector in applied research Raising of awareness of responsible officers on mitigation issues

10.6. Education and Public Awareness

Uzbekistan has rather developed infrastructure coordinating activity on fulfillment the liabilities under Article 6 of Convention and New Delhi Work Program on education, personnel training and public awareness on the Climate Change issues.

During the recent years activity on raising perception and awareness on the Climate Change problems at all public levels has significantly intensified in Uzbekistan. It is promoted by implementation of various international projects and programs. Conferences and seminars for the society are regularly arranged, scientific and training publications are published and widely disseminated as well as the paper articles; TV and radio programs are issued and ecological actions and campaigns as well as training activities are carried out.

The lack of financial and human resources remains the key obstacle for the long-term systematic implementation of this activity, which, as a sequence, leads to the gaps and difficulties for implementation of the large-scale educational and Promotion campaigns with high public coverage and large number of publications. In its turn, this causes the number of barriers in capacity building and affects the general level of understanding and awareness on the Climate Change problems in the country.

Certain gaps and needs in capacity building for development the activities on the public awareness on the Climate Change issues are provided in the Table 10.11.

Priority needs in the field of public awareness which are supposed to facilitate improvement of the further National Communications for the short-term and long-term perspective include the following activities:

- Regular conducting of specialized training on application the new methodologies and approaches for analysis and assessment the various Climate Change aspects.
- Development of the executive summary in the national language for politicians and decision makers on the Climate Change issues in Uzbekistan and associated required political decisions.
- Development of professional training courses on the Climate Change issues for the journalists and media specialists.
- Development of the training programs on mitigation and adaptation to the Climate Change for the various target groups of society and specialists of the key economic sectors.
- Preparation of the topical video movies on the Climate Change issues in Uzbekistan for the wide public.
- Updating of educational curricula of the schools, colleges and higher educational institutions with introduction of the Climate Change aspects.
- Issue of specialized scientific journals, regular special TV and radio programs on the Climate Change topics.

Table 10.11 Public awareness building gaps and needs to overcome them

Gaps and Constraints	Needs
Climate Change issue lacks priority in national policies, economic and educational programs Insufficient interaction among the ministries of education, NGOs and public agencies involved in environment protection Low level of Climate Change comprehension among decision makers and politicians Red tape and poor coordination impede development of adequate policy and measures on Climate Change	Government support in implementing national public awareness building program on Climate Change, including ongoing Climate Change education in the context of national requirements Strengthening of partnership and interaction among national government ministries, agencies and NGOs Promotion of awareness of mitigation and adaptation needs among decision makers, governments of all levels, industry specialists, private sector, teachers, journalists and youth
Climate Change issues are not included into curriculum of schools, colleges and institutions of higher education Special training courses for teachers in Climate Change as well as the respective trainers are not available	Inclusion of Climate Change issues linked with environmental education in curricula of schools, colleges and institutions of higher education Training courses for teachers in Climate Change at all levels of educational system
Inadequate training, lack of popular science and information materials, lack of manuals on Climate Change in Uzbek language	Printing and wide circulation of publications on Climate Change on regular basis Attraction of domestic and foreign investment for publishing Climate Change materials
Underutilization of mass media and lack of Climate Change focus NGOs and the public should be more proactively involved in Climate Change issues and making important decisions Nonsystematic training of specialists in modern methods of adverse Climate Change impact assessment in various sectors	Professional training courses on Climate Change issues for mass media Systematic informing of target population groups through all available means on Climate Change implications, possibilities of mitigation and adaptation (newspapers, TV, radio, electronic mass media, seminars, campaign with active involvement of NGOs) Enhancement of public awareness on availability of training in use of methods and instruments necessary for mitigation measures analysis, assessment of vulnerability and adaptation
Underdeveloped regional cooperation in enlightenment, training and public awareness building among the stakeholders (government and non-government) in Central Asian countries Undeveloped unified regional information network on Climate Change among the counties of Central Asia	Strengthening and expansion of sub-regional, regional and international cooperation Establishment of regional coordination unit for Central Asia engaged in Climate Change issues promotion and awareness building, including creation of regional information system on Climate Change

10.7. Financial and Technical Support for National Communications Development and the Long-term Need for their Improvement

Preparation of National Communications under the United Nations Framework Convention on Climate Change (UNFCCC) in Uzbekistan is fully linked with international cooperation and support within the framework of international programs and projects funded through Global Environment Facility (GEF), United Nations Development Programme (UNDP) and United Nations Environmental Programme (UNEP).

From 1997 to 1999 Uzbekistan has accomplished preparation of the First National Communication of the Republic of Uzbekistan on Climate Change under financial support of GEF and UNDP in amount of USD ***325.5*** thousand.

