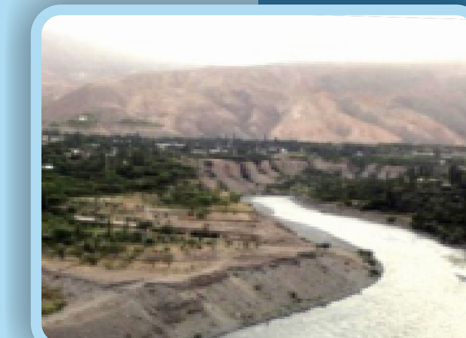
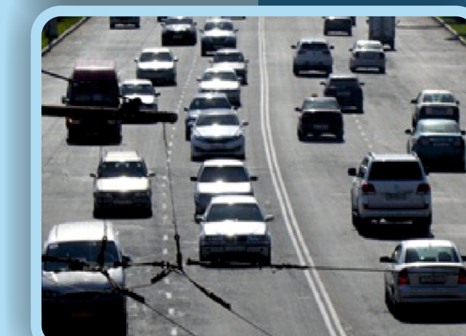
The Government of the Republic of Tajikistan
State Administration for Hydrometeorology
Committee on Environmental Protection
under the Government of the Republic of Tajikistan

2014

Third National Communication of the Republic of Tajikistan under the United Nations Framework Convention on Climate Change





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Dushanbe 2014

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The Third National Communication of the Republic of Tajikistan (TNC) under the UN Framework Convention on Climate Change (UNFCCC) was developed according to Articles 4.1 and 12.1 of the UNFCC and in line with the requirements of the non-Annex I Convention Parties. The TNC targets Convention Parties, stakeholders and a wider audience. The TNC was developed with funding support from the Global Environmental Facility (GEF) through the United Nations Development Programme (UNDP) in Tajikistan.

The following state agencies and their specialised institutions took part in the formulation of the Third National Communication:

- Ministry of Economic Development and Trade of the Republic of Tajikistan
- Ministry of Energy and Water Resources of the Republic of Tajikistan
- Ministry of Industry and New Technologies of the Republic of Tajikistan
- Ministry of Agriculture of the Republic of Tajikistan
- Ministry of Transport of the Republic of Tajikistan
- Committee on Environmental Protection under the Government of the Republic of Tajikistan
- Agency of Forestry under the Government of the Republic of Tajikistan
- Agency on Statistics under the President of the Republic of Tajikistan
- Agency on Land Reclamation and Irrigation under the Government of the Republic of Tajikistan
- State Committee of Land Management and Geodesy of the Republic of Tajikistan
- Academy of Sciences of the Republic of Tajikistan
- The Prophylactic Medicine Scientific-Research Institute of the Ministry of Health and Social Protection of the Republic of Tajikistan
- The 'Hydroenergyproject' Scientific-Research Institute of the Ministry of Energy and Water Resources of the Republic of Tajikistan
- State Service of Sanitary and Epidemiological Surveillance of the Ministry of Health and Social Protection of the Republic of Tajikistan

Public Organisations:

- Cooperation for Development
- Oftob
- Youth Ecological Centre
- Museum of the Antarctic
- CAREC branch in Tajikistan
- MANEB branch in Tajikistan

The State entity responsible for the development of the Third National Communication under the UNFCCC is the State Administration for Hydrometeorology of the Committee of Environmental Protection of the Republic of Tajikistan

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Foreword

Tajikistan is an active member of the United Nations Framework Convention on Climate Change and has the honour to submit its Third National Communication (TNC) to the Convention Parties, stakeholders and wider audience.

Positive developments have taken place in Tajikistan over the last 5 years. The use of renewable energy (solar, hydro, biomass) sources has considerably increased. This in turn has improved the level of energy supply to the population and to community facilities, including schools and hospitals, reduced the environmental burden on forests, and contributed to a reduction in GHG emissions from fossil fuels. The main roads and the system of traffic regulation are being modernized. Tunnels and bridges are being constructed to reduce the distances people travel and improve transport security. This has enabled Tajikistan to be linked with the main international transport corridors and, considering the prevailing use of gas fuel for transport, has contributed to a reduced level of GHG emissions from the transport sector.

The TNC aims to inform the UNFCCC parties, decision makers and the public on the current trends of climate change and its consequences, provide an inventory of GHG emissions and flows and describe the ability of Tajikistan to contribute to climate change mitigation and adaptation. The TNC also aims to provide a brief overview of completed, ongoing and planned measures of the Government, general public, scientists, business community and donors aimed at addressing climate change issues.

The TNC is made up of 7 sections providing information on climate change in Tajikistan and its consequences for natural resources, economic sub-sectors, and the health of the population. It also describes response measures aimed at addressing climate change issues. The present document is based on the previous National Communications (2002, 2008) and has been developed to conform to the requirements and guiding principles of UNFCCC. The main focus is on new developments, as well as the achievements and successes of the country in addressing climate change issues. We hope that the TNC will be found interesting and informative both for the Conference of UNFCC Parties and for local and international communities. About 50 experts and specialists representing the government, the Academy of Science, international partners and NGOs were involved in development of the TNC.

The main content of the TNC was discussed through the series of national workshops engaging and attended by a wide range of stakeholders, as well as international experts and mass media. All the suggestions and comments received were thoroughly analysed and, as far aspossible, addressed whilst finalising the document.

We would like to express our gratitude to the group leaders, leading authors, and specialists who provided information, materials and resources to the editors and reviewers, as well as to local and international consultants. These people have invested a lot of their time and effort in the development and review of the document. Also, we would like to express our gratitude to the Government of the Republic of Tajikistan, as well as the GEF and the UNDP in Tajikistan for financial and operational support and to the UNFCCC Secretariat for their coordination efforts and support in development of the present document.

Kh. Ibodzoda

Chairman, Committee on Environmental Protection
under the Government of the Republic of Tajikistan

List of abbreviations, definitions and unit measures

ADB	Asian Development Bank
AMS	Automated meteorological station
CAMP	Central Asian Mountain Partnership
CAWN	Central Asia Water network
CoES	Committee of Emergency Situations and Civil Defence
CAREC	Tajik branch of Central Asia Regional Environmental Center
DFID	Department for International Development
ENVSEC	Environment and Security Initiative
GCOS	Global climate observing system
GCW	Global Cryosphere Watch
GEF	Global Environmental Facility
Hydromet	State Administration for Hydrometeorology
GIS	Geographic Information Systems
GIZ	Gesellschaft für Internationale Zusammenarbeit
GLIMS	Global land ice measurements from space
HPP	Hydro Power Plant
ICSD	Intergovernmental Commission on Sustainable Development
IFSAS	International Fund to Save Aral Sea
IPCC	Intergovernmental Panel on Climate Change
IPY	International Polar Year
IWMCC	Intergovernmental Water Management and Coordination Commission
MANEB	Tajik branch of International Academy of Science on Ecology and Life Safety
MoHSP	Ministry of Health and Social Protection
NGO	Non-Governmental Organisation
NMHS	National Meteorological and Hydrological Service
POP	Persistent Organic Pollutant
PPCR	Pilot Programme for Climate Resilience
RES	Renewable Energy Sources
RT	Republic of Tajikistan
RHC	Regional Hydrology Centre of the IFSAS
SIC	Scientific-information centre
SDC	Swiss Agency for Development and Cooperation
SUE	State Unitary Enterprise
TNC	Third National Communication
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNESCO	United Nations Education, Science and Culture Organization
UNFCCC	UN Framework Convention on Climate Change
USAID	US Agency for International Development
WB	World Bank
WGMS	World Glacier Monitoring Service
WMO	World Meteorological Organisation

Chemical symbols:

CH_4	methane
CO	carbon oxide
CO_2	carbon dioxide
N_2O	nitrous oxide
NOx	nitrogen oxides
PFCs	perfluorocarbons
SO_2	sulphur dioxide

Units:

°C	Celsius degree
cal	calorie
cub.m	cubic meter
cub.m/s	cubic meter per second
cub.km	cubic kilometer
g	gram
Gg	gigagram = 1 000 tonnes
ha	hectare
J	joule
kW/h	kilowatt hour
$kW/h/m^2$	kilowatt hour per square meter = 3,6 MJ/m^2
Kg	kilogram
KJ	kilojoule
ccal	kilocalories
km	kilometer
m	meter
masl	meters above sea level
mm	millimeter
m/s	meters per second
MW	megawatt = 1000 000 watt
ppm	parts per million
sq.m	square meter
sec	second
TJ	terajoule = 1000 000 000 000 joule
t	ton
t.o.e.	tons of oil equivalent = 29308 KJ

1. Summary

National circumstances

The area of Tajikistan is 142.6 thousand square kilometers with 93% of the territory being mountainous. The altitude above sea level varies between 300 and 7495 meters, with approximately half of the settlements being above 3000 meters. The country is landlocked in continent and is distant from seas and oceans. Climate conditions are diverse ranging from both cold and hot arid areas to places with a humid subtropical climate.

Mountain ranges and the considerable differences in altitude give wide ranges of temperature, humidity and precipitation. The annual mean temperature in the south reaches +17°C, while in the mountains of the Pamir it reaches -6°C. Arctic, Mediterranean and Indian Ocean weather systems coupled with a mountainous terrain pose challenges for climate modeling and the assessment of climate change. The extremes of low and high temperatures observed in desert areas, as well as other extreme weather phenomena represent potential threats. Moreover, Tajikistan is located in a seismically active zone and together these tectonic and climatic features complicate the planning and design of infrastructure.

Public administration in Tajikistan originates from the Soviet era. However after two decades of independence the country has successfully created a national system of decision making which includes legislative and executive branches of power. The political system is distinct, with centralized vertical power in which the President and the Government play the leading roles. Nonetheless, the level of public participation in the decision making process is steadily increasing.

Presidential elections in November 2013 resulted in structural changes within the Government which have implications for climate change issues. For example, a Ministry of Energy and Water Resources was created, whilst the Ministries of Industry and New Technologies, Health and Social Protection, and Ministry of Education and Science were all re-organised.

Tajikistan is proud of having the lowest level of GHG emissions in the region, both in absolute and relative per capita terms. Hydropower is used to meet the main energy needs of the country. Due to geopolitical circumstances the supply of fossil fuels is limited, whilst a shortage of energy resources coupled with poverty prevents the development of industrial production, transport development and heat supply. Developing the huge hydropower potential is a priority for the country. The Ministry of Energy and Water Resources has the capacity to manage this process and reduce potential conflicts of interest in the water and energy sectors.

Due to population growth and increasing energy needs, the existing hydropower plants are not sufficient to meet annual and especially seasonal needs. To address the winter and autumn energy deficits, the use of power plants running on coal is envisaged. Having said that, further development of hydro-energy potential could serve as an alternative.

During the Soviet period, Tajikistan maintained political, economic, energy and transport relations with other Soviet republics. Despite their strategic importance, Afghanistan and China, remained outside the area of direct cooperation due to geopolitical circumstances, However Tajikistan is committed to developing regional partnerships in the field of the environment. The role of China as a strategic partner in economic development, and as a source of investments in technologies and improvement of the transport system is growing. Cross-border cooperation between Tajikistan and Afghanistan has resulted in the formulation of cooperation plans for environmental protection and hydrology, as well as the creation of new opportunities in the trade and transport sectors. Energy security and border issues are priority areas for both countries.

Greenhouse gas emissions

According to the last inventory of GHG emissions (2004-2010) and as confirmed by international sources, the level of absolute and per capita emissions in Tajikistan remains the lowest in Central Asia. Despite the fact that the country does not have quantitative UNFCCC commitments on the reduction of emissions, the current level of emissions as compared to 1990 have reduced by one third, mainly due to the collapse of the Soviet Union and structural changes resulting from the transition to a market economy and independence. During the last decade, the level of carbon dioxide has remained quite stable, however in the current decade an increase of emissions is expected.

The make up of emissions in Tajikistan differs from other Central Asian countries. Since the late 1990's to the present, agriculture has been the main source of GHG emissions. Considering the low level of mechanisation, underfeeding of livestock and limited use of fertilisers, emissions from the agriculture sector of Tajikistan are lower than in the other countries of Asia and Europe. Opportunities for any considerable reduction of carbon footprint in agriculture are therefore limited, while the measures in other economic subsectors, especially in energy and industry are more promising.

Currently 98% of the electricity in Tajikistan is generated from hydropower. This source of energy produces a minimum level of carbon dioxide and has a great potential for development and growth. Therefore, energy consumption could increase and still result in a smaller demand for other sources of energy. Also, neighbouring countries could use hydroenergy from Tajikistan to reduce their carbon footprint. Since 2010, coal mining has increased as a measure to address the seasonal energy deficits and as a substitute for gas imports which are often problematic. This coping strategy might result in an increase in carbon dioxide emissions in the near future. From an environmental point of view the option is not ideal, however the country's acute energy deficit, coupled with population growth, slow the pace of development and therefore capacity to eliminate poverty.

In Tajikistan the number of automobile users is the lowest among Central Asian countries, as is the general level of transport emissions. The present sector fully relies on imported fuel. Given that the price of natural gas is lower than the price of petrol and diesel, the number of vehicles using gas as a fuel or having hybrid fuel systems, is higher than the number of vehicles using other types of fuel. Since the emissions of vehicles running on gas as compared to those running on petrol is lower, the overall level of emissions in the sector is not high. New tunnels and improved road infrastructure in mountainous areas have considerably reduced travel times and consequently fuel consumption, which in turn has led to reduced emissions and increased road safety as well as improved transport communication between the regions and remote districts of the country.

Forest cover comprises only 3% of the land area of Tajikistan and the recent intensive deforestation has resulted in reduction in the carbon absorption capacity of forests. Even under these circumstances, forests absorb a considerable proportion of all emissions. Fruit and nut trees planted to ensure food security are also taken into account in reporting on emissions. During the last few years, an increase in sequestration of carbon dioxide in wood biomass has taken place through tree planting.

Twenty years ago domestic waste comprised a very small share of the total emissions. However due to changes in overall composition of emissions, there has been a notable increase of the level of domestic waste. In theory, all domestic waste is disposed of in waste landfills and only small part is processed informally. There are landfills in all major cities, however their number is considered insufficient for the country.

Uncertainties in the calculation of emissions varies from sector to sector. Uncertainties exist despite the fact that every effort is made to ensure a reliable calculation of emissions. Thus Tajikistan aims to improve the inventory system of GHG emissions to reduce these uncertainties, especially in the energy and industrial sectors. Existing statistical data is not sufficiently comprehensive to be considered reliable. Also there is a problem of calculating the emission coefficient. For instance, the applied coefficient of perfluorocarbons can vary by two or more times depending on the calculation method and application of periodic field measurements.

In the near future, Tajikistan plans to reduce uncertainties with regards to calculation of emissions. This will be achieved through enhancement of inventories, the creation of a national inventory of GHG emissions, the improvement of statistical data used in calculating the coefficient of emissions, as well as development of human resources. These improvements will enable the country to implement its commitments, if in 2015 the UNFCCC Conference takes a decision on the regulation, verification and reduction of GHG emissions for all Convention parties.

Vulnerability assessment and adaptation scenarios

During the development of the previous two National Communications a vulnerability assessment of natural systems and economic sectors sensitive to climate change, was carried out. Activities were implemented to develop the knowledge base, and gaps in capacity were identified and development measures were proposed. This third TNC covers new problems and revisits previous forecasts and assessments. To a large extent the present document is based on new work carried out by international and national experts. Attempts have also been made to accommodate the conclusions of several international assessments to reach a consensus and ensure coherence.

In the previous vulnerability assessments attention was paid to ecosystem services as well as to the condition and productivity of ecosystems. Tajikistan is well aware of the considerable role of the Pamir mountains as the 'water tower' of the region and understands that, in the context of climate change, the processes affecting the water resources in the areas where water originates also have implications for districts and countries downstream.

The earlier assessments were based on global models that were not wholly applicable to complex mountainous regions such as Tajikistan. These assessments often applied an approach that was based on expert opinion. Over time these global models have been improved and regional models developed and s a result predictions have become more frequent and reliable. Some activities were carried out purely for the purpose of scientific-research whilst others focused on practical application. The availability of new information and wider spectrum of knowledge has led to a re-evaluation and adjustment of previous conclusions.

Some studies have revealed changes in hydrology and state of glaciers resulting from climate change, although these changes have not yet had any measurable impact on the dependent economic subsectors or the most important parameters of flows. A reduction of water in the main rivers of the country up to 2050 is unlikely, although some seasonal changes and an increase of inter-annual fluctuations including a reduction of water flows in the peak summer season may happen.

During the implementation of the Pilot Programme on Climate Resilience (PPCR), donors and responsible state bodies assessed different aspects of vulnerability which went beyond physical and structural parameters. Human capital, including the level of knowledge, as well as social and cultural characteristics of the areas, is of critical importance in the assessment of vulnerability and the development of local adaptation strategies. Whilst undertaking the assessment, it was also important to consider well-being and security related factors which may fall outside standard climate change related assessments. A narrow outlook of the problem might negatively impact the effectiveness of chosen measures and levels of response.

The development of human capital opens up new opportunities for initiatives aimed at providing reliable access to energy resources, increasing the availability of electronic information, and the development of microfinance related approaches. Components of measures aimed at the development of human capital and the respective response measures vary in different regions of Tajikistan. In some regions there is a need to diversify income sources whilst in others people need reliable insurance services or access to quality seeds.

Currently the main climate change adaptation efforts in Tajikistan are focused on hydro-energy, RES, agriculture and forest management, adequate response and reduction of disaster risks as well as the provision of hydro-meteorological services. These adaptation efforts also include hydrology and flood related activities, as well as infrastructure development works. The majority of the adaptation projects are implemented in the south, with some in the northern and western regions of the country. The priority given to this region was to large extent because of its share of the vulnerable population and infrastructure. . The extreme consequences of climate change were secondary criteria. The ongoing climate change adaptation measures are focused on economic objects and subsectors of national importance. Nonetheless, NGOs dealing with environmental issues support the development of local adaptation plans and have already engaged many communities in this process. The Government recognizes the importance of enhancing focus at the local level.

Around 75% of the population of the country lives in rural areas with majority of being engaged in the agriculture sector. In addition to being materially poorand thus prone to financial risks, the agricultural sector is also vulnerable to variations in the climate and climate change. Nonetheless, local experts note that the agricultural sector also has a great potential to adapt to climate change and mitigate anthropogenic impact on climate. This potential can be developed through good planning and the application of relevant technologies to reduce the burden on critical water and land resources as well as for maintaining energy consumption at the minimal level.

Activities within the health sector taken in response to recommended adaptation measures in relation to the increasing rate of malaria have resulted in a substantive reduction of disaster risk. Progress in tackling water borne diseases remains limited despite the fact that these diseases are the main cause of child mortality in Tajikistan. Climate change further aggravates the problems resulting from poor sanitary conditions. For example, both seasonal and annual extreme weather conditions such as floods and droughts create favourable environments for the transmission of diseases. Work in this direction is of high priority and in line with Millennium Development Goals.

The assessment of the impact of temperature on reproductive health identified a safe threshold finding that health risks to pregnant women and infants increases if the temperature exceeds +37°C. In some districts such temperatures are frequent and this is an important determinant of health complications and mortality..During the years with frequent extreme temperatures, the frequency of health problems is considerably higher. Adaptation measures aimed at improving the quality of provision in the health sector as well as the implementation of preventive measures can mitigate for the increasing impact of the global warming.

Due to effects of long term exposure to high temperatures, the rural population in Tajikistan are prone to heat stress. Some research shows that the extreme heat in in 2001 resulted in increased mortality rates. The comparison of child mortality with average annual temperature for 2001 revealed that the higher than average temperatures increased were related to an increased rate of child mortality.

'Heat wave' warnings are not given in Tajikistan. Nevertheless, any adaptation strategy must take into account (a) the large number of people in rural and urban communities exposed to high temperatures for lengthy periods, and (b) the possibility that climate change will result in an increase of both maximum temperatures and their duration.

Climate change policies and measures

To implement the UNFCCC commitments and to strengthen climate protection measures, to date

Tajikistan has produced three National Communications on climate change. Tajikistan is one of the pioneers in the region in the preparation of a National Action Plan for climate change mitigation (2003). This plan also includes adaptation measures. Many of the planned measures are being implemented and currently recommendations on updating the National Action Plan are being developed.

Given the relevance of global environmental problems and their close links with local circumstances and environmental conditions, Tajikistan has joined and ratified several important international treaties.

To implement state policy and to meet the requirements of international treaties, Tajikistan has adopted several State Programmes, Strategies, Action Plans, Laws and enactments related to climate change.

Tajikistan is convinced that intentions and commitments of countries on GHG emissions must be implemented by all Convention Parties with consideration to their specific emissions, socio-economic conditions and development needs, geographic location, as well as the availability of financial resources and technologies.

Research and systemic observations

During the last 10 years the national capacity for conducting research has not increased, and possibly has even declined as result of the turnover of experienced staff and scientists,coupled with chronic financial constraints. International research using modern technologies such as supercomputers and remote sensing could fill many of the current gaps.

During the years of independence the frequency of systematic observations has reduced, especially in remote mountain districts. The number of hydro-meteorological stations has remained the same, while application of modern communication has increased the effectiveness and reliability of data transmission and exchange and also reduced the relevant costs. The level of station automation is increasing and in the next three to six years many of the stations will become half or fully automated, further enabling an improvement in climate related services. However currently a number of experts consider that the automated systems to be unreliable and therefore the capacity of automated stations is not used to their full extent.

Education and awareness rising

Public schools and universities in Tajikistan do not pay enough attention to environmental education and generally do not offer programmes on climate change issues. The entire education system is focused on training a large number of schoolchildren and students, yet the number of schools and teachers specialised in natural science is relatively small. Public organisations work with schools and conduct extracurricular activities for schoolchildren covering issues of climate change and its consequences.

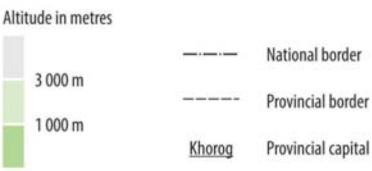
Although there are still people who deny that climate change is taking place yet the level of awareness of experts and relevant decision makers is increasing. Having said that, those in the mass media in Tajikistan show a lower level of interest compared to their colleagues in the West and in Asia. The public receives information on the subject matter only in the target areas of the projects implemented by NGOs.

2. National circumstances

2.1. Geographic location, features and administrative division

Tajikistan is located in the southern mountainous part of Central Asia between 36°40'N and 41°05'N (a latitude similar to Korea, Turkey, Greece and capital cities of Beijing and Washington) and 67°31'E and 75°14'E and stretches for 700 km from west to east and for 350 km from north to south. The area of the country is 142,600 sq. km^2, which is smaller than the other countries of Central Asia. Mountains occupy over 93% of country's territory and more than half of the country is more than 3,000metres above sea level. These areas are not suitable for agriculture due to extreme climatic and landscapes which consists predominantly of rocks, glaciers and highlands. Absolute altitudes vary from 300 m to 7,495 m. Tajikistan borders with Afghanistan in the south (for more than 1000 km), Uzbekistan in the west and north (for about 900 km), Kyrgyzstan in the north (for 630 km), and China in the east (for about 400 km). A large part of the country is prone to high seismic risks. Mountainous districts as well as arid and semi-arid zones are especially vulnerable to dangerous hydro-meteorological events.

Relief map of Tajikistan



The southwestern part of the country predominantly consists of arid and semi-arid lowlands which gradually merge into foothills. In the north lies the Fergana valley and Kuramin mountain range with the remaining territory adjoining the large mountain systems of Asia-Pamir, Gissar-Allai, the Hindukush and Tian Shan with a diversity of natural and climatic conditions. The Pamir is divided into western and eastern parts. The western part has the highest mountains divided by deep river valleys, whilst the eastern part is predominantly a high mountain and arid plateau area.

Beautiful mountains and historical monuments attract tourists to the country from all over the world. Mountain tourism takes place in the areas around Dushanbe city (Varzob, Qaratag, Shirkent and Romit gorges), Kuhistan (the Fann mountains, Marghuzor and Alauddin lakes, Iskanderkul) and the Pamir. Ancient towns and castles along the Silk Road (Penjikent, Khujand, Istarafshan, Gissar) and health resorts with healing springs 'Garmchashma', 'Obi Garm', 'Shohambari', 'Zumrad' and others are especially popular in the historical-cultural and health tourists.

Administratively, Tajikistan is divided into the following regions: Soughd oblast (north), Khatlon oblast (southwest), and also the Gorno-Badakhshan Autonomous oblast (GBAO) in the east. The GBAO occupies 45% of country's territory, but its population is only 250 thousand people (3% of total population). The Districts of Republican Subordination (DRS) are located in the centre and in the west of the country surrounding Dushanbe, the capital city. As of 1st January 2014 Tajikistan had 17 towns, 62 districts, 57 settlements and 369 Jamoats.

2.2. Climate conditions and characteristics

Tajikistan is located at the meeting point of powerful atmospheric circulation processes. One of them is the Siberian anti-cyclonic system that dominates the winter period. Cold air from the Arctic often reach the southwestern parts of Tajikistan and the mountains surrounding the country in the north and east create a favorable environment for retention of these cold air masses. As a rule, the inflow of warmer air in winter takes place as a result of the intrusion of tropical air masses. Thermal depressions are another important atmospheric process that dominates the summer period. The proximity of arid areas and high mountains, as well as clear, dry and hot weather contribute to their formation.

The annual mean temperature depends partly on altitude and varies between +17ºC in hot southern districts to -6ºC and lower in the Pamir highlands. The highest temperature is observed in July and the lowest in January. The Eastern Pamir is known for its extreme climate and here the lowest temperature reaches minus 63ºC. In the south of the country, the maximum air temperature reaches +47ºC. Thus, the difference between the highest and lowest air temperature in different parts of the country exceeds 100°C.

Approximately 75% of annual precipitation takes place during the colder times of the year. The majority of precipitation falls in mountain districts which are open to humid air masses from the west. High mountains create an effect of orographic opacity thus some districts 'fenced' or protected from humid air masses have less precipitation. These include the deep and closed valleys, mountains and highland plateau in the eastern part of the Pamir which has the least amount of precipitation (less than 100mm per year). The hot lowland deserts in the south of Tajikistan also have a low level of precipitation. The maximum level of precipitation is observed in the mountains of central Tajikistan which experiences 1,000-1,800 mm per year.

2.3. Forests, pastures and wild nature

Forests only take up3% (412,000 ha) of the land area of the country but still play an important role in the conservation of biodiversity and genetic resources as well as in atmospheric carbon absorption. In addition the forests are a natural protection for human settlements against floods, avalanches, and soil erosion. The forests also regulate the water balance and microclimate. Almost all forests in Tajikistan belong to the state and are considered to be Group 1 forests. Forest management activities are directed at conservation and the improvement of forest conditions.

Most of the forest (150 thousand ha) consists of evergreen, low productive and diffused Juniper forests (*Juniperus turkestanica, J. Seravcshanica, J. Semiglobosa*) and are found between1,500-3,500 metres above sea (masl) level. The main areas of Juniper are located on the hill slopes of the Turkestan, Zerafshan and Gissar mountain ranges, predominantly on the northern slopes. Juniper is a good regulator of surface flows and protect against erosion processes and is a reliable CO_2 reservoir. The area covered by broad-leaved forests is approximately 52 thousand ha and stretches along the southern hillslopes of the Gissar range, the Darvaz and upstream of Yakhsu and Kizilsu rivers at an altitude of 1,200-2,500 masl. These forests belong to the temperature and humidity tolerant broadleaved species, and consist predominantly of walnuts (8 thousand ha), Turkestan maple (44 thousand ha), and Asian wild apples (*Acer turkestanicum, Juglans regia*). Shrub forests cover approximately 15 thousand ha growing on the mountain plateau at an altitude of 2,000-3,500 masl and include willows, birches, poplar, sea-buckthorn, currant (*Salix turanica, Hippophae rhamnoides, Populus tadshicistanica, Betula tadshicistanica*) and others. MountainForests consisting of Asiatic poplar, tamarix, along with reed tangles and other vegetation (*Populus pruinosa, Elaegnus angustifolia, Tamarix laxa, Phragmites communis*) grow in the hotter lowland districts of Tajikistan and on the river floodplains. These floodplain forests have especially been well conserved in the protected area 'Tigrovaya Balka' along the lower reaches of the Vakhsh river. Desert saxaul forests grow in the south and cover less than 8 thousand ha but play a vital soil protection role. They are used as pasture during spring and autumn. Pistachios and almonds (*Pistacia vera, Amygdalus bucharica*) represent an especially valuable group of nut-bearing forests with a total area of up to 90 thousand ha and are found growing at altitudes of between 600-1,200 masl. In general, Tajikistan's dendroflora includes 268 types of trees and shrubs.

Since the 1930s there has been intensive reclamation of foothill and floodplain valleys to increase the area of arable land in Tajikistan but in the processup to 100 thousand ha of floodplain, pistachio and partially broad-leaved forests were destroyed. . During the economic and energy crises in 1990s juniper forests, which are difficult to reforest, were cut down. Deforestation and animal grazing in

Figure 1. Broad-Leaved forests in Shakhristan area.

forest areas has had a negative impact on the quality and diversity of forests and the natural regeneration of forests has practically stopped.

Pasture makes up 80% of agricultural land and are mainly found in the Khatlon region and the DRS. Pasture stocking is lower than during the Soviet period 25 years ago and the condition of pastures is not adequate. In the east of the Pamir the condition of the teresken (Eurotea) pastures has become critical. Here, due to a lack of energy sources, people have started a massive uprooting of teresken which is a valuable animal fodder and this has resulted in the desertification of highland pastures. In other districts cattle often graze near human settlements and thus local pastures have become overgrazed and degraded. More than half of the natural pastures in the country are in the highlands at altitudes varying from 1,700-2,000 to 3,500 masl. These pastures can be used for less than 100 days a year, mainly in summer. Access to these summer pastures has become difficult due to problems related with distant pastures, as well as the conditions of roads and bridges. On the lowland pasture, changes in the stand composition, predominantly of 'non-grazeable' grass, a reduction of productivity and increase of soil erosion and overgrazing has been observed.

The flora in Tajikistan is rich and diverse and includes 5000 species of higher plants, more than 3000 species of lower plants, including endemic and rare species. There is also a diverse wildlife that includes 84 mammal species, 385 bird species, 47 reptiles, 52 fish species, 2 amphibian species, and 10000 zoophyte species. The country's ecosystems are also very diverse and wild animals include rare and endangered species such as the markhoor, argali, Bukhara deer, and snow leopard. Tajikistan and neighbouring countries are considered as one of the world's biodiversity hot spots However poaching and illegal collecting and selling of natural resources, pollution and fragmentation of ecosystems plus increasing climate change impact threaten this uniquesituation.

2.4. Glaciers and water resources

Water resources in Tajikistan and neighbouring countries are mainly formed from glacial meltwater, frost and seasonal snow cover in the Pamir mountains. These sources feed the agricultural water supplies and power the turbines of hydropower stations. As a result of mudflows and floods, water resources can cause considerable damage to rural and mountainous areas and a deficit of water resources. The reduction in glacier runoff enhances the risk of droughts and the resulting degradation of aquatic ecosystems can cause damage to both the economy and the population. Glaciers and mountain ecosystems are abundant in Tajikistan and not only serve as water reservoirs and stream flow regulators, but also as the source of water for the Aral Sea river basins.

According to the Catalogue of Glaciers of the Soviet Union, in the period between 1960-1970, there were 8,492 glaciers in Tajikistan with total area of 8,476 km^2 . In 1983, based on a review of space images by the Tajik Branch of State Centre of USSR 'Nature', an Atlas, 'The Natural resources of the Tajik SSR' was published. The Atlas included a map of glaciers of the country at a scale of 1:500 000 and recorded 9,000 glaciers and glacier cover of 7,979 km^2. This period of assessment coincided with the inventory of glaciers in the Pamir and Gissar-Allai mountains undertaken by Central Asian Scientific-Research Institute in 1980. After this date no large scale and unified inventory of glaciers within the territory of Tajikistan has been carried out.

According to preliminary estimates the current glaciers (2003 – 2013) cover 7,000 km^2 or 4.8% of the land area of Tajikistan as compared to 6% in the middle of 20th century, as mentioned in the NAP. Due to warming, the area and volume of glaciers continues to shrink.

The glacier "Fedchenko" is largest in the world outside the polar regions. It attracts climate and glacier researchers, as well as politicians and the public. It is 72 km long, the ice depth of the mid-section reaches 1,000 m, and the volume of the main trunk is 125 km^3, 165 km^3 including side glaciers. In comparison, this is equivalent to total volume of all the glaciers in the European Alps. The glacier starts at an altitude of 6,300 m, while it's snout is located at an altitude of 2,910 m. The Fedchenko glacier is perhaps the most well studied glacier in the Pamir. The hydro-meteorological observatory named after Gorbunov was constructed on the glacier in 1933 but was shut in 1995 due to its remoteness and high maintenance costs. In 2005, an automatic meteorological station was installed instead. However field data is not yet accessible.

Photo. Glacier Fedchenko

There are over 100 glaciers that show surging characteristics in Tajikistan. Glaciers such as Medvejiy, RGO and others, experience fast movements which can block the rivers thus giving rise to potential flooding situations. The Hydrometeorology service of Tajikistan, jointly with other state structures, undertakes the monitoring of glacier movement ..

There are over 1000 lakes with water reserves of up to 46 km^3 in , with the salt lakesin highland deserts of the Pamir making up half of the reserve. The largest highland lakes include: Karakul – at 3,914 masl, Zorkul – at 4,126 masl and Sarez – at 3,260 masl. The total area of these lakes is over 680 km^2, whilst the total area of all lakes in Tajikistan is 700 km^2. Sarez is the deepest lake at over 400m and was formed as result of a landslide. It is a 'young' lake with an age of just slightly more than 100 years. More than 95% of all lakes in the country have an area of less than 1 km^2 and have small volumes of water. Many of them are vulnerable to tectonic and climate impact.

Photo. Lake Iskandarkul

Millions of people depend on the condition of snow reserves, glaciers and amount of precipitation in the mountains of Tajikistan - the 'water towers' of Central Asia. The rivers of the country supply approximately half of the flow to the Aral Sea basin. Average annual long-term natural run-off originating in Tajikistan is estimated at 53 km^3, which is 4 km^3 less than 50 years ago.

The average annual flow into the river basins 30-45 litres/sec/km^2 in the central mountain districts and less than 1 litre/sec/km^2 in arid districts. During the full flow, which coincides with intensive snowmelt and rainfall, rivers carry a large volume of suspended solids and the load of some rivers reaches 5 kg/m^3 (Amudarya, Kizilsu rivers). The level of water in the main rivers can increase by 2-4m during the flood periods leading to the destruction of roads, bridges and flooding of agricultural lands.

Starting in 2013/2014, Tajikistan is in a period of transition from an administrative to a hydrographical (or watershed) management of water resources. The country has a few large river basins: the Sirdarya (northern Tajikistan), the Zerafshan (central Tajikistan), the Kafernigan, Vakhsh and Pyanj rivers (southwestern Tajikistan and Pamirs), and basin of closed lakes in the eastern part of Pamir.

Photo. River Zerafshan

2.5. The Political situation

Tajikistan declared independence on 9th September 1991 and adopted its Constitution in November 1994. The constitution of the country adopted a presidential system of governance. The executive power of the country is nominated by the President and the Government of the Republic of Tajikistan. The President is the Head of the Government. Legislative power is composed of a bicameral parliament *(Majlisi Oli)*, a chamber of representatives (*Majlisi Namoyandagon*, 63 deputies) and a chamber of regions (*Majlisi Milli*, 33 representatives). Local government is comprised of representatives (Councils of People's Deputies) and executive bodies (*jamoat*).

Photo. Palace of Nation

The presidential elections in November 2013 were won by the current head of the government, Mr Emomali Rahmon. In November and December 2013 structural changes and a reorganization of the executive bodies of state power took place. The most important changes related to climate change included the formation of a Ministry of Energy and Water Resources (previously two separate agencies), and an increase and expansion of the functions of the State Committee on Land Management and the Ministry of Health and Social Protection, as well as the creation of the Local Development Committee. The integration of climate change issues into the planning and implementation of policies and measures by these and other governmental agencies is a high development priority. Implementation of the concept of e-governance is increasing and this development will have a positive impact on environmental reforms, including monitoring and reporting.

2.6. Socio-demographic situation and human capital

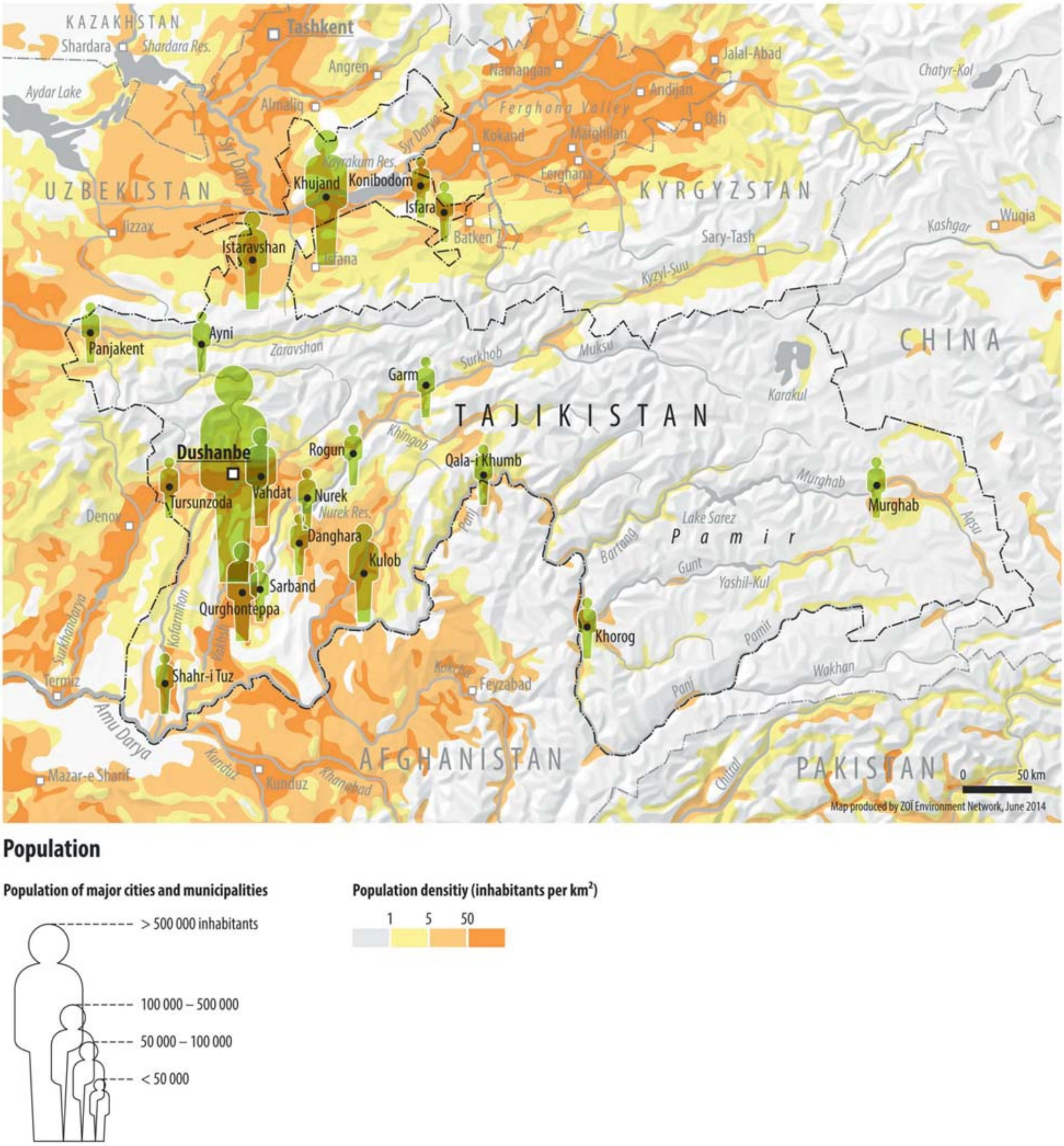
As of January 1st 2014, the population of Tajikistan was 8.1mln people, 1.5mln more than 10 years ago. In comparison, the total population of the country in 1950 was 1.5mln which means that the population has increased by more than 5 times during the last 60 years. The annual natural population growth is 2.3%. The population of Tajikistan is the 'youngest' in Central Asia. The average age is below 25 years, the median age of first marriage is 20 for women, whilst average the age of a mother at the birth of her first child is 22. The average birthrate is 3.8 children per women. Given the high birthrate, children comprise a considerable part of the population with 35% of the country's population being below the age of 15, whilst the population above 65 years is only 3%. Life expectancy is 72 years. Only 26% of Tajikistan's population lives in urban areas which makes the country the least urbanized in the region. Partly this is due to specific natural, historical and agrarian characteristics of the country. Although some of the towns are modern and 'young', other urban settlements in the north and south of Tajikistan such as Khujand (Alexandria Eskhata), Kulyab (Khulbuk), Penjikent, and Gissar have a rich one thousand year history.