In 2000-2001 Uzbekistan has implemented the Second Phase of the First National Communication financed by GEF/UNDP (totaled USD ***98*** thousand) which included assessment of technological needs for reduction of GHG emissions in key sectors of the economy.

Preparation of the Second National Communication of the Republic of Uzbekistan (2005-2008) was funded by GEF and UNEP in amount of USD ***420*** thousand and contribution of the Government in amount of USD 88 thousand.

The Republic of Uzbekistan highly appreciates efforts of GEF and other international organizations providing financial assistance for UNFCCC. However Uzbekistan has encountered certain impediments in approval of funding for the Second National Communication which was delayed for one year as a result of long procedures on introduction of new GEF guidelines. Therefore, Uzbekistan is welcoming decisions of UNFCCC Parties Conference with regards to relatively accelerated funding which would allow developing counties to undertake smooth preparation of subsequent National Communications without long breaks.

At the same time, different national circumstances of developing countries pertaining to conditions and rules of subsequent National Communications financing should be considered in allocation of GEF funds. Differentiated approach towards funding should be applied here. Unified approach which was applied for funding of the Second National Communications for developing countries envisaged flat rate for all the countries (USD ***405*** thousand and USD 15 thousand for preparation of project proposal) which is not sufficient for some countries to cover comprehensive studies, assessment and research.

In Uzbekistan priority areas in Climate Change are adaptation and mitigation. However due to the shortage of financial resources the country needs additional international financing and foreign investment for practical implementation of mitigation and adaptation measures.

An active effort of Adaptation Bureau is a well-timed support of developing countries in their adaptation activity. Small Grants Programme of GEF, which was recently launched in Uzbekistan, facilitates access to financial resources for demo and pilot projects, awareness building, involvement of NGOs and private sector in introduction of adaptation and mitigation technologies and measures.

One of key components of sustainable development policy of Uzbekistan is enhancement of available capacity, strengthening of national institutions and skill building. Under UNFCCC creation and development of human capacity was supported through various bilateral and multilateral programs. Needless to mention that capacity building requires regular training process. Therefore it would be necessary to continue practice of technical and financial assistance for participation of national specialists in training seminars and courses at international level. Special training of national experts is needed in the following areas:

- Use of new instruments in GHG inventory;
- Application of Climate Change impact assessment methods and tools on various social and economic sectors, including risk assessment;
- Use of approaches and methods for economic assessment of adaptation, analysis of potential costs and benefits of adaptation;
- Use of modeling for mitigation policy analysis;
- Use of cost-effectiveness methods for assessment of specific measures for GHG emission reduction; and
- Study of approaches and methods of integrated assessment of economic, social and environmental benefits from implementation of mitigation and adaptation measures.

List of Abbreviations, Acronyms, and Terminology

AALS	Aydar-Arnasay Lakes System
ADB	Asian Development Bank
APSIM	Agricultural Production Systems Simulator
ACS	Automated Control System
CIS	Commonwealth of Independent States
CNG	Compressed Natural Gas
CRE	Certified Reduced Emissions
CDM	Clean Development Mechanism
CE	Coefficient of Efficiency
CS	Compressor Station
CGS	Cryogenic Generator Set
CSER	Centre for Social and Economic Research
CROPWAT	Irrigation Model
CIDA	Canadian International Development Agency
CCPs	Combined-Cycle Plants
COPATH	Carbon Pasture Agricultural Total Harvesting
DSSAT	Decision Support System to facilitate of crop responses to management
EM	Environmental Manual for power development
ETO	Energy Technology Optimization
EWS	Earth Weather Satellite
EEKCA	Eastern Europe, Kazakhstan and Central Asia
EumetCast	Satellite Data Distribution System
EUMETSAT	Meteorological Satellite of the European Union
EurAsEc	Eurasian Economic Community
FER	Fuel-Energy Resources
FAO	Food and Agricultural Organization
FA	Farmers Association
GIS	Geographic Information System
Gosarchitectstroy	State Committee on Architecture and Urban Construction
Goskompriroda	State Committee for Nature Protection
GU	Gas compressor Unit
GTS	Global Telecommunication System
GTU	Gas Turbine Unit
GTPS	Gas Turbine Power Station
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GCOS	Global Climate Observation System
GEF	Global Environment Facility
GF	Global Fund
GASMO	Spreadsheet module for project-based mitigation analysis
GCM	General Circulation Model
GSN	Global Surface Network
HWDI	Heat Wave Duration Index
HFCs	Hydro Fluorine Carbohydrates
HPS	Hydro Power Station
ISAREG	The Irrigation Scheduling Simulation Model by the Institute of Agronomy, Technical University of Lisbon
IDB	Islamic development Bank
IWRM	Integrated Water Resources Management
ICT	Information-Communication Technologies
IYG	International Year of Geophysics