The indigenous population of Tajikistan are the Tajiks who make up about 85% of the total population. Tajik belongs to the Persian group of languages and is the state language of Tajikistan. The main religion is Islam, dominated by Sunnies with exception of GBAO where Shiism (*Ismailies*) are predominant. The Russian language is the language of international communication and communication between different groups in the country. The Uzbek language (14%) is common in the north and the west of the country, while the Pamiri and Kyrgyz dialects are common in the east of the country.

The most densely populated areas (90-110 per km^2) include northern, central, and southern districts and oblasts with developed agriculture and industry. The average population density is 55 people per km^2 with highest density being in Dushanbe where over 765 thousand people live and the lowest is in the Pamir (3 per km^2).

The poverty rate has halved from 80-83% in 1999-2000 to 40-45% in 2009-2011 with the most notable improvements being in rural areas The development of entrepreneurship, attraction of investment, micro-financing activities and foreign aid have all resulted in job creation and poverty reduction. The main causes of poverty in Tajikistan are a high level of unemployment, especially among young people, a low level of education, limited access to power supply, water and sewage systems, and the degradation of natural resources. Tajikistan's Human Development Index was 0.622 2012 giving it the rank of 125th out of 190 countries, similar to Kyrgyzstan's. Living standards vary from region to region in the country.

Salary rates are low. The average salary in 2013 was 700 TJS with a ranging from the lowest salary of less than 300 TJS in agricultural sector to the highest salary exceeding 1,500 TJS in financial, industrial and construction sectors. As a result a considerable part of the working population,



predominantly men, have become labour migrants. The minimum salary and state pension is 300TJS. Unemployment statistics do not reflect the full picture since only 55,000people (2.5% of 2.2 mln of economically active population) have official unemployed status. According to the statistics, more than 200,000 jobs are created annually. However, major proportion of these are for temporary or seasonal work.

Labour migration to other former Soviet republics, especially to Russia and Kazakhstan, has significantly contributed to an increase in people's incomes and purchasing power. Annually, 1-1.5 mln labour migrants send remittances equivalent to 3-4 bln USD, which is about half (45-47%) of the country's GDP. Remittances from labour migrants' are the main source of family income and the financing of small businesses. According to the

World Bank (2011), remittances comprise about 40% of income of rural families. The rate of labour migration remains high due to the growing gap between increasing labour force and the pace of job creation over the last decade.

During the vulnerability assessment carried out by UNDP in 2012, migration was often mentioned by the respondents as a factor weakening the resilience of the population, especially to natural disasters. Other factors included the need to enhance the quality of, and access to, health services, as well as the need to maintain education standards and create incentives for young people and relevant specialists.

The health system includes about 450 functioning state hospitals, 1,700 medical centres and 3,700 different medical facilities. The state run Health Service is provided to the population by about 16,200 doctors, and 38,600 primary health care workers (20 doctors and 48 primary health care workers per 10 thousand people). About 6% of the state budget is spent on the health system. Annually, the number of private clinics and doctors is increasing, although even in the state institutions part of the treatment costs have to be covered by the population. A medical insurance system is underdeveloped.

Mortality as a result of infectious diseases such as malaria and typhoid, which are influenced by the climatic factors, has considerably reduced from the peak rates between 1996-1998. Success of anti-malaria activities was possible mainly due to the support of the World Health Organization (WHO), UNDP and bilateral aid. Despite the progress made in the improvement of mother and child care, many problems related to reproductive health remain unresolved. Goitre, anemia, and vitamin deficiency among children and women are still prevalent. Child mortality (under 5 years old) has reduced from 120 per thousand live births children in 1993, to 76 in 1998-2002 and further to 43 in 2008-2012. The highest rate of child mortality is in Khatlon oblast (south of the country), whilst the lowest is in Dushanbe city. In Dushanbe the infant mortality rate (under 1 year) is 34 per thousand live births children, while the child mortality is 9 per thousand live births.

In Tajikistan the prevalence of HIV/AIDS remains low with 0.3% of the population being HIV positive in 2011, the majority of whom are of aged 15-49. The disease is most common among the drug users.

Education is a priority sector for the country. Up to 16% of the state budget (above 2 bln TJS) is allocated to the education sector. The number of schoolchildren in 2014 exceeded 1.8mln, with a further 200000 students enrolled in higher education and specialized technical institutions. More than 90-98% of children attend elementary school (grades 1 – 4) and 85% attend secondary schools (grades 5 – 11). In elementary schools there is no real difference between the enrollment of boys and girls.

There are 3700 comprehensive secondary schools, and more than 100 technical and higher education institutions providing training in 150 specialisms. The highest number of people with higher education, especially among girls (20%), is in Dushanbe city and in the GBAO. More than 5000 students from Tajikistan are enrolled at higher education institutions in USA, Europe, Russia, China, Turkey and other countries. The specialized technical education institutions train specialists in education, health, culture, economy and agriculture sectors. The number of non-state education institutions is increasing every year. Elementary and secondary education remains free and accessible to majority of the population. However, the quality has declined. Over 200000 people are engaged in the education sector. The level and quality of education, knowledge and awareness, as well as the skills of the teachers and students does not meet any current international standards and requires continuous improvement. Despite significant progress, knowledge and understanding of climate change issues remains limited.

Access to electronic information and mass media is increasing and improving. The ownership of mobile phones has grown from 10% in 2005 to more than 90% in 2012. Almost all households (95%) in Tajikistan have a television but only 25% have radios. About 30% of the population read newspapers and magazines. The percentage of information obtained from different sources is similar. Five to ten percent of the population has permanent access to internet with a considerable proportion of the population having irregular access to internet, including through mobile phones.

2.7. Macroeconomic situation and development

After gaining independence, structural reforms and a change of priorities have taken place in Tajikistan. The transition from a centrally planned to market economy, and collapse of the economy has affected the composition and volume of the country's GDP. Between1992-1997, there was a sharp decline in production and hence of GDP. The situation was further aggravated by the Civil War. Since 1998 the situation started to stabilise and improve and there has been a rapid growth in many economic areas over the last decade. In 2012, GDP reached 6.7bln USD (961 USD per capita). The average annual increase in GDP exceeded 6%, mainly due to remittances from labour migrants, the development of the service sector, agriculture and industry. The annual rate of inflation fell from 30% in 2000 to its current 6-7%. The local currency strengthened and so did the budget. Per capita GDP increased by more than 5 times. The government is taking active measures to improve the investment climate, to reduce barriers to doing business, and to attract private investment. In 2013, Tajikistan joined the World Trade Organisation (WTO) but still the volume of private investment remains low (below 5% of GDP).

The country exports aluminum, light industrial goods, cotton, agricultural goods, electrical energy, semi-precious stones and other mountain products. The main export partners include: Turkey (40%), Russia (10%), Iran (10%), as well as Afghanistan, China, Kazakhstan and Switzerland. The main imported goods are energy products, timber, metals, pharmaceuticals, food and household goods. The goods are mainly imported from the following countries: Russia (20%), Kazakhstan (15%), China (15%), as well as Lithuania, USA, Kyrgyzstan, Turkey and Iran. Insufficient use of energy-saving technologies and insufficient energy supply pose considerable barriers in enhancing the competitiveness of local production.

There are four Free Economic Zones in Tajikistan: the Soughd (area of 320 ha, 11 business entities producing solar panels, tubes, doors, windows, plastic containers, and meat products), Pyanj (400 ha, construction is ongoing), Dangara (520 ha, construction is ongoing) and Ishkashim (200 ha).

The global economic crises 2008-2010 had a negative impact on country's economy and also affected the earnings of labour migrants.. As a result many of the labour migrants had to return to Tajikistan. The situation has improved in 2012-2014 when the volume of labour migrant remittances reached their maximum.

2.8. Energy and energy resources

One of the preconditions for sustainable socio-economic development and poverty reduction in Tajikistan is the development and effective use of energy resources. Tajikistan is the world's leader in terms of its hydro energy potential (3.6 mln kWh/ 1 km^2 /year). Almost all energy needs of the country are met through hydro power.

The country has oil (more than 100 mln tons), gas (more than 80 bln m^3) and coal (4 bln tons, including 320 mln tons of industrial reserves) deposits. However, the volume of mining and processing is insignificant. Therefore Tajikistan has to import oil. Internal gas production output is 7-8 mln m^3, but 30 times more than this is imported.

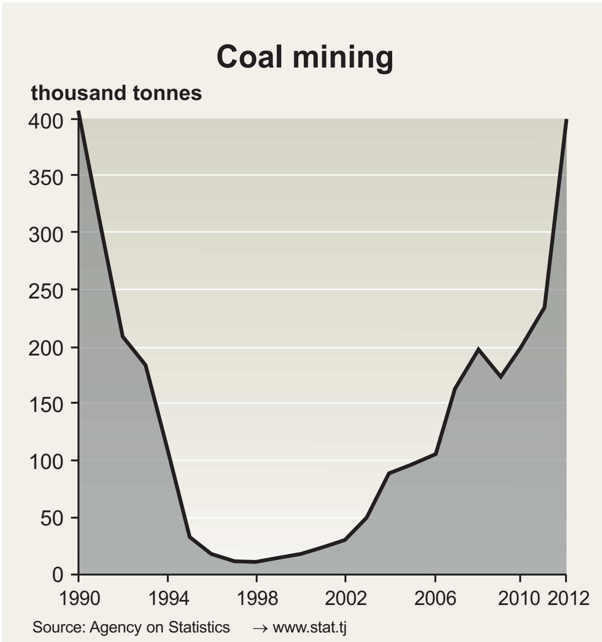
There are 42.2 mln tons of known and predicted coal reserves in Tajikistan made up of 0.2 mln tons of lignite and 42 mln tons of anthracite. The energy

Photo. Nurek Hydro Power Plant

content of the coal varies between 6,500 and 9,100 kKal/kg. The main coal reserves are at the Fon Yaghnob mine located in central Tajikistan. Total production in 2013 exceeded 515,000 tons, including 415,000 tons of anthracite and 100,000 tons of lignite For comparison, total production of coal in 1991 was 310000 tons. Extracted coal is used for industrial purposes and the needs of the population. Tajikistan is making an effort to reduce dependency on oil imports through increased coal mining.

The current situation in energy sector is quite complex. On the one hand Tajikistan remains the lead producer of eco-friendly hydro-energy, whilst on the other , reducing the energy deficit requires diversification of energy sources through the construction of new of coal fired power plants. This is an environmentally hazardous was of producing electricity, but at the same time a necessary measure. Having said that the construction of thermal power plants based on new coal fired power station technologies would be a possible option.

Gas-fields are being actively explored in the southern districts of the country by Chinese, Russian, and Western companies. It is estimated that the majority of potential large fields are located at a depth of more than 6km and therefore require large investment. The predicted reserves are promising and perhaps after 5-10 years of extraction, Tajikistan might be able to overcome energy shortages of gas. As for oil products, the Limited Liability Company 'Gazpromneft of Tajikistan' is the leading supplier of petrol and diesel imported from Russia. Internal production of oil is below 100,000 tons and there are currently no oil refining plants in the country. In cooperation with China, the construction of a refinery with a capacity of 1mln tons per year started in 2014.



Traditionally, natural gas used in Tajikistan was supplied by Uzbekistan. In the early 1990s gas consumption exceeded 4-5bln m^3. In 2004 – 2012 the volume gas imported dropped from 620-640 mln m^3 to 130 mln m^3 and in 2013 the contract for supply of gas from Uzbekistan was not renewed and thus the supply ceased. As a result, a number of industrial plants and communities were left without energy.. The aluminum plant, which is the largest gas consumer, switched to coal gasification. As an alternative source of fuel, the supply of liquid gas from Kazakhstan was increased, exceeding 200 thousand tons in 2013. China is planning the construction of a gas pipeline from Turkmenistan which will result in increased supply of gas to Tajikistan.

After the collapse of the USSR, Tajikistan faced a challenging situation in supplying the economy and the population with fuel and energy resources. The current make up of fuel consumption has changed

Energy sources

Hydroenergy
Total potential: 527 bln kWh
Cost-effective potential:
317 bln kWh
Average production:
16.5 bln kWh

Traditional Thermal energy
Insufficient development of thermal energy
Energy units run based on coal
Contribution to generation of electricity is less than2%

Hydrocarbon resources

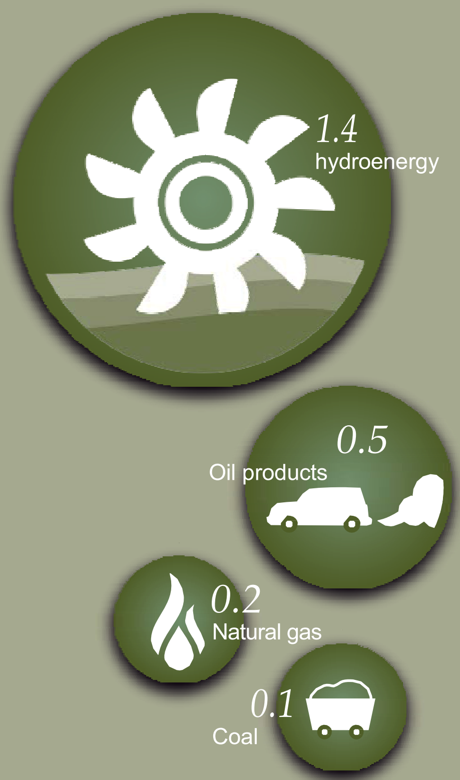
Coal 4 bln tonnes
Oil 100 mln tonnes
Gas 80 bln mi

Renewable energy potential (estimate)
Solar 25 bln kWh
(insufficient use)
Wind 25 bln kWh
(insufficient use)
Geothermal 25 bln kWh
(not used)
Biomass 2 bln kWh
(not used)

Source: UNDP Tajikistan (2011), Strategy for Integrated Rural Development based on Renewable Energy Sources

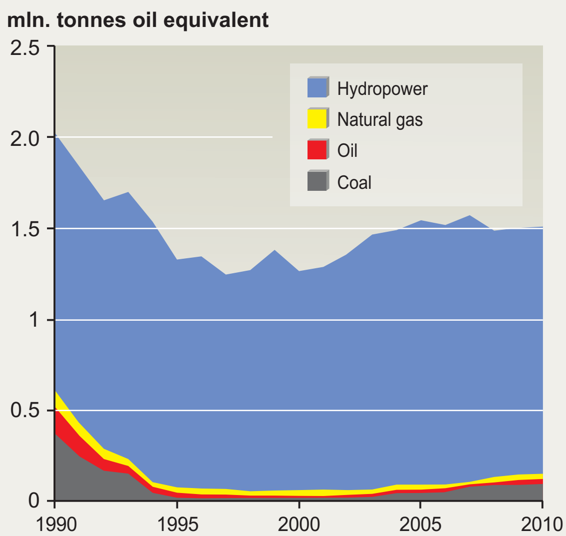
Primary use of energy sources

mln tonnes of oil equivalent



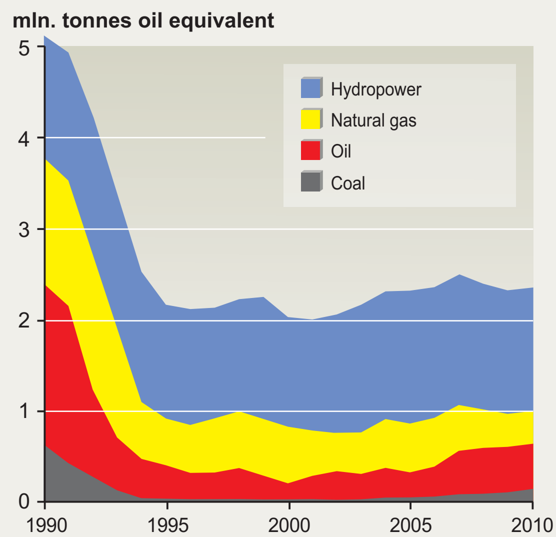
Source: International Energy Agency www.iea.org

Energy production



Source: IEA → www.iea.org

Primary energy supply



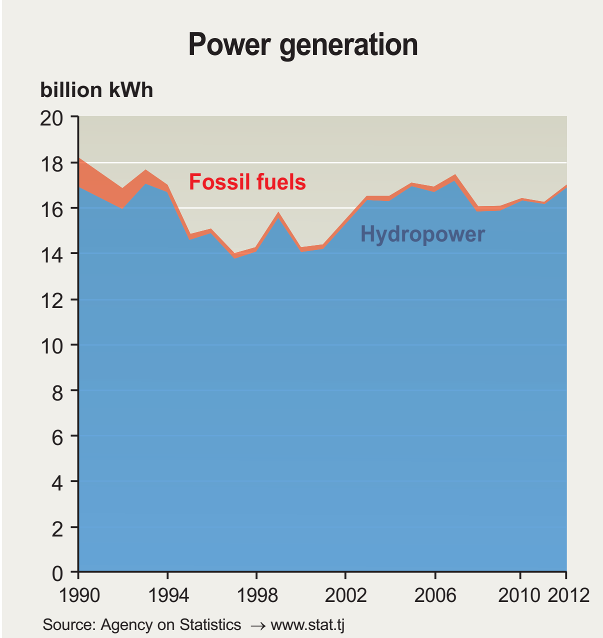
Source: IEA → www.iea.org

considerably compared to 1991. In 2010, the consumption of gas fuel reduced by 8-10 times (the import of natural gas completely stopped), and of oil by 5-8 times. On the 10th January 2014, one power unit (5mW) of a new Thermal Power Plant with a total production capacity of 100mW located in the centre of Dushanbe was commissioned. The construction of new coal based thermal power plant with the capacity of 50mW in Khujand (north of the country) is planned.

Water is the main and most promising source of energy in Tajikistan, with hydropower being Tajikistan's main source of electrical energy. Hydropower potential is estimated at 527bln kWh per year, including a cost-effective (technical) potential of more than 317bln kWh per year. Currently less than 4-5% of this potential is being realised. Hydropower is renewable. It does not create GHG emissions and is highly profitable.

The total capacity of power stations is 5,200mW made up of 94% hydro and 6% thermal power. The capacity of Tajikistan's power plants as of the 1st January 2012 reduced to 1,100 mW (a reduction of 4,100 mW) because of the deteriorating state of equipment. The area of water reservoirs is 665km^2, and the volume, 15.3 km^3, including 7.6 km^3 of usable storage. The generation of electricity varies between 17-18 bln kWh per year. Due to the high cost and lack of fuel oil (masut), diesel fuel and natural gas, thermal power stations are only partially operational. In fact, 99.5% of energy was generated from hydropower in 2013. During the year, there are two peaks of power generation (in summer and in winter). In spring (March – April) the level of water in rivers is low and is allowed to build up in reservoirs. In the autumn (October – November), water is saved for power generation in winter period.

The energy system in Tajikistan consists of 6 large Hydro Power Plants (HPP) 3 thermal power plants, and many small, micro and mini-hydro power plants. The work on the construction and renovation of vital infrastructure plants such as the HPP Roghun, the TPP in Dushanbe, the small HPPs on the Vakhsh and Zerafshan rivers, and the high



voltage power transmission line between Kyrgyzstan, Tajikistan and Afghanistan are ongoing. In 2011 a unified energy system of the country linking the southern and northern energy systems was built.

To improve energy security and reduce the dependence of communities on imported of energy sources and electrical power, more than 300 small and mini-HPPs with the capacity varying from 5 to 2 500 kW have been built of which 175-200 units are currently operational. They are located in the DRS, Soughd oblast, and in the GBAO and their total capacity is 16-20 thousand kW. Subject to a timely implementation of the State Programme on construction of small and mini-HPPs, it is expected that by 2020 the total capacity of these HPPs will reach 90 mW generating 40mln kWh per year. The main causes of the slow development of hydropower are the current legislative and legal requirement, as well as the complexity of obtaining permission documents and a number of other technical and human resource related problems.

The HPP Nurek produces 75% of total energy generated in the country with anaverage annual power generation of 11 bln kWh. The 2nd largest HPP is Sangtuda – 1 which generates 15% of the total volume of energy.

Photo. Thermal Power Plant in Dushanbe

The current hydropower potential of Tajikistan comprises the cascade of HPPs on the Vakhsh river the largest of which is HPP Nurek (3 thousand mW). Others include the HPPs Sangtuda - 1 (670 mW), Sangtuda -2 (220 mW), Baipazi (600 mW), Golovnaya (240 mW). Other cascades of HPPs are based on the Varzob (25 mW) and on the Sirdarya rivers (HPP Kayrakkum, 126 mW). Since 2002 HPPs in the Pamir have been under the concession of the Aga Khan Foundation through the 'Pamir Energy Co.', including HPP's Pamir – 1 (14 mW), Qalaikhumb (0.2 mW), Vanj (1.2 mW), Namangut (2.5 mW), Ak-Su (0.64 mW) and others with total capacity of 28 mW.

Except for HPP Sangtuda - 1 (operational since 2008) and Sangtuda – 2 (operational since 2012), all the other HPPs were constructed in Soviet times and thus require modernization. With funding from international financial institutions and private capital the State Energy Company 'Barqi Tojik' is reconstructing the HPP Kairakkum and planning to reconstruct the HPP Nurek and HPP Golovnaya. Recently the reconstruction of a cascade of HPPs on the Varzob river was completed.

Despite sufficient per capita production indicators, energy supply to the rural population is limited and the energy deficit during autumn and winter reaches 2.5bln kWh. Therefore power supply limits are introduced every year. Except for the larger cities, electricity is supplied to the population for 2-8 hours per day. These circumstances compel the rural population to use forest wood, cotton stems and other biomass for heating and preparing food. The rural population makes up 75% of the total population, but uses less than 10% of the total volume of electricity. Annually, due to electricity cuts in rural areas, agricultural losses reach 30% and many small entities stop working.

In summer period Tajikistan can generate sufficient electricity to meet the local demand and also to export to neighboring countries. The volume of water discharge through the HPP turbines in the summer period depends on the dryness of the year and varies from 3.5 to 7.5 bln kWh, averaging 6bln kWh. Taking into account the average price of 3 cents per kWh for electricity, Tajikistan could make a profit of 100-200 mln USD from selling surplus energy to external consumers.

In Soviet times and early years of independence, no energy deficits were faced in Tajikistan because there was a unified energy system for Central Asia and Kazakhstan enabling mutually beneficial

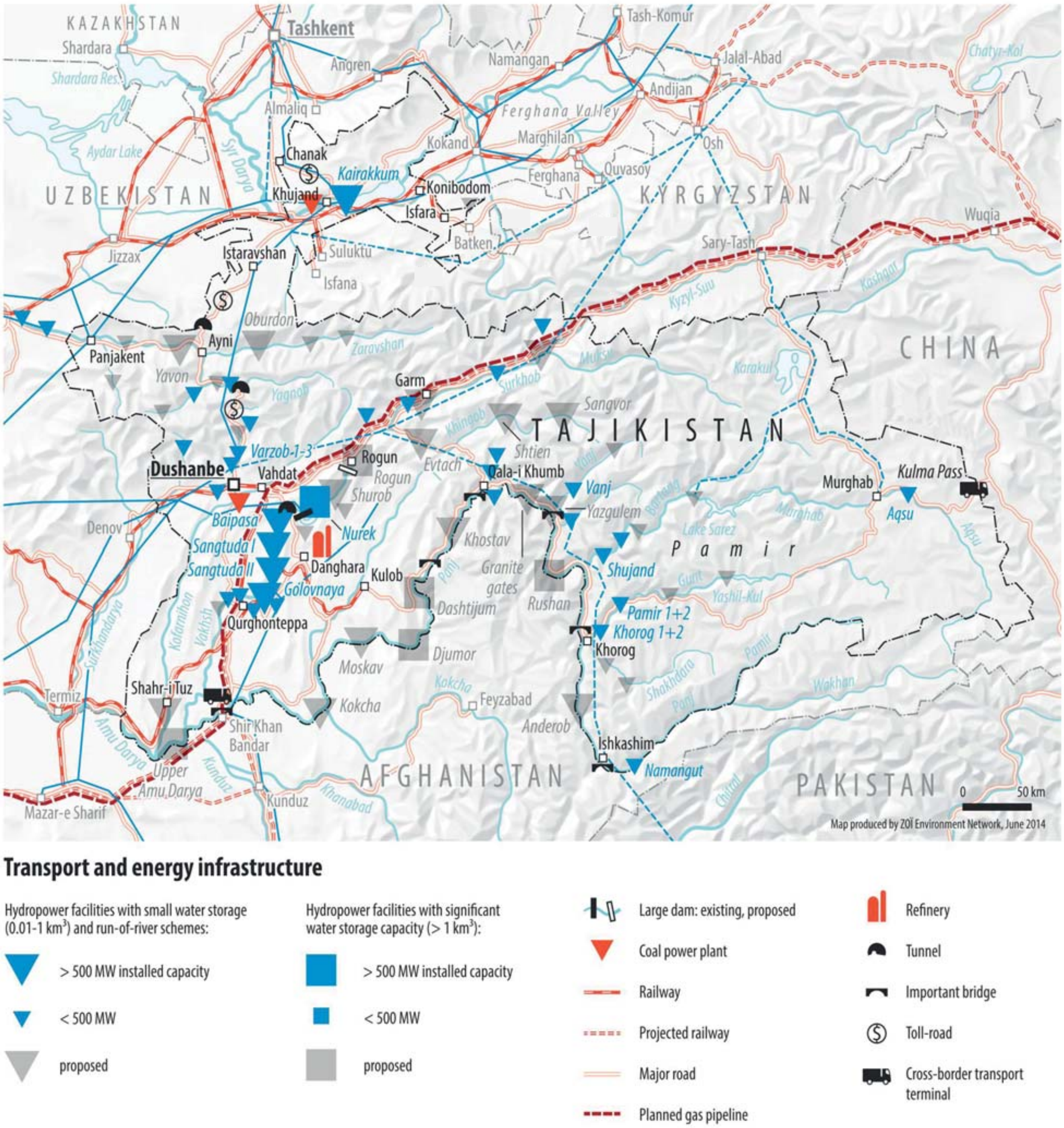
Photo. Power Transmission Lines

exchanges of electricity (up to 2bln kWh). In 2009, Uzbekistan left this unified system and this affected the situation in Tajikistan. The exchange of electricity with Kyrgyzstan continues, but in considerably smaller volumes.

The construction of the HPP Roghun on the Vakhsh river with the total capacity of 3.6 thousand mW was started in Soviet times. Operation of this HPP could have substantively improved the current situation of energy and water shortages in Tajikistan and neighboring countries. In 2010 – 2013, an independent socio-environmental assessment and technical assessment was made of different designs for the construction and operation of the HPP, supported by the World Bank. In summer 2014 the report was submitted and a round of regional consultations carried out and it is planned that by 2020 the HPP will start supplying energy from the first two power units. The completion of all construction and filling of the reservoir is expected to be completed by 2030. The new design estimates follow the latest international standards which apply greater coefficients for sustainability and reliability of hydraulic structures than those of the previous Soviet Union. Negotiations are taking place on the construction of a power transmission line CASA-1000 linking Kyrgyzstan and Tajikistan with other Asian countries, especially Afghanistan and Pakistan, which experience shortages of electricity in summer. Power supply in remote mountain districts is very limited and the use of small and micro-HPPs as well as other renewable energy sources could serve as a promising solution.

In view of the limited supply of heat and natural gas in urban areas and an inadequate supply of energy in rural areas, the population has to use electricity for heating and cooking purposes. Demographic growth and socio-economic development of the country has resulted in an increased demand for energy. Hence, the consumption of electricity by the population has increased by 7-8 times in last 20 years.

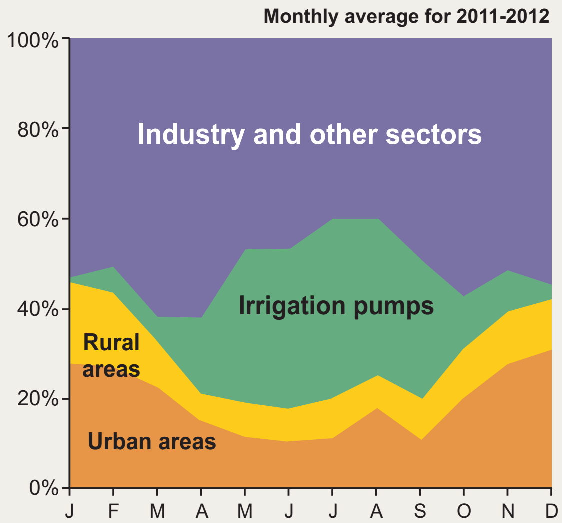
2000, 2001, and 2008 were years of extreme climate conditions with low precipitation or extremely low temperatures in winter and spring. These conditions led to a reduction of water supply to the Nurek HPP. . 2002 was a dry year and Tajikistan had to allow a huge discharge of water from the Nurek reservoir to maintain the agricultural lands downstream in countries sharing the Amudarya basin namely Uzbekistan and Turkmenistan. In exchange, these countries covered the power generation deficits experienced by Tajikistan through increased energy exports. The winter 2007-2008 was extremely cold with air temperatures reaching –minus 30°C there was a significant reduction of water flow to the Nurek reservoir. At this time the grid power load has increased, while the volume of power generation reduced, resulting in economic losses.



A lack of energy or its deficit has a negative impact on both the economy and people's well-being with service provision in communities and housing, education and health sectors all being affected. Problems caused by an ongoing and systematic lack of electricity for households also creates social tensions. To ensure a more efficient use of electricity the Government of Tajikistan took the decision to ban the use of traditional filament bulbs and switch to energy-saving lamps. Companies producing energy-saving lamps have been established and recycling sites set up. Given the increasing demand for energy at the household level, standards on energy-efficiency for household and communal goods were developed.

The industrial sector, mainly the aluminum company 'TALCO', is the biggest end-user of electrical energy (40% of the total). The general population consumes 30% two thirds of which is consumed by the urban population and one third by the rural population. Electricall energy consumption by irrigation machinery increases from April to September. Pumping stations consume up to 20% of Tajikistan's electricity, while the remaining sectors consume up to 10%. In 2011, the average per capita energy consumption was 1 000 kWh per year for urban residents, and 250 kWh per year for rural residents.

Power consumption



Source National energy company Barki Tojik → www.barkitojik.tj

Energy tariffs in Tajikistan are not very high. However, given the low level of income, these tariffs represent a substantial item of expenditure in the household budget. As of 1st April 2012, the energy tariffs were as follows: 11 dirams per kWh for the domestic consumers, 26 dirams per kWh for industrial consumers (except for aluminum production for which the tariff was set at 7 dirams per kWh), 10 dirams per kWh for the public sector, including the community and transport sectors. A reduced tariff is applied to pumping stations (irrigation and water supply) of 1.5-2 dirams per kWh.

Any increase in tariffs for the general population can increase social tensions and the vulnerability of poorer population groups, as well as making it more difficult to pay for electricity. Annually the government provides budget subsidies for electricity to 130000 low income families. The main non-payers are pumping stations and the industrial sector.

In the GBAO energy is supplied by the Private Company 'Pamir Energy'. From the start of its operations the company experienced considerable commercial and technical losses and non-payment by consumers As a result of building professional capacity, an improvement in the measurement of electricity use and the application of modern methods for controlling consumption, the collection of tariffs increased to 100%. The energy surplus is sold to Afghanistan through the renovated power transmission lines. The experience of the company shows that the development of small energy companies can accelerate the achievement of the Millennium/Sustainable Development Goals in remote mountain regions. In other regions of Tajikistan energy losses remain high, at times reaching up to 2 bln kWh per year (14-18% of total generated power).

To date, photovoltaic and wind energy systems are used only on a pilot basis. With the support of private entrepreneurs and donors, solar panels and solar water heaters have been installed in some urban and rural hospitals, schools, and private houses.

In the medium term until 2020, there is the possibility of uncertainty ofsupply in the fuel and energy sector due to increased energy consumption by industrial and domestic consumers on one hand and the underdevelopment of sources of power supply on the other. This problem is being addressed through the introduction of energy-saving technologies, construction of new power plants including those based on available fossil fuels, and the development of RES. The World Bank is supporting Tajikistan in identifying other options of power supply.

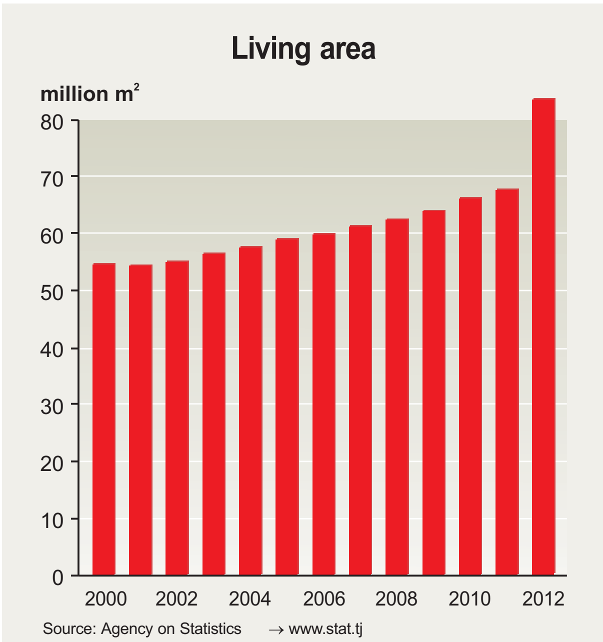
2.9. Housing conditions and infrastructure

The population of Tajikistan was 6.1mln in 2004 and more than 8.1 mln in 2014. The urban population made up 26% (about 2mln people) of the total population. Urban residential buildings are generally heated by gas as large cities have centralised

Photo. Solar panels for power supply to a medical institution (Dushanbe)

heating systems. However, over the last ten years the supply of gas has been limited and therefore many of the central heating and hot water systems stopped working whilst those that are still operational are not used to their full potential. Rural residential buildings, farms, and greenhouses are heated using many different types of energy including electricity, coal and animal waste. Urban residential buildings,especially those built with reinforced concrete,are not energy-efficient. Therefore energy consumption for heating or air conditioning is very high. Due to the deterioration of residential buildings in cities, people have to use more energy in their homes and this compounds the effect of low energy-efficient buildings. In rural areas the construction materials used for building houses and the types of stoves/heaters and heating systems used affect energy consumption. According to expert assessments, large scale adoption of energy-saving and energy-efficient measures coupled with the use of RES could increase the efficiency of energy consumption in the communal sector by 20-40%.

In rural households electricity consumption constitutes between 2% and 15% of all energy needs. The use of wood makes up between 35 to 85%. The remaining energy sources include animal waste, coal, and fuel gas. In urban households, energy is: electricity consumption,35% (with exception of Dushanbe –where it is 90%), wood 30-35%, and coal and oil products 15%. For all households, the main energy sources used for heating are wood (40%), electricity (25-30%), dried animal waste (10-15%) and coal (less than 15%). Energy sources used for cooking purposes include electricity (50%), wood (more than 20%), and liquid gas. More than half of the households, mainly in urban areas, use refrigerators and fans. The use of air conditioning is not widespread. Poverty also exacerbates problem of power supply since expenditure on fuel and energy in the winter period takes 35-50% of a household budget, with this mainly being spent on coal and wood.

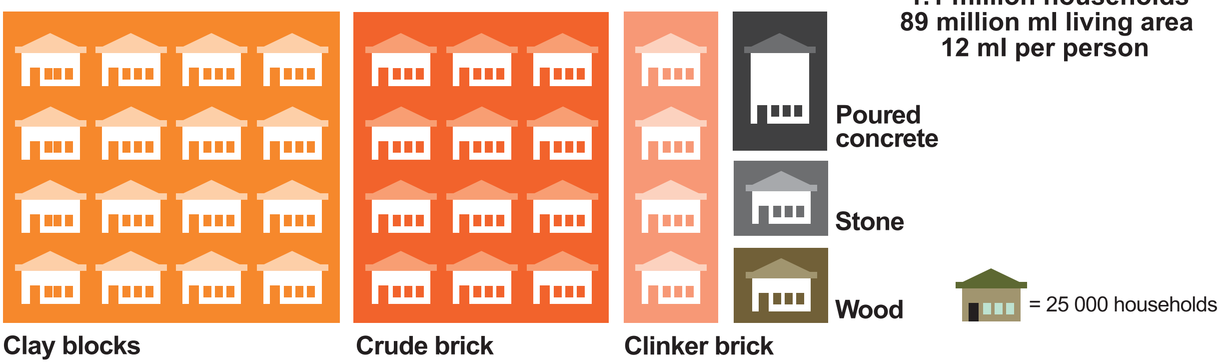


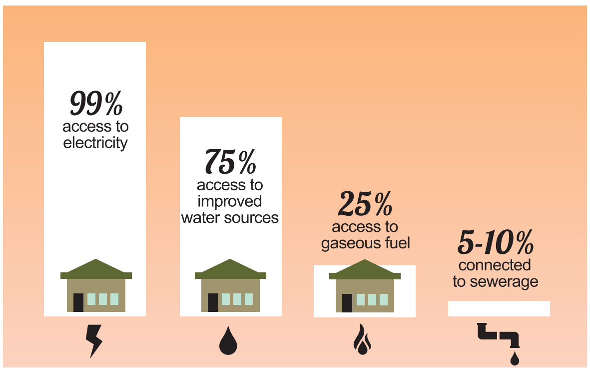
There were 1.1 mln dwellings in Tajikistan as of 1st January 2010, including 920,000 individual houses accommodating 6.5 mln people and approximately 220,000 apartments accommodating 1 mln people.

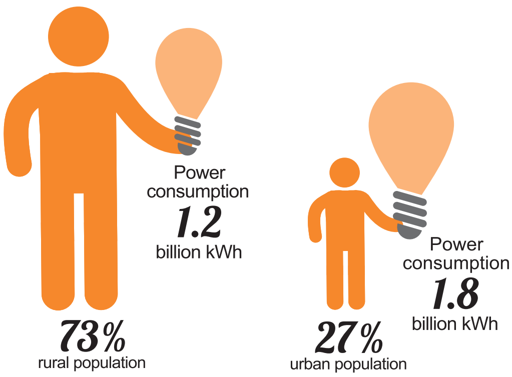
The residential sector and energy use by population

Energy use by households

Construction materials







Approximately 1mln households are composed of 4-5 or more people, while the average household size is 6 people. There are 10,000 appartment buildings predominantly in urban areas. More than 90% of residential buildings are privately owned.

After two decades of stagnation in the construction sector, an individual and multistory housing construction boom started in Tajikistan in 2010. It is expected that in the coming years house building and the number of houses will substantially increase. Depending on available finances, many private entrepreneurs and construction companies use modern energy efficient construction materials and solutions. At the same time energy related building requirements becoming more stringent.