IPCC	Intergovernmental Panel on Climate Change
IFAS	International Fund for the Aral Sea Saving
LEAP	Long-range Energy Alternatives Planning System
LULUCF	Land Use and Land Use Change and Forestry
METEOSAT	Meteorological Satellite
MPE	Ministry of Public Education
MES	Ministry of Extraordinary Situations
NASA	National Aeronautics and Space Administration
NCSP	National Communication Support Program
NWP	Nairobi Work Program on Vulnerability and Adaptation
NHMS	National Hydrometeorological Service
NGO	Non-Governmental Organization
OGPP	Oil and Gas Processing Plant
ORP	Oil Refinery Plant
OSCE	Organization for Security and Cooperation in Europe
PPP	Parity of Purchasing Power
PRECIS	Regional Model «Providing Regional Climates for Impacts Studies»
RUz	Republic of Uzbekistan
RES	Renewable Energy Sources
RSRHI-WDC	Russian Scientific-Research Hydrometeorological Institute-World Data Centre
SJSC	State Joint Stock Company
SDPS	State District Power Station
SMVI	State Motor Vehicle Inspectorate
SHP	Small Hydropower Plants
SHW	Solid Household Wastes
SPS	Solar Photovoltaic Systems
SPA	Scientific-Production Association
SHC	State Holding Company
STAIR	Services, Transport, Agricultural, Industry and Residential energy model
TACIS	European Union Technical Assistance for Commonwealth of Independent States
TPH	Thermal Power Heater
TPS	Thermal Power Station
Uzavtotrans	Uzbek Agency for Transportation
Uzbekturizm	Uzbektourism National Company
Uzhydromet	Centre of Hydrometeorological Service under the Cabinet of Ministers of the Republic of Uzbekistan
UNCCD	Unite Nations Convention to Combat Desertification
UNCBD	Unite Nations Convention on Biological Diversity
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNEP	United Nations Environmental Programme
UNESCO	United Nations Organization for Education, Science and Culture
USAID	United States Agency on International Development
WUA	Water Users Association
WEAP	Water Evaluating and Planning System
WWF	World Wild Fund
WB	World Bank
WMO	World Meteorological Organization
WHO	World Health Organization

Measurement Units

°C	Degree Celsius
t.e.f.	Ton of Equivalent Fuel
ha	Hectare
km	Kilometer
km^2	Square Kilometer
km^3	Cubic Kilometer
m^3	Cubic Meter
mm	Millimeter
t.	Tons
t.o.e..	Tons in oil equivalent
t CO_2-eq.	Tons in CO_2-equivalent
kW/h	Kilowatt/hour
MW	Megawatt
kg/ha	Kilogram per Hectare
mg/l	Milligram per Liter

Chemical Symbols

H_2O	Water
CO	Carbon monoxide
CO_2	Carbon dioxide
HFCs	Hydro Fluorine Carbohydrates
N_2O	Nitrous oxide
NOx	Nitrogen oxides
CH_4	Methane

Appendix: GHG Overview Tables

Table 1

Summary of National Inventory of Anthropogenic Emissions and Removals of all GHGs not Controlled by the Montreal Protocol and GHGs Precursor, 1990

GHG Source and Sink Categories	CO_2 Emission (Gg)	CO_2 Removal (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NOx (Gg)	NMVOC (Gg)	SO_2 (Gg)
Total of National Emissions and Removals	113 287	-1 566	2 700	42	1 947	412	409	681
1. Energy	107 009		2 216	1	1 904	410	381	676
A. Fuel Combustion (Sectoral Approach)	107 009		18	1	1 903	410	337	503
1. Energy Industries	55 100		1	0	17	151	4	302
2. Manufacturing Industries and Construction	10 168		1	0	6	29	1	28
3. Transport	16 491		2	0	1568	158	272	35
4. Other Sectors	24 747		14	0	313	71	59	139
5. Other (Lubricants)	503							
B. Fugitive Emissions Fuel			2 197		1	0	44	172
1. Solid Fuel			22					
2. Oil and Natural Gas			2 175		1	0	44	172
2. Industrial Processes	6 277		0	6	14	1	29	6
A. Mineral Products	2 997				0	0	0	2
B. Chemical Industry	2 282		0	6	14	1	8	4
C. Metal Production	998		0	0	0	0	0	0
D. Other Production							20	
E. Production of Fluorocarbon and Sulfur Hexafluoride								
F. Consumption of Fluorocarbon and Sulfur Hexafluoride								
G. Other (please specify)								
3. Solvent and Other Product Use								
4. Agriculture			311	34	29	1		
A. Enteric Fermentation			278					
B. Manure Management			20	1				
C. Rice Cultivation			12					
D. Agricultural Soils				33				
E. Prescribed Burning of Savannas								
F. Field Burning of Agriculture Residues			1	0	29	1		
G. Other (please specify)								
5. Land–Use Change and Forestry		-1 566						
A. Changes in Forest and Other Woody Biomass Stocks		- 421						
B. Forests Grassland and Conversion								
C. Abandonment of Management Lands		0						
D. CO_2 Emissions and Removals from Soil		- 1 145						
E. Other (please specify)								
6. Waste			173	1				
A. Solid Waste Disposal on Land			159					
B. Wastewater Handling			14	1				
C. Waste Incineration								
D. Other (please specify)								
7. Other (please specify)								
Memo Items:								
International Bunker	2 818		0	0	4	12	2	2
Aviation	2 818		0	0	4	12	2	2
Marine								
CO_2 Emissions from Biomass	856							