As is the case in the entire former Soviet Union, in Tajikistan there is a problem of maintenance and servicing multi-storey buildings. These buildings were inherited from the Soviet times and then privatised. Laws and regulations on the maintenance of such buildings have been adopted, however in practice these are not implemented. Mechanisms for maintenance and the amount of financing available do not meet the real needs. In addition many individual houses were constructed without project designs and often do not meet construction regulations. The construction of individual properties mainly relies on locally accessible construction materials and are often financed through savings of future owners. Rental and mortgage systems are not well developed and not accessible. Decent urban housing is too expensive for the majority of the population. Procedures for property registration and land use planning are still complicated.

Electricity is supplied to 99% of the population. Gas fuel, mainly bottled gas, is used by 2 mln people (25%). Centralised heating sysems are accessible to only 70,000 people mainly in the central districts of large cities. Traditional stoves are used by more than 5.5 mln people, while 1.3 mln people heat their houses using electricity. The heating system for cities and other urban settlements of Tajikistan in Soviets, envisaged a centralized supply through gas and/or mazut based boiler-houses. Due to the shortage and high cost of gas and mazut, none of the boilers now work, whilst many of the centralised heating systems have been dismantled. For cooking, the rural population uses solid fuels (wood, animal waste and coal) more often than the urban population. The proportion of the rural population using solid fuels for cooking has reduced from 48% in 2005 to 40% in 2012. Eight out of ten households cook meals outside the house, in the street or in a separate building and which reduces the risk of air pollution from the smoke from fires.

Up to two million people obtain water from a central water supply system. Approximately the same number of people use water from taps outside their houses. More than 3mln people use 'open' sources of water. The proportion of population having access to improved water sources has increased from 57% in 2000 to 76% in 2012 (including 95% of urban and 71% of rural population with highest coverage in Dushanbe and lowest in the Pamir). Around 50% of the population has an indoor water supply. Washing hands with soap and water is a proven hygiene practice that reduces the risk of disease transmission and it is estimated that this practice is applied by 80-90% of households.

Photo. Urban settlements in Dushanbe

Photo. Typical rural settlement in mountainous area

About 1.5 mln people have access to a centralised sewage system and septic tank. Around 1mln people have indoor toilets and 6.5mln people have outdoor toilets. Almost all households use an improved latrine structure with most of them being slabbed pit latrines (mainly in rural areas). More than 2.5 mln people, mostly those living in urban areas, benefit from waste collection. More than 5mln people, also mainly those living in rural areas, put their garbage outside where sometimes it is collected. Water supply, sewage and waste collection systems are degraded and thus not able to meet the needs of the growing population.

2.10. Transport and communication

One of the strategic objectives of Tajikistan's economic policy is to reduce the impacts of its geographical isolation and transform the country into one with a convenient and modern communication infrastructure. In this area real progress has been achieved over the last 10 years. Over 1,600 km of roads, 15 km of tunnels and more than 100 bridges including 6 bridges over river Pyanj, have been built and/or reconstructed. The volume of export-import transport and transit through Tajikistan is increasing and so is the road safety.

From the beginning of the 20th century Tajikistan has been transformed from a land of 'off roads', dangerous mountainous passes and caravan trails to a country with a developed road system. Currently the country has over 500km of railways and 14 thousand km of public roads including 13 thousand km of surfaced roads. The length of all roads is 26 835 km.

Globally, the number of motor vehicles is increasing every year. This trend is also true for Tajikistan. In 2005 there were 250,000 vehicles in the country, including 210000 individual vehicles most of which were more than 10 years old. By 2013, the number of vehicles had reached 400,000. Having said that, vehicle ownership is still very low at 45-55 vehicles per 1000 people, the lowest rate in Central Asia. Moreover, as a result of economic pressures, a large proportion of vehicles, around 60%, have been converted to liquid gas fuel.. This has led to reduced level of pollutants and GHG emissions. Nevertheless, in 2012, carbon dioxide emissions from transport made up 70% of total emissions which is 3 times higher than 15 years ago. Between 2008 and 2012, the annual number of imported vehicles varied from 34,000 to 94,000 with an average of 50,000 vehicles per year. These are mainly secondhand vehicles from Baltic and Eastern European countries and vehicles constitute the largest share (25%) of goods imported to the country. According to expert assessments, the number of vehicles will rapidly increase and might double in 5 years time and as a result emissions of GHG and harmful substances will also increase. In view of this, the gas and transport sector, as well as infrastructure will require more attention whilst roads need to be constantly modernized and the streets greened.

Automobile transport and infrastructure plays a leading role in economic development and livelihood activities. More than 90% of freight and passenger transport within the country takes place using vehicle transport because the railways are not well developed due to the mountainous terrain. Annually, 1mln passengers are transported by airlines to Central Asian countries, Russia, Turkey, Arab Emirates, Iran, Afghanistan, and China.

City public transport is underdeveloped. An increase in private city transport (microbuses) has on one hand partially reduced the problem of passenger traffic in large cities, whilst on the other hand, coupled with the increase of private vehicles, the increase often causes traffic jams and thus poses additional safety risks for passengers and pedestrians.

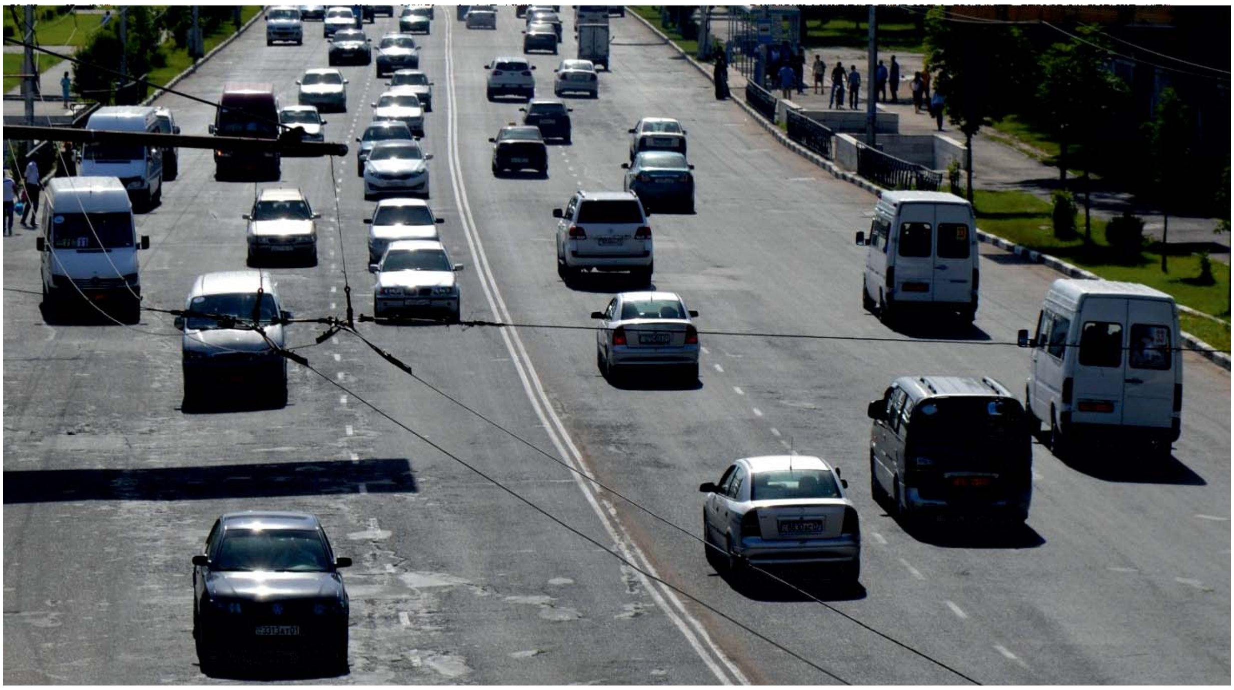


Photo. Automobile Roads in Dushanbe

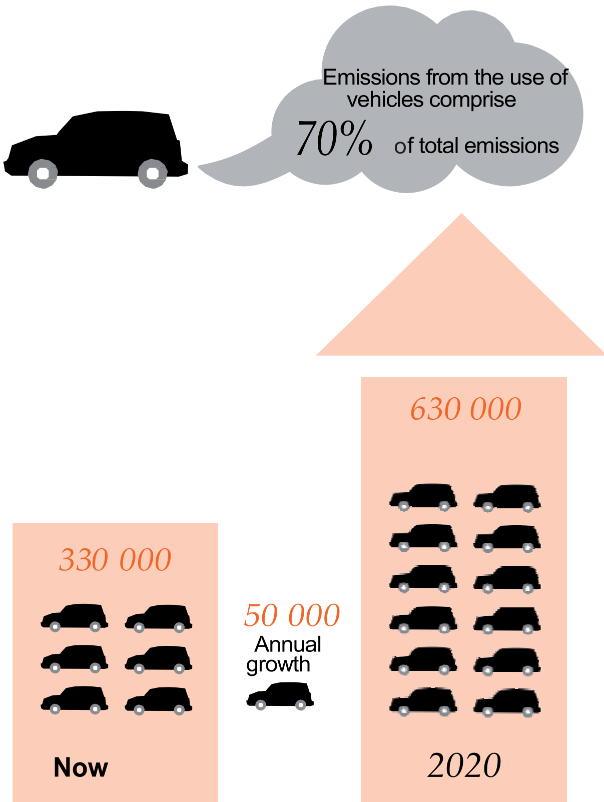
Transport and infrastructure

Automobile
Length of roads more than 13,500km; main passenger and freight traffic takes place via automobile roads

Railroads
Length of railroads is around 500km; network is limited due to mountainous landscape

Air
4 international airports and more than 15 air planes serve 1.5 mln people

Silk Road
New roads, tunnels and bridges connecting bordering areas and terminals of Afghanistan and China, were constructed.

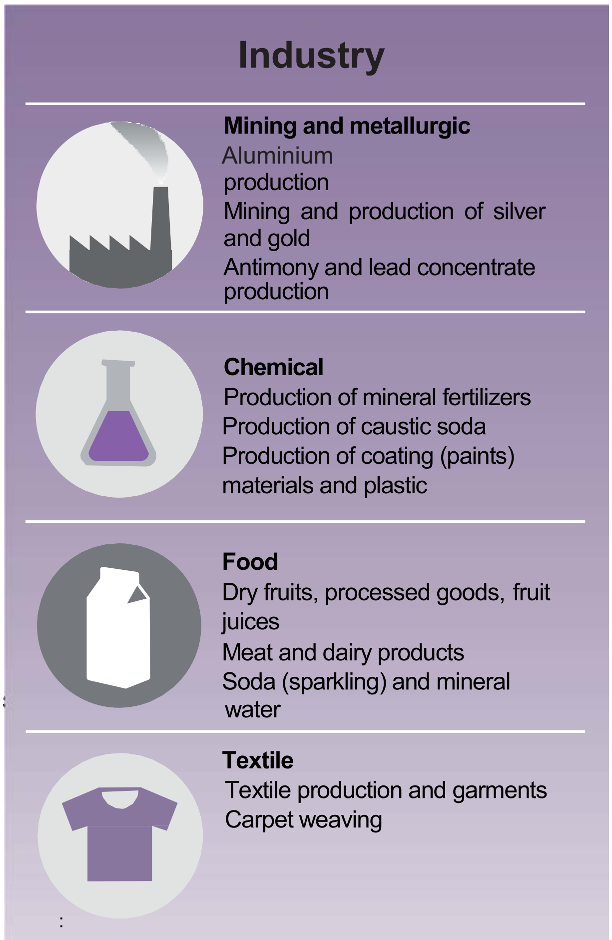


Source: State Statistics Agency under

2.11. Industry

The structure of industrial production is largely associated with the chemical and metal industries. Textile and clothing manufacturing as well as the food industry are also well developed. Nonetheless, industrial share of GDP has declined from 24% in 2000 to 12% in 2010. Just before the collapse of the Soviet Union, the leading industrial sectors were light (50%) and food (15%) industry. The situation has changed since 1991. Now the leading sector is the non-ferrous metal industry (35-40%), food industry (20-27%), and others. Primary aluminum is the main item of export (40-55%) which is equivalent

to approximately 500mln USD per annum. The Soughd oblast is the leader by volume of industrial output. More than 100000 people are engaged in industrial sector.

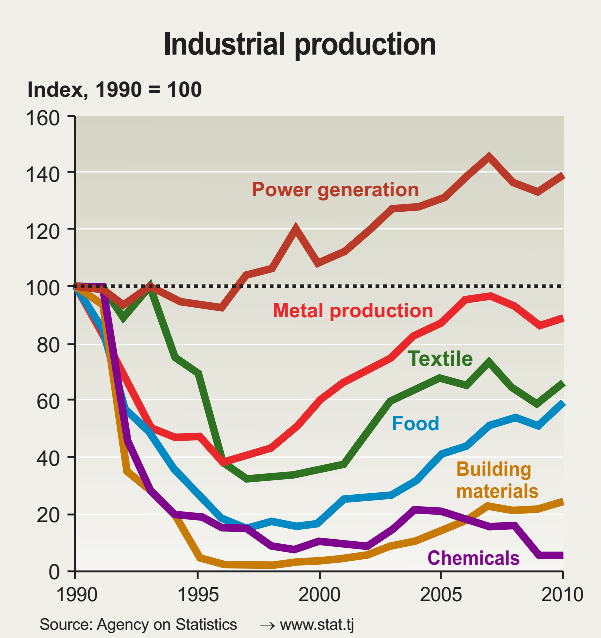


Despite the abundance of precious metals such as gold, the volume of extraction remains insignificant. During the last few years, the average volume of production reached 2-2.5 tons, with more than half of the volume being extracted by a China-Tajikistan Joint Venture 'Zarafshon' (the Chinese partner is the ZiJin Mining Group) in central Tajikistan. It is expected that by 2015 production will increase to up to 5 tons per year. In 2014 construction started on a new Steel Mill in the north of the country with the total capacity of processing 50,000 tons of zinc and 50 000 tons of lead per year.

Until recently, there was only one cement production company in Tajikistan, the Dushanbe Cement Plant. Currently, 11 cement production companies operate and the opening of an additional 4 is envisaged. The total volume of cement produced in the country in 2013 reached 384.2 thousand tons, including 47.1 thousand tons produced in the Soughd Oblast (with 5 operational plants, with the opening of two additional plants expected), 293 thousand tons in the Khatlon Oblast (with 3 operational plants and the opening of one moreexpected), and 6.2 thousand tons in the DRS (with 5 operational plants). During the same period, the Dushanbe Cement Plant produced 37.9 thousand tons of cement.

The Tajik Aluminum Company ('TALCO', previously 'TadAZ') is the largest export oriented company and major industrial employer (9 thousand people). Between 2010-2013 the production of aluminum varied between 216 and 350 thousand tons per year with 280 thousand tons being the average. Energy consumption was 5.5 bln kWh. A reduction in output is related to the decline in the global market price for metal and also due to a reduction in the supply of natural gas and a switch of the plant from gas to coal.

In 2013-2014 'TALCO' launched a programme for a transition towards using domestic raw materials and the creation of chemical-metallurgical corporation which will be joined by companies producing caustic soda, cryolite, alum schist, aluminum fluoride and processing anthracite as well as a cement plant. This programme will provide 'TALCO' with 50-60% of domestic raw materials. The investment is more than 2 bln USD.



In 2012, under the auspices of the World Bank, a consortium of firms led by the Norwegian *Norsk Energi* carried out an assessment of the energy efficiency of 'TALCO's main equipment and production lines and identified possible measures to save energy and improve environmental indicators, including GHG emissions. Their report showed that gross electricity consumption in the process of electrolysis in 'TALCO' was satisfactory,.but that more modern plants will allow a saving up to 20% energy per production unit. Other advanced technologies (such as the Hall-Heroult process) will allow an energy consumption of 10 kW/kg of aluminum which is 40% less than the current level.

There is therefore a good potential for increasing the efficiency of energy consumption at 'TALCO' through electrolysis systems, automated alumina feeding, enhancing the quality of anodes and so on.. To improve environmental indicators, modernization of the plant has been carried out. Also reconstruction and capacity strengthening of gas purification facilities and landscaping has been undertaken.

Other entities in the non-ferrous metals and mining industry include: the Isfara Leach Plant, Anzob Mining and Concentration Complex, Adrasman Plumbing and Zinc Complex, the Gold Mining Companies 'Aprelevka' and 'Darvaz'. The Chemical industry includes 'TajikAzot' producing hydrogen nitride and carbamide and 'Tajikkhimprom' producing products containing chlorine containing. O the last few years, the production of both 'TajikAzot' and 'Tajikkhimprom' has declined due to the irregular supply of natural gas and worn-out of technologies.

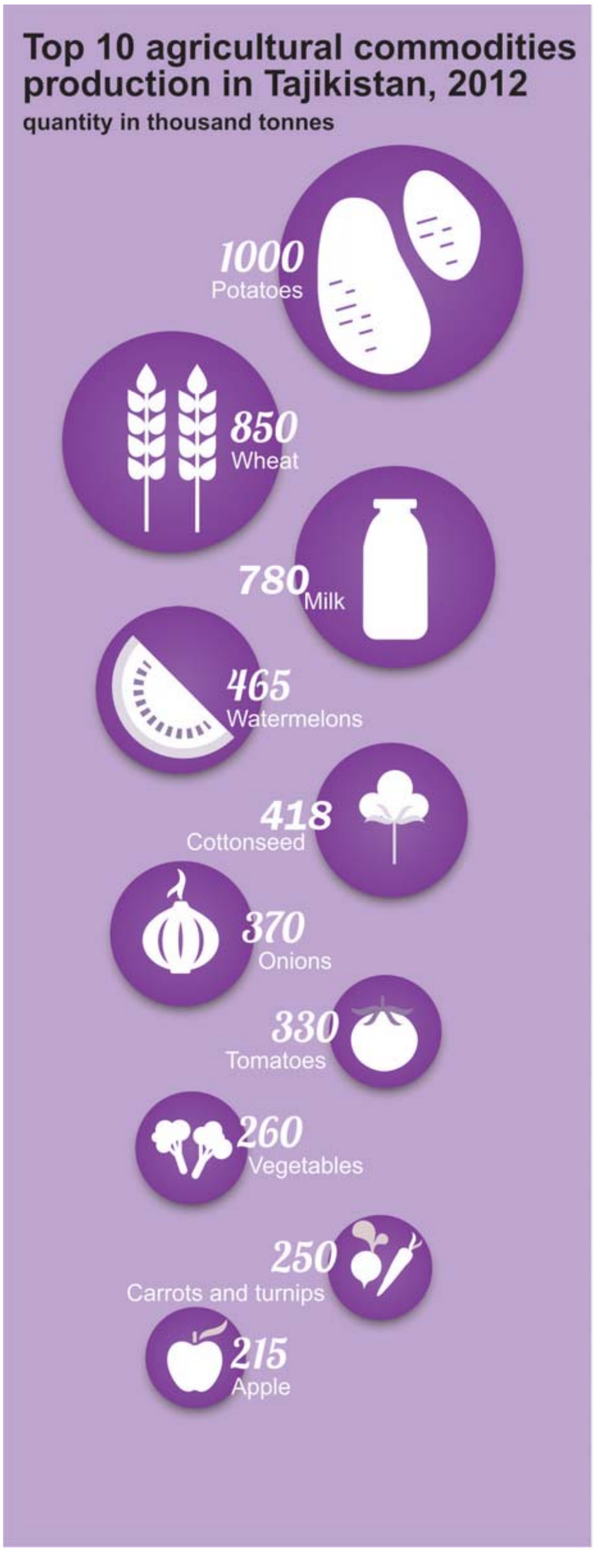
2.12. Agriculture and food security

Agriculture employs 500 thousand people and contributes more than 20% to GDP. Agriculture is mainly focused on growing wheat, cotton, potatoes, vegetables, gourds, grapes and cattle breeding.

Agriculture and land use are undergoing fundamental changes. To date more than 110 thousand privately owned farms (Dekhkan Farms (DF)) have been created. Twenty to twenty five years ago all farms were state owned and were of a larger scale and therefore lower in number. Around 80% (543

Photo. Aluminum Plant 'TALCO'

thousand ha) of the arable land in the country is privately managed by farmers . From the total 744 thousand ha of arable land, 20% suffers from water shortages. Compared to the Soviet period, the acreage of cotton and cotton production has declined by 2.5-3 times. At the same time the acreage, size of the harvest and volumes of wheat, potato, vegetables and fruit has substantially increased to ensure food security and to meet the needs of a growing population.