Note:
CO_2 emissions estimates are presented as positive numbers (+), CO_2 removals as negative numbers (-).
No assessment of HFCs, PFCs and SF_6 was conducted in 1990 and thus not represented.

Table 2

Summary of National Inventory of Anthropogenic Emissions and Removals of all GHGs not Controlled by the Montreal Protocol and GHGs Precursor, 1994

GHG Source and Sink Categories	CO_2 Emission (Gg)	CO_2 Removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NOx (Gg)	NMVOC (Gg)	SO_2 (Gg)
Total of National Emissions and Removals	101 368	-1 352	3 504	39	1 120	295	252	361
1. Energy	96 894		2 966	0	1 056	292	232	358
A. Fuel Combustion (Sectoral Approach)	96 894		9	0	1 055	292	192	249
1. Energy Industries	44 952		1	0	15	122	4	161
2. Manufacturing Industries and Construction	6 058		0	0	3	17	1	9
3. Transport	8 720		1	0	854	86	150	20
4. Other Sectors	36 827		7	0	183	67	37	59
5. Other (Lubricants)	337							
B. Fugitive Emissions Fuel			2 957		1	0	40	109
1. Solid Fuel			13					
2. Oil and Natural Gas			2 944		1	0	40	109
2. Industrial Processes	4 474		0	5	8	1	20	3
A. Mineral Products	2 403				0	0	0	1
B. Chemical Industry	1 297		0	5	8	1	5	2
C. Metal Production	774		0	0	0	0	0	0
D. Other Production							15	
E. Production of Fluorocarbon and Sulfur Hexafluoride								
F. Consumption of Fluorocarbon and Sulfur Hexafluoride								
G. Other (please specify)								
3. Solvent and Other Product Use								
4. Agriculture			358	32	56	2		
A. Enteric Fermentation			319					
B. Manure Management			23	1				
C. Rice Cultivation			14					
D. Agricultural Soils				31				
E. Prescribed Burning of Savannas								
F. Field Burning of Agriculture Residues			2	0	56	2		
G. Other (please specify)								
5. Land-Use Change and Forestry	0	-1 352	0	0	0	0	0	0
A. Changes in Forest and Other Woody Biomass Stocks	0	- 399						
B. Forests and Grassland Conversion								
C. Abandonment of Management Lands		0						
D. CO_2 Emissions and Removals from Soil		- 953						
E. Other (please specify)								
6. Waste			180	2				
A. Solid Waste Disposal on Land			166					
B. Wastewater Handling			14	2				
C. Waste Incineration								
D. Other (please specify)								
7. Other (please specify)								
Memo Items:								
International Bunker	964		0	0	1	4	1	1
Aviation	964		0	0	1	4	1	1
Marine								
CO_2 Emissions from Biomass	1 565							

Note:
CO_2 emissions estimates are presented as positive numbers (+), CO_2 removal as negative numbers (-).
No assessment of HFCs, PFCs and SF_6 was conducted in 1994 and thus not represented.

Table 3

Summary of National Inventory of Anthropogenic Emissions and Removals of all GHGs not Controlled by the Montreal Protocol and GHGs Precursor, 2000

GHG Source and Sink Categories	CO_2 Emission (Gg)	CO_2 Removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NOx (Gg)	NMVOC (Gg)	SO_2 (Gg)
Total of National Emissions and Removals	108 606	- 1 018	3 892	35	1 184	286	251	294
1. Energy	105 016		3 352	0	1 066	282	228	292
A. Fuel Combustion (Sectoral Approach)	105 016		7	0	1 066	282	191	223
1.Energy Industries	44 284		1	0	14	120	4	185
2. Manufacturing Industries and Construction	4 982		0	0	3	14	0	4
3. Transport	11 132		1	0	929	80	161	6
4. Other Sectors	44 413		4	0	120	67	26	28
5. Other (Lubricants)	206							
B. Fugitive Emissions Fuel			3 345		1	0	37	69
1. Solid Fuel			11					
2. Oil and Natural Gas			3 334		1	0	37	69
2. Industrial Processes	3 590		0	4	8	1	23	2
A. Mineral Products	1627				0	0	0	1
B. Chemical Industry	1298		0	4	8	1	5	1
C. Metal Production	665		0	0	0	0	0	0
D. Other Production							19	
E. Production of Fluorocarbon and Sulfur Hexafluoride								
F. Consumption of Fluorocarbon and Sulfur Hexafluoride								
G. Other (please specify)								
3. Solvent and Other Product Use								
4. Agriculture			350	28	109	4		
A. Enteric Fermentation			314					
B. Manure Management			23	1				
C. Rice Cultivation			9					
D. Agricultural Soils				28				
E. Prescribed Burning of Savannas								
F. Field Burning of Agriculture Residues			4	0	109	4		
G. Other (please specify)								
5. Land –Use Change and Forestry		- 1 018						
A. Changes in Forest and Other Woody Biomass Stocks		- 751						
B. Forests and Grassland Conversion								
C. Abandonment of Management Lands		0						
D. CO_2 Emissions and Removals from Soil		- 267						
E. Other (please specify)								
6. Waste			191	2				
A. Solid Wastes Disposal on Land			176					
B. Wastewater Handling			14	2				
C. Waste Incineration								
D. Other (please specify)								
7. Other (please specify)								
Memo Items:								
International Bunker	1 116		0	0	2	5	1	1
Aviation	1 116		0	0	2	5	1	1
Marine								
CO_2 Emissions from Biomass	3 002							

Note:
CO_2 emissions estimates are presented as positive numbers (+), CO_2 removals as negative numbers (-).

Table 4

Inventory of Anthropogenic Emissions of Potential HFCs, PFS and SF_6 in 2000

GHG Source Categories	HFCs (Gg)					PFCs (Gg)		SF_6 (Gg)
	HFC-32	HFC-125	HFC-134a	HFC-143a	Others	CF_4	Others	
Total of National Emissions	0.00005	0.00030	0.00357	0.00022	NE	NE	NE	NE
2. Industrial Processes	0.00005	0.00030	0.00357	0.00022	NE	NE	NE	NE
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO
E. Production of Fluorocarbon and Sulfur Hexafluoride	NO	NO	NO	NO	NO	NO	NO	NO
F. Consumption of Fluorocarbon and Sulfur Hexafluoride	0.00005	0.00030	0.00357	0.00022	NE	NE	NE	NE

Table 5

Summary of National Inventory of Anthropogenic Emissions and Removals of all GHGs not Controlled by the Montreal Protocol and GHGs Precursor, 2005

GHG Source and Sink Categories	CO_2 Emission (Gg)	CO_2 Removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NOx (Gg)	NMVOC (Gg)	SO_2 (Gg)
Total of National Emissions and Removals	100 836	0	4 250	32	1 113	257	220	171
1. Energy	95 648		3 639	0	939	251	197	168
A. Fuel Combustion (Sectoral Approach)	95 648		7	0	938	251	168	125
1. Energy Industries	36 695		1	0	12	100	3	100
2. Manufacturing Industries and Construction	5 327		0	0	3	15	0	2
3. Transport	9 588		1	0	826	76	144	7
4. Other Sectors	43 703		4	0	98	60	20	17
5. Other (Lubricants)	334							
B. Fugitive Emissions Fuels			3 633		0	0	29	43
1. Solid Fuels			6					
2. Oil and Natural Gas			3 626		0	0	29	43
2. Industrial Processes	4 771		0	5	8	1	23	3
A. Mineral Products	2 396				0	0	0	2
B. Chemical Industry	1 403		0	5	8	1	5	1
C. Metal Production	972		0	0	0	0	0	0
D. Other Production							18	
E. Production of Fluorocarbon and Sulfur Hexafluoride								
F. Consumption of Fluorocarbon and Sulfur Hexafluoride								
G. Other (please specify)								
3. Solvent and Other Product Use								
4. Agriculture			414	25	166	6		
A. Enteric Fermentation			376					
B. Manure Management			27	1				
C. Rice Cultivation			5					
D. Agricultural Soils				24				
E. Prescribed Burning of Savannas								
F. Field Burning of Agriculture Residues			6	0	166	6		
G. Other (indicate)								
5. Land-Use Change and Forestry	417							
A. Changes in Forest and Other Woody Biomass Stocks		- 562						
B. Forests and Grassland Conversion								
C. Abandonment of Management Lands		0						
D. CO_2 Emissions and Removals from Soil	980							
E. Other (please specify)								
6. Waste			197	2				
A. Solid Waste Disposal on Land			182					
B. Wastewater Handling			15	2				
C. Waste Incineration								
D. Other (please specify)								
7. Other (please specify)								
Memo Items:								
International Bunker	894		0	0	1	4	1	1
Aviation	894		0	0	1	4	1	1
Marine								
CO_2 Emissions from Biomass	4 532							