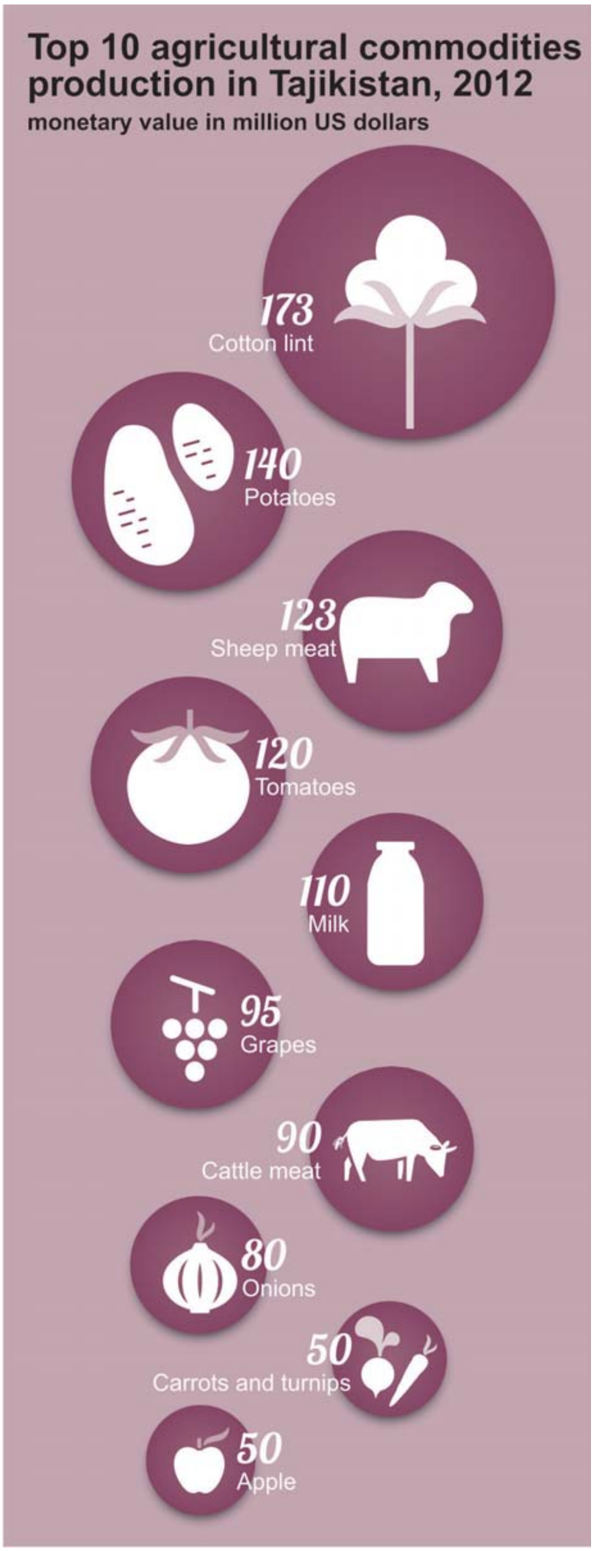


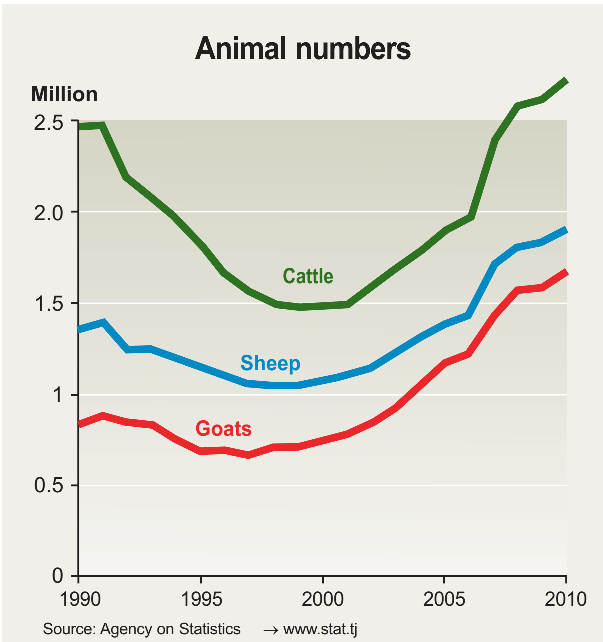
Photo. Mountain pastures

The main share (90%) of agriculture goods are produced by the private sector Dekhan Farms, including 90% of horticultural products and 95% of cattle. About half the agricultural land, including general fields, pasture lands, and perennial plantings belong to or are under tenure of farmers. The Khatlon oblast is the leader in terms of the total volume of production, especially of cereal crops, cotton, vegetables, and gourds. Total wheat production in Tajikistan in 2013 reached 1.4mln tons. However this does not allow Tajikistan to be self-sufficient therefore around 600 thousand tons of wheat are imported each year from Kazakhstan. In 2013, the volume agricultural goods produced included 393 thousand tons of cotton, 1.1 mln tons of potatoes, 1.5 mln tons of vegetables, 500 thousand gourds, 330 thousand tons of fruits and 175 thousand tons of vines.

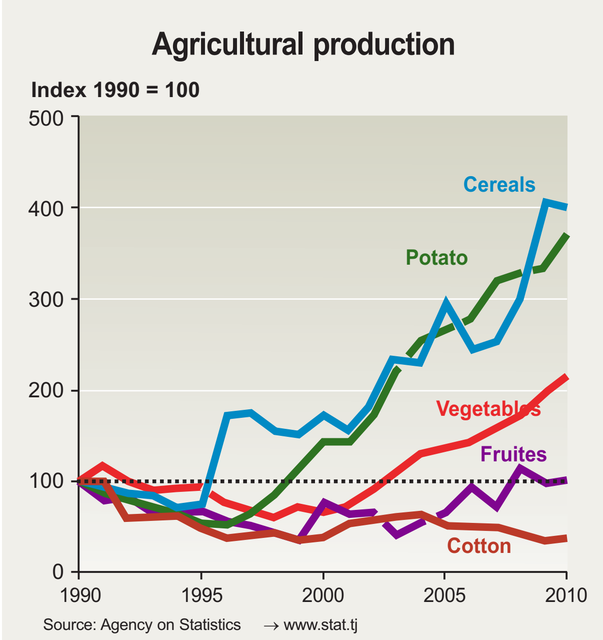
The most intensive application of mineral fertiliser is carried out on potatoes (200-380 kg/ha) and cotton (150-200 kg/a). Applications of 100-200 kg/ha are made on cereal crops and 100-150kg/ha for gourds and vegetables. The use of mineral fertilizer per hectare and this has reduced emissions of nitrogen monoxide from agricultural soil.

The use of pesticides and other chemicals which in some districts were used very intensively in agriculture during the Soviet period has caused toxic and chemical pollution of 30 thousand ha of soil in the south and the north of the country. Environmental 'hot spots' of outdated pesticides have been found in the Vakhsh and Kanibadam landfills which were used for the disposal of pesticide waste. They contain more than 10 thousand tons of waste, POPs, and polluted soil.

Over the last 10 years, the number of livestock has increased and matches the peak number found in the Soviet times (at the end of 1980s). In



2013, the number of cattle reached 2.1 mln, plus 4.9 mln sheep and goats, 5 mln fowl, and 77 thousand horses. In 2013, 172 tons of meat and 827 tons of milk were produced. This is sufficient to meet only one third of the established need of beef and dairy products and therefore significant volumes of both are imported. Tajikistan has a fish catch of 1,700 tons a year and this is also insufficient to meet demand. Because of high prices, per capita consumption of beef and dairy products continues to remain the lowest in the region.



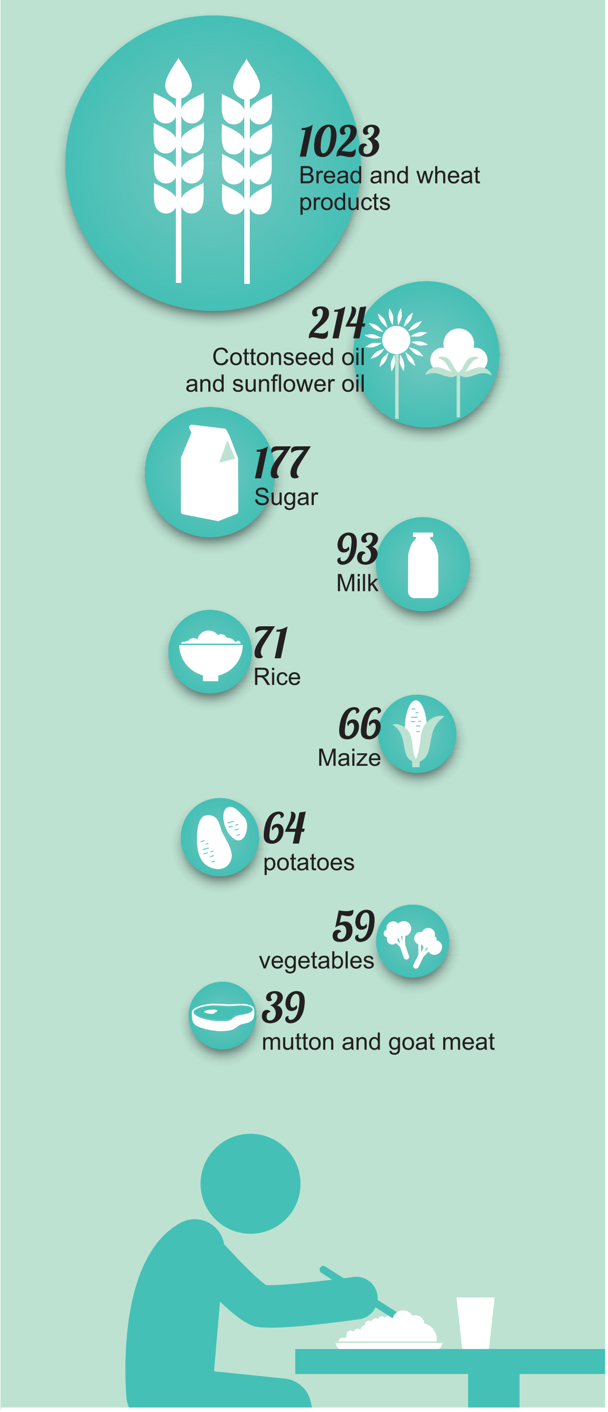
For reference the cost of major items of foodstuffs as of December 2013 was as follows: (all prices refer to the cost of 1 kg) meat (beef) – 30 TJS, bread - 3 TJS; rice – 7 TJS; potato – 2 TJS; apples - 7 TJS; sugar - 5 TJS. Bread, fruit and vegetables make up more than half of a typical family food basket. The consumption of of potato, cereals, and vegetable oils per person usually conforms to the recommended amounts. Beef and dairy products make up 25% of food consumed. By 2012 the calorific value of food consumption reached the level recommended by FAO. In terms of food consumption people in Tajikistan stand out as having a low dietary 'carbon footprint' because of the limited consumption of meat and processed goods which are both is energy intensive.

Photo.- Agricultural Products Exhibition in Dushanbe

The key strategic goal of the agricultural sector is to increase wheat production to reach self-sufficiency and to develop gardening and vine growing to meet local needs and to increase exports.

The government supports the agricultural sector through providing favorable loans, and the supply of agricultural machinery, seeds and fertilizers. Nevertheless, the export of local goods and ability of local producers to compete is difficult given the expansion of foreign trade, as well as trade and custom related barriers, including lengthy and complicated border crossing procedures.

Main diet in Tajikistan
Food products consumption in 2012
kcal per person per day



Source: FAO (faostat.fao.org)

Around half of the existing DFs are managed by professionals possessing higher and/or specialized vocational education and with experience in agriculture and of living in rural areas. Others are small sized DFs created by the general public as a source of livelihood. Also, there are farms created by people who are unqualified who do not have any experience in the agricultural sector.

Until recently cotton growers were in debt. This problem was addressed through restructuring and debt write offs. The supply of agricultural materials and machinery is limited while marketing systems and value chains are underdeveloped. The lowest level of management has been weakened and farmers knowledge is limited. Due to a large scale migration of men, the labour force in rural areas is mainly made up of young people, women and the elderly. The use of water resources is inefficient, whilst the need to improve drainage systems remains a priority. The level of mechanisation is very low. Irrigation systems are outdated and in some districts they don't work. There is a shortage of chemical crop protection products. All these problems lead to a considerable loss of crops. The lack of adequate feeding and grazing of cattle has resulted in reduced numbers and productivity. In winter only 50% of required feed is given to animals and in extremely cold winters the loss (mortality) of livestock becomes a huge problem.

International financial organizations and a number of countries such as China provide substantial support to improve the agricultural sector in Tajikistan. A cooperation agreement was signed between the Ministries of Agriculture of Tajikistan and People's Republic of China to develop horticulture, livestock breeding, plant protection, the supply of agricultural machinery, and the creation of opportunities for joint farming and specialist training.

2.13. Consumption of water, quality of water and sanitation

During the last decade (2000-2010) the average annual intake of water from surface and underground sources was 9 km^3 and 2 km^3 respectively. As of 2011-2012 the per capita consumption of water totaled less than 1000 m^3 per year. Annually, Tajikistan consumes 15-20% of water produced within its territory. About one third (4 km^3) of water intake is returned to rivers as through drainage or other forms of discharged waters. More than 20% of the volume of water is lost during its transport. The length of inter-farm irrigation channels is 6000 km, of which 40% has a concrete lining or is made of reinforced concrete. The total length of intra-farm irrigation channels is about 26 thousand km, of which 35% are covered with concrete linings, or is in chutes, and pipes. Irrigation systems are around 55-65% efficient. The net irrigation requirement (at the field level) varies between 6 and 16 thousand m^3/ha (with an average of 9 thousand m^3/ha) depending on location, the application of water-saving technologies and whether an integrated water resource management (IWRM) approach has been adopted. Around 85% of total water intake is used for irrigated farming, 4% for water supply, 4% for industry, 1% for fish farming, and 6% for other sectors. During the last few years, water intake for communal water supply was up to 450 mln m^3 per year, including 100 mln m^3 per year directly used by the population.

Compared to the Soviet period, water consumption has reduced by 10-15% due to reforms in the agricultural sector, the introduction of water fees, a reduction in production output, a change of structure and area of agricultural crops, an increase of irrigated waste-lands and malfunctioning of irrigation systems. Losses and an underestimation of water intake are high due to inadequate channels and irrigation methods, as well as due to inaccurate statistical and actual data at the farm level.. There are different entry points for enhancing water efficiency. These include increasing the efficiency of irrigation systems (potentially giving a 10-20% saving of water), large scale introduction of water efficient technologies and IWRM (20-30%). It is expected that growth of agricultural production will be achieved through increasing agricultural crops yield and enhancing water and agriculture management capacities. A minor increase in the area of irrigated land is envisaged for the near future.

About half of the irrigated land (~380 thousand ha) in Tajikistan is irrigated by 480 pumping stations. The equipment at these stations is outdated and therefore the energy use is excessive. The limited power supply in rural areas results in up to a 30% of loss of agricultural products. Delayed payment for water supply services results in increased debts for electrical power, and a further inability of the irrigation system managers to undertake the planned improvements. As a result, annually, over 60 thousand ha of irrigated land is not used. Water supply payments vary between 60-70%, while the low electricity tariffs for pumping stations during the growing period do not leave enough leeway for energy saving and the efficient use of energy.

The dominant method of irrigating agricultural crops is furrow irrigation (98% of total irrigated area). The land where rice is cultivated (12-20 thousand ha, 2%) is irrigated through check dams. A very small area (around 100ha) is irrigated through drip irrigation. Irrigation machines are not used because they are energy intensive and there is a shortage of power.

More than 3mln people in Tajikistan do not have regular access to drinking water. They use water from open sources such as springs, wells, 'aryks' (ditches), and channels which often do not meet hygiene and sanitary requirements for drinking water. One third of the water supply networks do not function. In many towns the quality of water treatment has declined due to a lack of disinfectants and outdated equipment for cleaning and disinfection of water. Outside Dushanbe city, water is often supplied for just for few hours per day. Around 20% of the population has access to sewage system. These are mainly the residents of towns and urban

Photo. Irrigation Channel

settlements. The efficiency of waste water treatment plants is not high (40%). The number of operational breakdowns of the water systems in the cities is high reaching 2.8-3.7 breakdowns per 1 km of water line per year, while the acceptable frequency is 0.2-0.3. Given the worn-out state of water supply networks and high frequency of breakdowns, the losses of water can reach up to 50%.

2.14. Land use, land use change and forest management

Specific characteristics of land use in Tajikistan include:

- There are large areas of non-agricultural land such as rocks, cliff debris, glacial lakes and glaciers, abandoned land and other types of land not suitable for farming are predominant;
- There are only small areas of forest and shrub;
- Agricultural land is mainly made up of natural pasture lands. The area of arable land is insignificant;
- The most valued areas of available land include irrigated lands, especially farm fields;
- 80% of land is prone to erosive processes.

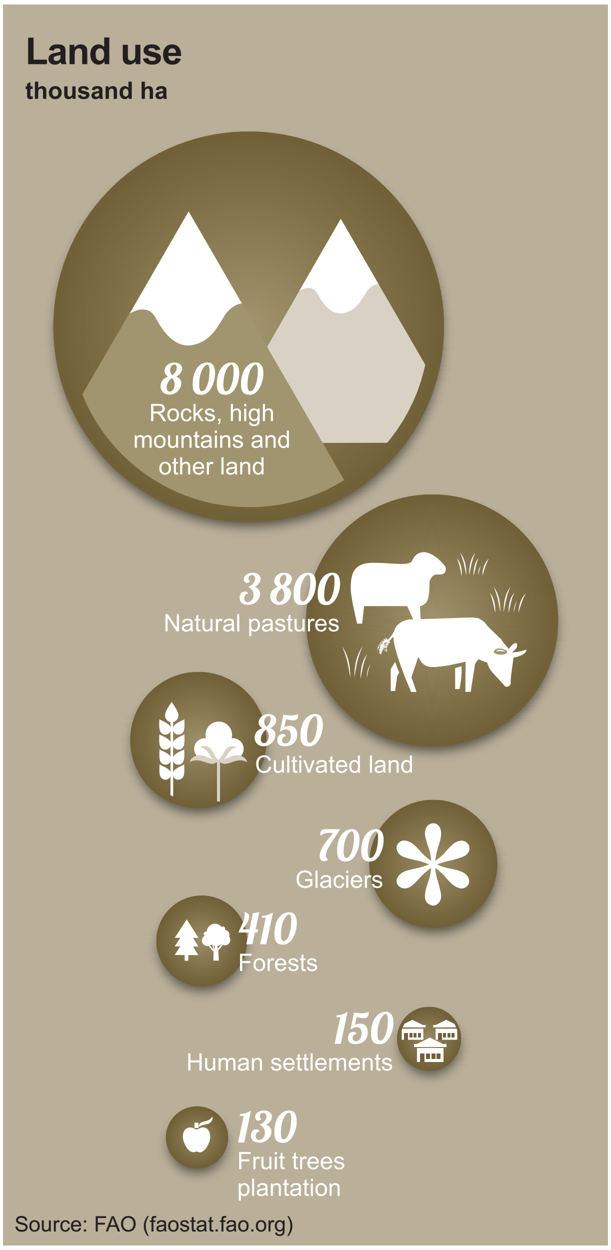
According to the Land Code of the Republic of Tajikistan, the land is in state ownership. However, after obtaining due state registration, individuals and organizations can become permanent users of specified areas of land.

Out of 14.2 mln ha of Tajikistan, only 4.8mln ha or 33% of total area of the country is used for agriculture. This includes 3.8mln ha of natural pasture land and 850 thousand ha of arable land, and 138 thousand ha of perennial crops.. Gardens and vineyards are developing and expanding. In 2012 and 2013 up to 10 thousand ha of new orchards were created each year.