CO_2 emissions estimates are presented as positive numbers (+), CO_2 removals as negative numbers (-).

Table 6

Inventory of Anthropogenic Emissions of Potential HFCs, PFS and SF_6 in 2005

GHG Source Categories	HFCs (Gg)					PFCs (Gg)		SF_6 (Gg)
	HFC-32	HFC-125	HFC-134a	HFC-143a	Others	CF_4	Others	
Total of National Emissions	0.00009	0.00058	0.00682	0.00041	NE	NE	NE	NE
2. Industrial Processes	0.00009	0.00058	0.00682	0.00041	NE	NE	NE	NE
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO
E. Production of Fluorocarbon and Sulfur Hexafluoride	NO	NO	NO	NO	NO	NO	NO	NO
F. Consumption of Fluorocarbon and Sulfur Hexafluoride	0.00009	0.00058	0.00682	0.00041	NE	NE	NE	NE

Table 7

GHG Emissions and Removals in Gg CO_2-equivalent in 1990

GHG Source and Sink Categories	CO_2 [a]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Total of National Emissions and Removals [b]	113 287	56 699	12 914				182 898
1. Energy	107 009	46 526	177				153 712
A. Fuel Combustion (Sectoral Approach)	107 009	385	177				107 571
1. Energy Industries	55 100	24	81				55 205
2. Manufacturing Industries and Construction	10 168	18	13				10 199
3. Transport	16 491	51	32				16 574
4. Other Sectors	24 747	292	51				25 090
5. Other (Lubricants)	503						503
B. Fugitive Emissions Fuel		46 141					46 141
1. Solid Fuel		469					469
2. Oil and Natural Gas		45 672					45 672
2. Industrial Processes	6 277	0	1 782				8 059
A. Mineral Products	2 997						2 997
B. Chemical Industry	2 282		1 782				4 064
C. Metal Production	998						998
D. Other Industries							
E. Production of Fluorocarbon and Sulfur Hexafluoride							
F. Consumption of Fluorocarbon and Sulfur Hexafluoride							
G. Other (please specify)							
3. Solvent and Other Product Use							
4. Agriculture		6 538	10 517				17 055
A. Enteric Fermentation		5 833					5 833
B. Manure Management		420	287				707
C. Rice Cultivation		262					262
D. Agricultural Soils			10 222				10 222
E. Prescribed Burning of Savannas							
F. Field Burning of Agriculture Residues		23	9				32
G. Other (please specify)							
5. Land-Use Change and Forestry	- 1 566						- 1 566
A. Changes in Forests and Other Woody Biomass Stocks	- 421						- 421
B. Forests and Grassland Conversion							
C. Abandonment of Management Lands	0						0
D. CO_2 Emissions and Removals from Soil	- 1 145						- 1 145
E. Other (please specify)							
6. Waste		3 635	438				4 073
A. Solid Waste Disposal on Land		3 343					3 343
B. Wastewater Handling		292	438				730
C. Waste Incineration							
D. Other (please specify)							
7. Other (please specify)							
Memo Items:							
International Bunker	2 818	0	25				2 844
Aviation	2 818	0	25				2 844
Marine							
CO_2 Emissions from Biomass	856						856

a) CO_2 emissions estimates are presented as positive numbers (+), CO_2 removals as negative numbers (-) in the "Land-Use Change and Forestry" Sector.

b) National Total Emissions are presented without Accounting the "Land-Use Change and Forestry" Sector.

Table 8

GHG Emissions and Removals in Gg CO_2-equivalent in 1994

GHG Source and Sink Categories	CO_2 [a]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Total of National Emissions and Removals [b]	101 368	73 588	12 041				186 998
1. Energy	96 894	62 287	109				159 290
A. Fuel Combustion (Sectoral Approach)	96 894	196	109				97 199
1. Energy Industries	44 952	20	49				45 020
2. Manufacturing Industries and Construction	6 058	10	6				6 074
3. Transport	8 720	28	17				8 765
4. Other Sectors	36 827	139	37				37 003
5. Other (Lubricants)	337						337
B. Fugitive Emissions Fuel		62 090					62 090
1. Solid Fuel		274					274
2. Oil and Natural Gas		61816					61816
2. Industrial Processes	4 474	0	1 475				5 949
A. Mineral Products	2 402						2 402
B. Chemical Industry	1 297		1 475				2 772
C. Metal Production	774						774
D. Other Production							
E. Production of Fluorocarbon and Sulfur Hexafluoride							
F. Consumption of Fluorocarbon and Sulfur Hexafluoride							
G. Other (please specify)							
3. Solvent and Other Product Use							
4. Agriculture		7 522	9 980				17 502
A. Enteric Fermentation		6 706					6 706
B. Manure Management		483	261				744
C. Rice Cultivation		288					288
D. Agricultural Soils			9 703				9 703
E. Prescribed Burning of Savannas							
F. Field Burning of Agriculture Residues		44	16				60
G. Other (please specify)							
5. Land–Use Change and Forestry	- 1 352						- 1 352
A. Changes in Forest and Other Woody Biomass Stocks	- 399						- 399
B. Forest and Grassland Conversion							
C. Abandonment of Management Lands	0						0
D. CO_2 Emissions and Removals from Soil	- 953						- 953
E. Other (please specify)							
6. Waste		3 779	477				4 257
A. Solid Wastes Disposal on Land		3 492					3 492
B. Wastewater Handling		287	477				765
C. Waste Incineration							
D. Other (please specify)							
7. Other (please specify)							
Memo Items:							
International Bunker	964	0	8				972
Aviation	964	0	8				972
Marine							
CO_2 Emissions from Biomass	1 565						1 565

a) CO_2 emission estimates are presented as positive numbers (+), CO_2 removals as negative numbers (-) in the "Land – Use Change and Forestry" Sector.

b) National Emissions Amount is presented without Accounting the "Land – Use Change and Forestry" Sector.

Table 9

GHG Emissions and Removals in Gg CO_2-equivalent in 2000

GHG Source and Sink Categories	CO_2 [a]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Total of National Emissions and Removals [b]	108 606	81 742	10 812	6			201 167
1. Energy	105 016	70 391	110				175 517
A. Fuel Combustion (Sectoral Approach)	105 016	146	110				105 273
1. Energy Industries	44 284	20	54				44 359
2. Manufacturing Industries and Construction	4 982	9	5				4 996
3. Transport	11 132	31	16				11 179
4. Other Sectors	44 413	86	35				44 534
5. Other (Lubricants)	206						206
B. Fugitive Emissions Fuel		70 245					70 245
1. Solid Fuel		225					225
2. Oil and Natural Gas		70 020					70 020
2. Industrial Processes	3 590	0	1 374	6			4 970
A. Mineral Products	1 627						1 627
B. Chemical Industry	1 298	0	1 374				2 672
C. Metal Production	665						665
D. Other Production							
E. Production of Fluorocarbon and Sulfur Hexafluoride							
F. Consumption of Fluorocarbon and Sulfur Hexafluoride				6			6
G. Other (please specify)							
3. Solvent and Other Product Use							
4. Agriculture		7 348	8 800				16 148
A. Enteric Fermentation		6 592					6 592
B. Manure Management		480	229				709
C. Rice Cultivation		188					188
D. Agricultural Soils			8 539				8 539
E. Prescribed Burning of Savannas							
F. Field Burning of Agriculture Residues		87	32				119
G. Other (please specify)							
5. Land-Use Change and Forestry	- 1 018						- 1 018
A. Changes in Forest and Other Woody Biomass Stocks	- 751						- 751
B. Forests and Grassland Conversion							
C. Abandonment of Management Lands	0						0
D. CO_2 Emissions and Removals from Soil	- 267						- 267
E. Other (please specify)							
6. Waste		4 004	528				4 532
A. Solid Waste Disposal on Land		3 705					3 705
B. Wastewater Handling		299	528				827
C. Waste Incineration							
D. Other (please specify)							
7. Other (please specify)							
Memo Items:							
International Bunker	1 116	0	10				1 126
Aviation	1 116	0	10				1 126
Marine							
CO_2 Emissions from Biomass	3 002						3 002

a) CO_2 emissions estimates are presented as positive numbers (+), CO_2 removals as negative numbers (-) in the "Land-Use Change and Forestry" Sector.
b) Total National Emissions are presented without Accounting the "Land-Use Change and Forestry" Sector.