As of the 1st January 2014 there were 86 thousand DFs, 600 agricultural cooperatives, and more than 1,130 individual farms, many of which have land certificates to show that they are the users of the land.

In view of the economic instability before 1997 and given the shortages of foodstuffs, the population of mountain and remote districts was compelled to (a) plough the more steeply sloping land and other land not really suitable for agriculture, (b) cut the wood and shrub biomass, and (c) graze animals near to settlements. These practices have added to land degradation. Despite the fact that the people are reclaiming mountainous land, the total area of arable land declined between 1990 and 2012 from 565 to 475 thousand ha as a result of soil degradation and the consequent taking of land out of agriculture, lack of access to water resources, lack of seeds and declining availability of motor fuels. The area of all agricultural land with irrigation systems is 740 thousand ha. However, not all of this area is used for the reasons described above.

The area of land occupied by settlements is 155.2 thousand ha. Between 1990 – 2012, the area of settlement expanded and this trend is likely to continue as a result of the growth of population. During the same period, the area occupied by industry lands reduced from 200 to 180 thousand ha due to restructuring of the industrial sector and the redistribution of land.



The area of protected land is 2,685 thousand ha. The main share of this land belongs to the Tajik National Park. The state owned forest reserves make up 1,342 thousand ha, including 412 thousand ha of forest cover. The forest cover in Tajikistan is the lowest of the Central Asian states and a large part of the forest area is given for long-term use as pasture.

There are five main forest nurseries in the country with total area ranging from 30 to 90 ha. In addition, small forest nurseries have been created in many forest farms and the total production is now 3mln saplings per year. Reforestation activities cover 2-3 thousand ha per year with a sapling survival rate of 60-70%. The main tree species used in plantation forests include pistachios, almond, poplar, and fir tree (spruce).Considerable attention is paid to creation of nut crop plantations (pistachio, nut, almond, and sea buckthorn). To meet the demand for wood, planting of quick

Photo. Reclamation of boharic lands

growing species such as poplar and willow has increased. Over the last 5 years 2 thousand ha of new forest and shrubs have been planted around the Nurek water reservoir.

The forests of south Tajikistan (pistachios and almonds), the floodplain forests of the 'Tigrovaya Balka' protected area and other forests along Pyanj, Vakhsh and Amudarya rivers are the most at risk from forest fires. Savanna vegetation and dry bulrushes serve as the main 'fuel' for these fires which are predominantly caused by people. A shortage of food and energy forces the population to use land on mountain slopes and cut forest trees. This results in increased soil erosion.

2.15. Waste and other environmental problems

The largest proportion of the population is based in the southern, northern and western parts of the country. Consequently agricultural activities and the large industrial companies of Tajikistan are also based in these regions and therefore most of the waste is created and collected in these regions. The safe storage of industrial waste, especially the uranium tailings inherited from Soviet times, is the major environmental problem in the north of Tajikistan where the condition of the tailings are also negatively affected by natural disasters and erosional processes. Landfills of old and banned toxic chemicals near Vakhsh (7 thousand tons) and Kanibadam (3 thousand tons) contain hundreds of tons of persistent organic pollutants (POPs) and other toxic substances posing both environmental and health related risks. The landfills were initially fenced, however this fencing has gradually disappeared and therefore people and animals are able to freely access the contaminated areas. Increased prices for toxic chemicals has encouraged local people to illegally dig the landfills to extract pesticides. Unsatisfactory waste management in health and transport is also of high concern. Both Central and Local Governments, as well as donors and NGOs are carrying out interventions to localise the pollution and to reduce the risks of toxic waste.

Industrial activities result in the production of 1-1.5 mln tons of waste per year and approximately the same volume of solid domestic (communal) waste is produced. It is estimated that the total amount of waste collected from Soviet times to date reaches 200 mln tons. There are more than 100 domestic and industrial waste (including toxic chemicals) disposal sites with a total area of 1.4 thousand ha. Positive developments during the years of independence include starting to sort and recycle construction waste and solid domestic waste as well as reprocessing of industrial (aluminium and textile) waste.

Awareness amongst the population of environmental hygiene is very low. The majority of urban waste landfills and other types of disposal sites are in a very poor state. The current situation regarding the sorting, processing and recycling of solid waste does not meet the established requirements.

Tajikistan has a potential for improving the waste management system through:

- the development a national waste register and improvement of waste statistics;
- revisiting financing schemes and incentives for waste processing and recycling;
- encouraging youth initiatives aimed at enhancing environmental education, including on waste management;
- improvement of landfill conditions and strict compliance with regulations for storage of hazardous waste;
- ensuring the safety of uranium tailings prone to natural disasters and erosion.

2.16. The Governmental system of environmental protection and division of responsibilities

The Government of RT has adopted more than 30 environmental laws and by-laws. More than 10 state programmes and action plans have been developed. National centres have been created to address global and local environmental challenges. All the key state agencies and programme executives, including those dealing with environmental issues, report to the Executive Office of the President of the Republic of Tajikistan. Correspond-

ing departments of the Executive Office of the President monitor and coordinate policies and the measures of different ministries and other state institutions, and inform high level officials on the adoption of national programmes and action plans.
The Parliament (*Majlisi Oli*) plays a key role in the development of legislation and ensure its compliance with international treaties, including those on climate change. Members of the Parliamentary Committee on Environmental Protection are well aware of climate change issues. Considering the ongoing negotiations on development of a new post-2015 Development Agenda, they are ready to promote legislative initiatives in this direction.

The Committee on Environmental Protection (CEP) under the Government of RT, including its subcommittees at the local level, is the lead state executive body responsible for the implementation of state policy on hydrometeorology, the effective use of natural resources, as well as the control and protection of the environment. The CEP is composed of service departments and units responsible for monitoring, analytical control, environmental impact assessment, inspections, and environmental data processing. The CEP is authorised to develop environmental policy and implement the UNFCCC commitments. In addition, it analyses and develops recommendations for the improvement of legal and regulatory systems of environmental protection.

The State Administration for Hydrometeorology under the CEP (Gidromet) is the national executive body responsible for the coordination of climate change related issues in Tajikistan. The Director of Gidromet is the national coordinator on UNFCCC. The Centre on Climate Change operates under Gidromet. After the launch of PPCR, a Climate Change Secretariat and permanent Working Group led by Deputy Prime Minister of RT were created.

The Ministry of Energy and Water Resources is the state executive body leading the implementation of a unified state policy and regulation of the fuel and energy sector, the management of water resources and promoting the use of renewable energy sources. The Ministry is directly involved in climate change issues and acts as the authorized body for implementing functions related to the Clean Development Mechanism of Kyoto Protocol and reporting to the UNFCCC. Before November 2013 these functions were undertaken by the former Ministry of Energy and Industry. Also, the Ministry takes an active part in implementation of investment projects.

The Ministry of Economic Development and Trade is the lead executive body for oversight of the system of economic planning and forecasting. The mandate of the Ministry includes the formulation and implementation of economic development programmes, as well as strategies aimed at poverty reduction and sustainable development.
The Ministry of Agriculture develops and coordinates the state policy, programmes and plans in the agricultural sphere. The Ministry also oversees the Academy of Agricultural Science which is the centre of agrarian science closely linked to the Tajik Agrarian University.

The Ministry of Industry and New Technologies is the state body developing and implementing a unified state policy in the industrial sector. When it comes to the environment and climate change, the Ministry is in charge of developing and implementing multi-sectoral research and development programmes and innovative projects. The Ministry oversees the implementation of investment projects using modern energy saving technologies and 'green' products. The Ministry also oversees the compliance of industrial enterprises with technological, environmental and other related standards or state requirements.

The Ministry of Education and Science is the key executive body which implements a unified state policy and regulates legal requirements in education and science, teaching, research and development, as well as social protection of students enrolled in education and science institutions. The Ministry takes an active part in the development and implementation of environmental programmes in schools and higher education institutions.

The Ministry of Health and Social Protection includes the State Sanitary and Epidemiological Service (which has 75 oblast, town and district level Centres of Sanitary and Epidemiological Monitoring), the Republican Tropical Diseases Centres and Healthy Lifestyle Centres, as well as centres related to the problems of nutrition and prophylactic disinfections. These structures cover issues related to climate risk reduction and prevention of diseases in the context of climate change and extreme water and weather related events. The Ministry implements state sanitary-epidemiological monitoring, and jointly with the scientific research institutes, develops and approves state sanitary standards, as well as rules and norms. Under the regional health and climate change programme of the World Health Organisation (WHO), a Strategy for Health and Climate Change in Tajikistan was developed.

The Agency of Forest Management under the Government is the central executive body of the Republic of Tajikistan implementing functions related to forest management. This includes the development and implementation of a unified state policy, as well legal and normative regulations related to the management of forests and forest resources, hunting and game management, plant and animal life, and also protected areas, including management and state oversight functions. The Agency takes an active part in the implementation of programmes and projects on climate change.

The State Statistics Agency under the President is the state body responsible for statistics policy and economic analysis. The Agency implements its work through the collection and dissemination of statistical data based on the principles of objective and comprehensive analysis of socio-economic and environmental processes taking place in the country. The Agency also registers administrative-territorial units and settlements.

The State Committee on Land Management and Geodesy is the lead state body in the sphere of land use, as well as related reforms and land inventories. The Committee is responsible for the control of land use, making inventories and the registration of land use rights, setting land tax, monitoring the changes in land use and in forest management.

The Committee on Emergency Situations and Civil Defence (CoES) is engaged in early warning, disaster prevention and recovery, as well as disaster risk reduction. The early warning and monitoring system for water overspill from Lake Sarez is operating under the oversight of CoES. The CoES also controls and forecasts natural disasters and undertakes laboratory analysis.

Within its competency, the Majlis of People's Deputies in the GBAO and Dushanbe, as well as in other towns and districts of the country:

- approves and oversees the implementations of programmes on environmental protection and the effective use of natural resources of the corresponding administrative-territorial area;
- approves and oversees the implementation of employment and poverty reduction programmes;
- regulates relations related to the use of water, land and other natural resources according to state regulations of RT;

2.17. Scientific and production capacity and consulting services

The State Project Design Institute 'Hydro - EnergyProject' develops project documentation for the planning and construction of new HPPs and reconstruction and/or modernisation of existing HPPs. The Institute started its work 15 years ago. During this period a design for small HPPs was prepared, an assessment of water resources in the country was carried out and the schemes for using small rivers were developed.

Studies on RES as well as on the creation of water heating units, solar cookers, mini-HPPs, mobile micro-HPPs and biogas units have been and are currently carried out by the Physics and Technical Institute of the Academy of Science of RT. Under the auspices of the Institute, there is a scientific research centre on RES.

The Institute of Water and Environment under the Academy of Science of RT includes a laboratory for the study of climatology and glaciology.

The experimental and industrial enterprises such as State Unitary Enterprise (SUE) 'Sadaf', 'Tajikspetsavotmatika', 'Vostokredmet', the Tajik Aluminum Company 'TALCO', and Chkalovsk Mechanical Engineering have the necessary technical and personnel expertise to establish production of RES units in Tajikistan, namely the solar panels, photovoltaic panels, mini-HPP and biogas units.

Consulting and other types of services on the development of small hydro-energy are being developed. In 2010, with the support of Ministry of Foreign Affairs of Norway and the Ministry of Energy and Industry of RT, a Consulting Company TajHydro was established to develop partnerships between the authorities and investors and to assess the capacity for small hydroenergy units, tariffs, and so on.

2.18. Non-governmental Non-commercial Public Organisations and local initiatives

NGOs in Tajikistan show special interest on issues of climate change. Among the most active NGOs in the country dealing with climate related issues are the Youth Ecological Centre, 'Malenkata Zemlya' (Little Earth), NGO 'Hamkori bahri Taraqqiyot' (Cooperation for Development), 'Zan va Zamin' (Woman and Earth), 'Molodyoj 21-go veka' (Youth of the 21st century), the Centre for Climate Change and Disaster Risk Reduction, and the Tajik Branch of the Regional Environmental Centre for Central Asia (CAREC) These NGOs conduct seminars, competitions, and youth camps. They demonstrate climate change adaptation and mitigation approaches and measures. The NGOs have created a Club on Climate and Environmental Policy. The news on climate change is circulated via e-mail. Nevertheless, in Tajikistan, as is the case in other countries of the region, the level of general awareness about climate change issues is quite low because of limited information provided through local mass media, a lack of training and discussions on climate change and energy issues in schools and higher education institutes, and a low awareness within local governments.

The establishment of the 'Museum of Antarctics' in 2010, the brainchild of Tajik Professor and Polar Explorer, A. Kayumov, aims to raise awareness and disseminate knowledge about glaciers and climate change problems via the mass media, and organise scientific expeditions. The Museum is officially registered within the Ministry of Justice of RT (ref. 1281 on 2nd April 2010) as a Public Organisation.

Photo. Museum of Antarctics in Dushanbe

In 2001, UNDP in Tajikistan supported the establishment of the Jamoat Resource Centres to implement community based projects such as micro-financing, the provision of small grants, disaster risk reduction, agricultural management, forest management, development of micro-HPPs, improvement of health services, including fight against malaria and other activities.

Centres operating under auspices of Aarhus Convention of UNECE play an important role in the dissemination of environmental information. From 1st January 2014, 5 such Centres became operational and are based in Dushanbe, Khujand, Kurgan-Tyube, Khorog and Kulyab. These Centres conduct awareness campaigns on environmental topics also covering the causes and consequences of climate change.

2.19. The formulation process of the Third National Communication

The development of the Third National Communication was possible with the financial support from GEF and the active participation and contribution of UNDP. General and technical support of the process wasprovided by the Project Implementation Team based at Gidromet. Thematic expert groups were formed and technical meetings and seminars organised. In addition, visits to the regions of Tajikistan were undertaken to collect information and to raise awareness of the population. Press conferences and interviews were held. The TNC was formulated based on the guiding documents and decisions of UNFCCC, the Intergovernmental Panel on Climate Change (IPCC), as well as local and international experience.

2.20. Participation of Tajikistan in international cooperation on climate change

High level initiatives, such as the recommendation of the President of RT on the creation of an International Glacier Conservation Fund (announced at the Third Conference on World Climate in Geneva and UNFCCC Conference in Copenhagen in 2009) and the State programme of RT on the study and conservation of glaciers of RT [which is the first state programme in the region] emphasises the importance of the problem of glacier degradation and climate change. Side events were organised by the Tajik delegation jointly with international partners in 2009, 2010 and 2013 at the 15th, 16th and 19th sessions of the UNFCCC Conference.

Tajikistan is the active member of International Fund for Saving Aral Sea (IFSAS) - the main regional organisation on trans-boundary water-environmental cooperation in Central Asia, led by the Heads of States. National Units operate in each country. IFSAS pays considerable attention to hydro-meteorological observations and climate change problems. Under the auspices of IFSAS, studies on the impact of climate change on water resources and the energy sector and expeditions to glaciers have been carried out.

Photo. Side Event at the Conference of Parties (COP 19, Warsaw, Poland, 2013)

Photo. Interstate Sustainable Development Commission in Dushanbe (2014)

The IFSAS structures such as the Interstate Sustainable Development Commission (ISDC) and Interstate Water Coordination Commission also undertake research on climate change. Tajikistan chaired the ICSD in 2013-2014. Tajik experts take part in regional events organised by the above commissions.

During the third International Polar Year (IPY) in 2007-08, the work of researchers from different parts of the world resulted in new discoveries, especially related to glacier cover of the polar areas of the planet. The main objective of the IPY was to assess the consequences of climate change at the global level and to develop recommendations on sustainable socio-economic development. Events during the IPY were attended by more than 60 thousand scientists from different countries of the world. Following the outcomes of the IPY, the World Meteorological Organisation (WMO) created the Global Cryosphere Service in 2011 in which Tajikistan takes an active part.

In 2008, following the initiative of Professor A. Kayumov and according to Governmental Decree (#587 as of 30th November 2007) under the auspices of the IPY and with the support of 54th Russian Expedition to Antarctic, the first Tajik Expedition to the Antarctic was organised. As a continuation of this initiative the first comprehensive international scientific expedition to study the state of glaciers and environmental situation in upstream areas of the Vakhsh and Pyanj rivers was organised with the support of UNDP. Experts from Central Asia and Russia also took part in the expedition.

According to the expedition data and following an instruction from the Deputy Prime Minister as of 4th May 2011 (ref. #60489) an International Conference 'Climate change and disaster risks in mountainous districts' was organised in Dushanbe with the support of UNDP and the United Nations Education, Science and Culture Organisation (UNESCO). The Conference was attended by representatives of 30 countries.

UNESCO plays an important role in hydrological and glacial research and knowledge transfer. Under the patronage of UNESCO, the Regional Glacial Centre in Almaty, Kazakhstan was created in 2012 and Regional Conferences on snow, ice and water resources of Asia were organised. Tajik experts also took part in these events.

Photo. The First Tajik Expedition to Antarctic in 2008-2009. Antarctic Station 'Mirniy' (06.01.2009)

3. Inventory of greenhouse gases

3.1. Process and methodology for developing inventory of GHG emissions

Making an inventory of greenhouse gases is a commitment of Tajikistan under the UNFCCC. In addition, the Millennium Development Goals and the new Sustainable Development Goals from the RIO+20 UN Conference on Sustainable Development (Rio de Janiero, Brazil, June 2012) require countries to report on GHG emissions and to monitor progress against each goal. According to a decision of the UNFCCC Conference in 2012, all countries will submit their results to the UNFCCC Secretariat.

The assessment of the sources and flows of GHG emissions in Tajikistan covers the period from 2004-2010. This is same as the period covered by the TNC. Moreover, the outcomes of the previous inventory exercises (1999-2003) were revisited and cross checked. The anthropogenic sources of emissions and GHG flows in five sectors were assessed in five sectors in accordance with the guidelines of IPCC, UNFCCC recommendations. These sectors are:

1. Energy (extraction and consumption of fuel);
2. Industrial processes;
3. Agriculture;
4. Changes in land use and forest management;
5. Waste

Whilst undertaking the inventory exercise, official data from the following state institutions were used: State Statistics Agency under the President of RT, the Agency of Forest Management under the Government of RT, Ministry of Industry and New Technologies of RT, Ministry of Energy and Water Resources, Ministry of Agriculture, Ministry of Economic Development and Trade, Committee on Environment Protection under the Government, State Committee on Land, and Customs Committee. Data from specialised companies and enterprises such as the Open Joint Stock Holding Company 'Barqi Tojik' was also used. Other data sources include the SUE's 'Tojikiston' and Railroad Company 'Rohi Ohani Tojikiston' (on transport), the Open Joint Stock Company 'Naftrason', and SUE 'Tajikgas' (on fuels), the Committee on Environmental Protection under the Government of RT (on waste) and FAO (on certain agricultural subsectors and waste).

As of August 2014, the State Agency on Hydrometeorology,which is also the UNFCCC Coordinator in Tajikistan, is responsible for compilation of data and preparing the GHG inventory.

Five sub groups were established on Energy, Industrial processes, Agriculture, Changes in Land Use and Forest Management, each consisting of experts on data analysis for their subject. A specialist unit for quality assessment and data presentation was also established.

Preparation of the GHG inventory for the TNC builds on the experience and data collected during the development of the First and Second National Communications and also on the outcomes of a regional project on the improvement of the quality of national GHG inventories in Eastern Europe and CIS region.

The new inventory cycle included:

1. Approval of the Group Coordinator (Senior National Expert/Consultant) for the GHG inventory;2. Identification of goals, objectives and methodology for the GHG inventory in line with the most recent decisions of UNFCCC and IPCC;
3. Identification of partners and the establishment of relations with key organizations: State Statistics Committee, the Ministry of Water Resources and Energy, Ministry of Industry and Innovations, and the Committee of Environmental Protection under the Government of RT;
4. Selection of lead experts and running an introductory seminar to discuss methodologies, work plan, data sources and expected outcomes. Estimation of budget and technical capacities;
5. Development of the GHG inventory plan;
6. Collection of the main statistical data and supporting documents;

7. Actual calculation of GHG emissions and absorption;
8. Quality control and development of the National Report on the GHG Inventory;
9. Running a national seminar to present and discuss the preliminary results of GHG inventory;
10. Data archive for future GHG inventory exercises and description of the process;

The main guiding documents and calculation methods applied during the GHG inventory were those decided on by the UNFCCC Parties, the recommendations of UNFCCC expert groups, the National Communications of others countries, as well as IPCC Guidance on National GHG Inventory (1996; 2006) as well as UNFCCC 1.3 software.