Table 10

GHG Emissions and Removals in Gg CO_2-equivalent in 2005

GHG Source and Sink Categories	CO_2 [a]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Total of National Emissions and Removals [b]	100 419	89 258	9 973	12			199 662
1. Energy	95 648	76 424	91				172 162
A. Fuel Combustion (Sectoral Approach)	95 648	137	91				95 876
1. Energy Industries	36 695	15	39				36 750
2. Manufacturing Industries and Construction	5 327	10	4				5 341
3. Transport	9 588	28	15				9 632
4. Other Sectors	43 703	84	33				43 820
5. Other (Lubricants)	334						334
B. Fugitive Emissions Fuel		76 286					76 286
1. Solid Fuel		132					132
2. Oil and Natural Gas		76 154					76 154
2. Industrial Processes	4 771	3	1 581	12			6 366
A. Mineral Products	2 396						2 396
B. Chemical Industry	1 403	3	1 581				2 986
C. Metal Production	972						972
D. Other Production							
E. Production of Fluorocarbon and Sulfur Hexafluoride							
F. Consumption of Fluorocarbon and Sulfur Hexafluoride				12			12
G. Other (pleas specify)							
3. Solvent and Other Product Use							
4. Agriculture		8 702	7 740				16 442
A. Enteric Fermentation		7 902					7 902
B. Manure Management		567	276				843
C. Rice Cultivation		100					100
D. Agricultural Soils			7 415				7 415
E. Prescribed Burning of Savannas							
F. Field Burning of Agriculture Residues		133	49				182
G. Other (pleas specify)							
5. Land-Use Change and Forestry	417						417
A. Changes in Forest and Other Woody Biomass Stocks	- 562						- 562
B. Forests and Grassland Conversion							
C. Abandonment of Management Lands	0						0
D. CO_2 Emissions and Removals of Soil	980						980
E. Other (pleas specify)							
6. Waste		4 130	560				4 691
A. Solid Wastes Disposal on Land		3 814					3 814
B. Wastewater Handling		316	560				876
C. Waste Incineration							
D. Other (pleas specify)							
7. Other (pleas specify)							
Memo Items:							
International Bunker	894	0	8				902
Aviation	894	0	8				902
Marine							
CO_2 Emissions from Biomass	4 532						4 532

a) CO_2 emissions estimates are presented as positive numbers (+), CO_2 removals as negative numbers (-) in the "Land-Use Change and Forestry" Sector.
b) Total National Emissions are presented without Accounting the "Land-Use Change and Forestry" Sector.

Table 11

Trends of Emissions by Gases

GHG Emissions	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	Gg CO_2-equivalent.															
CO_2 Net emissions / removals	111 720	111 635	104 467	105 213	100 016	99 624	102 367	99 619	98 650	102 654	107 587	107 904	110 723	106 253	103 868	100 836
CO_2 Emissions without accounting of "Land-Us Change and Forestry" Sector	113 287	113 302	106 307	106 808	101 368	101 021	104 014	101 267	99 999	104 052	108 606	107 874	111 019	106 839	104 821	100 419
CH_4 Emissions	56 699	59 091	59 222	87 533	73 588	74 375	76 335	68 165	64 544	69 667	81 742	84 811	85 942	87 939	87 074	89 258
N_2O Emissions	12 914	13 461	13 433	12 828	12 041	11 482	11 395	11 221	11 293	10 984	10 812	10 484	10 706	10 529	10 547	9 973
HFCs Emissions											6	6	2	9	38	12
PFCs Emissions																
SF_6 Emissions																

Table 12

Trends of Emissions by Sectors

GHG Source and Sink Categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	Gg CO_2-equivalent.															
1. Energy	153 712	155 557	148 479	177 644	159 290	160 553	165 440	154 609	149 680	159 032	175 517	177 748	181 596	178 758	174 787	172 162
2. Industrial Processes	8 059	8 618	8 295	7 422	5 949	5 354	5 612	5 302	5 270	4 828	4 970	5 042	5 118	5 418	6 136	6 366
3. Solvent and Other Product Use																
4. Agriculture	17 055	17 558	18 014	17 881	17 502	16 679	16 343	16 337	16 423	16 333	16 148	15 819	16 333	16 491	16 888	16 442
5. Land-Use Change and Forestry	- 1 566	- 1 667	- 1 839	- 1 596	- 1 352	- 1 397	- 1 647	- 1 649	- 1 349	- 1 398	- 1 018	+ 30	- 2096	- 586	- 953	+ 417
6. Waste	4 073	4 121	4 176	4 221	4 257	4 292	4 348	4 406	4 463	4 510	4 532	4 567	4 622	4 650	4 670	4 691
7. Other (please specify)																