According to IPCC instructions, the national GHG inventory covers anthropogenic sources of emissions and the flows of 9 gases with direct and indirect greenhouse effects, covering the period of 2004-2010. This exercise also included cross-checking of previous national inventory covering 1990-2003.

The inventory covered the following gases with (a) *direct greenhouse effects,* including CO_2 (carbon dioxide), CH_4 (methane), N_2O (nitrogen monoxide) and perfluorinated hydrocarbons, namely CF_4 (tetrafluorocarbon) and C_2F_6 (hexafluorocarbon), and (b) *indirect greenhouse effects,* namely carbon monoxide (CO), nitric oxides (NO_x) and non-methane volatile organic compounds. Sulphur dioxide (SO_2) was reviewed as a gas contributing to formation of aerosols.

The results of the inventory exercise are presented in both absolute and relative units of CO_2-equivalent. This is in line with IPCC requirements on the identification of the relative GHG contribution to total emissions and the level of impact on climatic systems. Relative units are used for comparing the contribution of emissions of different gases to total emissions. Relative units depend on the Global Warming Potential which defines the numeric warming effect of the certain GHGs in relation to carbon dioxide (called CO_2equivalent).

All estimate are based on the State statistical reports and intra-departmental data. The unit measure of greenhouse gases is gigagramme (Gg).

3.2. Sources of GHG emissions and absorption

In all estimates, a Level 1 method based on the use of general and publicly accessible data was applied.

The 'Energy' sector covers GHG emissions from mining, processing and the burning of fossil fuels. The estimates were based on data on mining, actual fuel consumption as well as a carbon emission coefficient and the fraction of oxidized carbon. The accepted conversion coefficient used for coal and natural gas is the same as in other CIS countries with similar conditions. The coefficients of thermal net values were applied accordance with IPCC recommendations. The IPCC emission rate was used by default. The major barrier in the estimation of emissions in this sector is the lack of energy balance and reliable fuel consumption data in Tajikistan from 1990 ie for the full period of inventory. There are some inconsistencies and gaps in the data, and a lack of official statistics on certain topics such as the number of vehicles in private sector, import of fuel and vehicles and fuel consumption.

The 'Industrial processes' sector covers GHG emissions to the atmosphere resulting from physical and chemical production processes and also includes the production of non-metallic minerals such as cement and lime, the production of ammonia and aluminum, the processing of cast iron and steel, as well as the production and consumption of caustic ash and others. The rate of emissions used for the 'industrial sector' is in line with IPCC recommendations. The production and use of halogen gas is not included since it falls under the Montreal Protocol, a protocol to the

Vienna Convention on the protection of the ozone layer. The complexities that faced the calculation of emissions in the 'Industrial processes' sector are similar to those mentioned under 'Energy' sector including inaccessibility or lack of data, particularly on production of aluminum which is the main industrial source of GHG emissions.

In Tajikistan there are plants [both operational and under construction] involved in the processing of non-metallic minerals, chemical, metallurgic and other enterprises. The major sources of emissions include the Dushanbe Cement Plant, Aluminum Plant, and the Joint Stock Company 'Tajikazot' (Vakhsh azotic-fertiliser plant).

Under the 'Agriculture' sector, GHG emissions come from activities related to livestock breeding (the anaerobic decomposition in the process of animal's digestion and waste), rice cultivation, burning of agricultural waste in the field, and emissions from the nitrogen cycle in agricultural soil. The emission rate applied in the agricultural sector is in line with IPCC recommendations. Given the restructuring of agricultural sector and lack of statistical data, the results obtained have a high level of uncertainty. The feature that distinguishes Tajikistan from other Central Asian countries is that in recent years, the agricultural sector contributed 50% of total national emissions in CO_2-equivalent. The sector is considered to be the key source of emissions in Tajikistan.

Under the 'Land use, changes in land use and forest management' sector, the estimates cover two areas including forest range and land use. During the inventory process, the emission coefficients in the revised IPCC Good Practice Guidance for Land Use, Land Use Change and Forest management, published in 2005, were used. Based on the proportions of land use in Tajikistan an assessment of emissions and the accumulation of carbon dioxide due to changes in land use was carried out. In Tajikistan, data on forest cover is available from the state statistics and annual land inventory conducted by the State Committee of Land of RT. This land inventory is carried in cooperation with the land users and is approved by the Government. According to the land inventory, despite a reduction in forest area, an increase in the planting of perennials and shrubs has been observed. The forests of Tajikistan are mainly subtropical (including pistachio, and almond nut bearing trees) and boreal (mountain Junipers).

Under the 'Waste' sector, methane emissions from the urban solid waste landfills, and industrial and residential waste waters have been calculated. Residential waste in rural areas was not considered given its diffuse nature in the area, nor were insignificant methane emissions from small uncontrolled disposal sites.

3.3. Barriers in regular biannual reporting

The main problem faced during the previous and current inventory process is the lack of statistical data. A GHG inventory in Tajikistan is not carried out on annual basis and is not part of environmental reporting. The existing information gaps, especially on fuel consumption, require urgent and coherent solutions to enable an improvement in the assessment of the country's energy balance and security, regardless of GHG inventory needs. There is a need to develop and adopt robust approaches to: the collection of statistical data, reporting, the optimization of data sources and flows, as well as the allocation of responsibilities in preparing the GHG inventory, and the process of regular biannual reporting.

The State Statistics Agency and MEDT keep track of the consumption of liquid fuels however there is a difference in magnitude of 5-8 times between the two organisations due to differing data sources and data collection methods. According to the expert assessments, the MEDT data is the more robust. However, there are shortcomings such a lack of clarity in the allocation of data to different sectors. The records on the consumption of solid (coal) fuels are very poor, however, given the complexities and high import price of this type of fuel, the total consumption volume and emissions are not very high. Until recently, the main types of fuel for the energy and industrial sector were gas and mazut. The situation started to change in 2011-2014 due to considerable increase of coal mining and start-up of coal based energy and industrial units.

In the industrial sector, statistical data (form #1-p 'Industrial enterprise production report) is submitted on a monthly and annual basis by each enterprise, regardless on the type of ownership. Industrial enterprises submit a production report to the local statistical departments however the existing system of industrial statistics does not cover all areas of important data. For instance, firms and enterprises undertaking the construction of roads also produce asphalt for their internal needs and as a result data on asphalt production is not provided separately, but integrated under 'road construction' statistics. The same applies to the production of bricks and the processing of metals. Annual reports of enterprises are kept in the central statistical office for one year and then are returned to the regional departments. Therefore, to collect data on production by enterprise, a written request must be submitted to the regional department of statistics or to the enterprise itself.

Due to lack of data on the annual production, processing, utilisation and final disposal of solid domestic waste in Tajikistan, the total volume waste created was calculated based on the size of the urban/rural population next to the landfills serving that community and alsoon the average expected waste produced per person(1.92 kg/person/day, according to SUE 'Khojagi Manzili Communali' (Housing and Communal Service)). The proportion of waste disposed of in landfills (94%) was also taken into account. To improve the GHG inventory for the 'waste' sector, there is a need to carry out field observations of local methane emissions factors at the large landfills and disposal sites. There is also a need to introduce a system for waste statistics where currently it does not exist or doesn't work and clarify the “per person” waste norms.

3.4. Contribution of Tajikistan to global warming

An increase of GHG concentration leads to increased global and local surface air temperatures. In 2014, concentration of the main GHG, carbon dioxide, passed the symbolic threshold of 400 ppm (parts per million), while the average temperature of the last decade was highest since instrumental records began both globally and in Tajikistan.

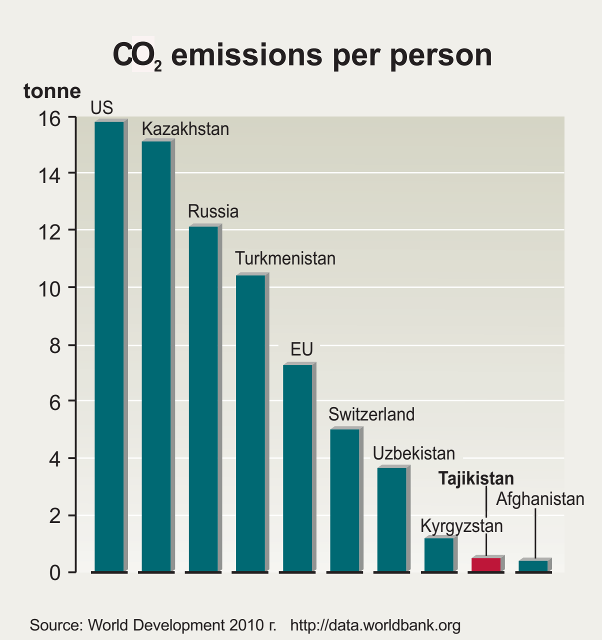
Historically and to date, the main contributors to GHGs are the developed countries and regions (USA, Canada, Japan, EU) as well as rapidly developing countries such as India, China, Brazil, Iran, Saudi Arabia, Indonesia, and Russia. In 2008, China was ranked first in terms of volume of GHG emissions (more than 8bln tons). According to WB indicators, in 2010 Tajikistan was ranked 160th out of 200 countries in terms of per capita CO_2 emissions at 0.4 tons/person though this figure refers only to energy related emissions. In the central Asian region, Kyrgyzstan's rank is among nearest to Tajikistan (at 1.2 tons/person), whilst the global average is 4 tons/per person. In other words, the intensity of per capita emissions in Tajikistan is 10 times lower than the global average.

In terms of total emissions (as opposed to per capita emissions) Tajikistan was ranked 135th and is the lowest of the CIS countries among. Energy based emissions of CO_2 from Tajikistan comprise less than 1% of the total emissions of Central Asian region which can be explained by the large share of hydropower, the use of gas fuel, and the restructuring of industrial sector. Thus, the acute energy deficit experienced by the country is a positive factor in the reduction of GHG emissions. In addition, about the half the GDP of Tajikistan is made up of remittances sent by labour migrants (reaching 3-4bln USD per year) which means that this economic activity does not directly contribute towards Tajikistan's 'carbon footprint'. This is because migrants emissions from things like food consumption, energy and transport are not included in Tajikistan's footprint. In view of the

CO_2 emissions from burning fossil fuels and production of cement in 2010

Global rank	Country	Emissions in 2010, mln tons of CO_2
1	China (excluding Taiwan)	8281
2	USA	5429
3	India	2007
4	Russian Federation	1739
5	Japan	1170
6	Germany	745
7	Iran	571
8	Republic of Korea	567
9	Canada	499
10	United Kingdom	493
11	Saudi Arabia	464
12	South Africa	460
13	Mexico	443
14	Indonesia	434
15	Brazil	419
20	Ukraine	305
25	Kazakhstan	249
38	Uzbekistan	104
50	Byelorussia	62
58	Turkmenistan	53
66	Azerbaijan	46
112	Kyrgyzstan	6,4
114	Georgia	6,2
119	Moldova	4,9
125	Armenia	4,2
135	Tajikistan	2,9

Source: Boden, T., Marland, G., Andres, B., & Marland, G. (2013). *National CO_2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-2010*. Oak Ridge, TN: Carbon Dioxide Information Analysis Center. [Data available at http://dx.doi.org/10.3334/CDIAC/00001_V2013]



above, Tajikistan's contribution to global warming is insignificant. Given the economic restructuring, Tajikistan has achieved managed to decouple the level of emissions from GDP and population growth. Despite this growth, the level of emissions remained relatively stable.

On one hand, there is potential for a reduction of GHG emissions in Tajikistan, but on the other hand, the energy crisis and the growth of population requires improvement of energy and food security. Geopolitical factors prevent Tajikistan from developing its hydropower potential. As a result coal mining and consumption as well as introduction of coal based industry and energy technologies have increased.

3.5. GHG emissions and absorption trends in 1990 - 2010

According to the national GHG inventory for 1990-2010, the largest volume of GHG emissions were observed in 1990 reaching 25,500Gg (25.5mln tons) of CO_2-equivalent or 23,600Gg (23.6mln tons) after absorption is taken into account. The smallest volume of GHG emissions in CO_2-equivalent were observed in 2000 comprising 7,400Gg or 5,500Gg after the absorption. In 2010 the total volume of emissions reached 9,011Gg. The major reductions in GHG emissions in CO_2-equivalent were observed in the Energy sector. GHG emissions in this sector reduced from 17mln tons in 1990 to less than 2mln tons in 2005-2010. In the agriculture sector the opposite trend was observed in that emissions increased from 5.1mln tons in 1990 to 5.5mln tons in 2010, although there was some decline in the middle of this period. Given the economic growth from 2000 onwards an the increase of emissions is observed. But even in 2010, the total volume of emissions was only 40% of total emissions in 1990.

During the last two decades, the composition of emissions has changed significantly. In 1990, the energy sector was the major contributor (67%) to GHG emissions,followed by agriculture (20%), industry (10%) and waste (3%) sectors. By 2010, the general trend involved a reduction in emissions in all sectors except for agriculture. In 2010, only 15% of GHG emissions were from energy activities, whilst the share of agriculture reached 60% of total emissions.

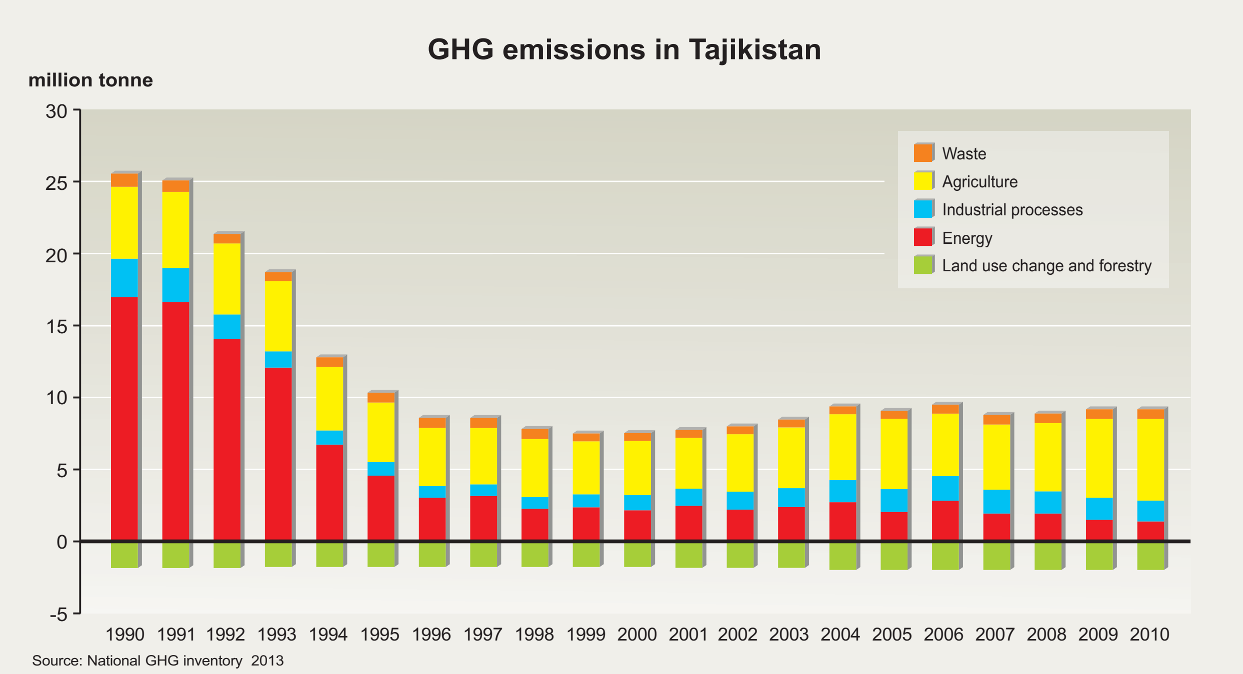
The main GHG contributors are: CO_2 – 69% (1990), 29% (2005) and 21% (2010.); CH_4 – 14% (1990), 30% (2005) and 38% (2010); N_2O – 12% (1990), 31% (2005) and 32% (2010). In CO_2-equivalent, perfluorocarbon is the smallest contributor to GHG emissions comprising 4% in 1990, 10% in 2000 and 9% in 2010.

During the last 10 years the overall volume and the structure of emissions was stable. This is mainly due to the completion of structural changes in economy that Tajikistan underwent after collapse of the Soviet Union, and the stable development in all sectors except for energy and the generally unstable supply of energy sources.

3.6. Emission by types of gases

Carbon dioxide (CO_2) emissions

Energy (mining, transportation and the consumption of coal, natural gas and oil products) and the industrial (production of cement and aluminum)



Source: National GHG inventory 2013

sectors are the main sources of anthropogenic CO_2 emissions in Tajikistan. Between 1990 and 2010 the largest volumes of CO_2 emissions in Tajikistan were observed in 1990 (17.7mln tons) mainly due to burning fuel. The largest volume of absorption (2.1mln tons) took place in 2010.

During independence (starting from 1991), due to a sudden reduction in the consumption of fossil fuels in the energy and transport sectors as well as by the general population, emissions of carbon dioxide reduced 10 fold. Between1998- 2010 carbon dioxide emissions leveled out and now CO_2 absorption by the forests and soils (of about 2mln tons) is about the same as CO_2 emitted.

The main sources of carbon dioxide in the energy sector include:

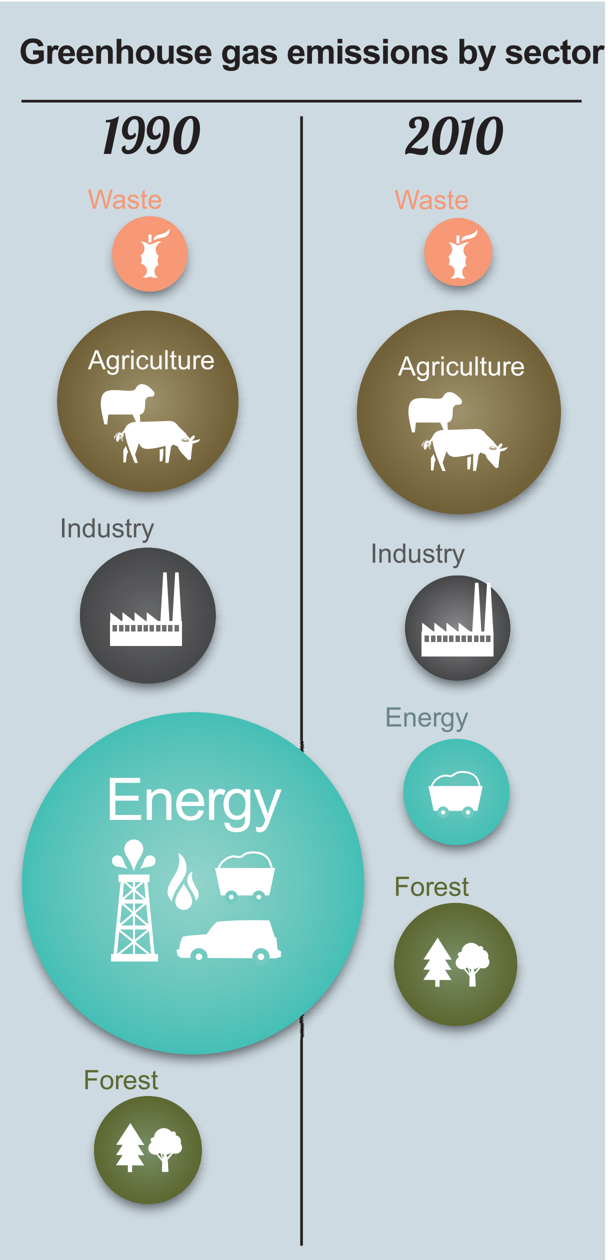
- Energy production (Thermal Power Plants, boiler houses);
- Fuel consumption in industry and construction sectors;
- Transport (vehicular, air, railroad);
- Other sectors: communal housing and agriculture.

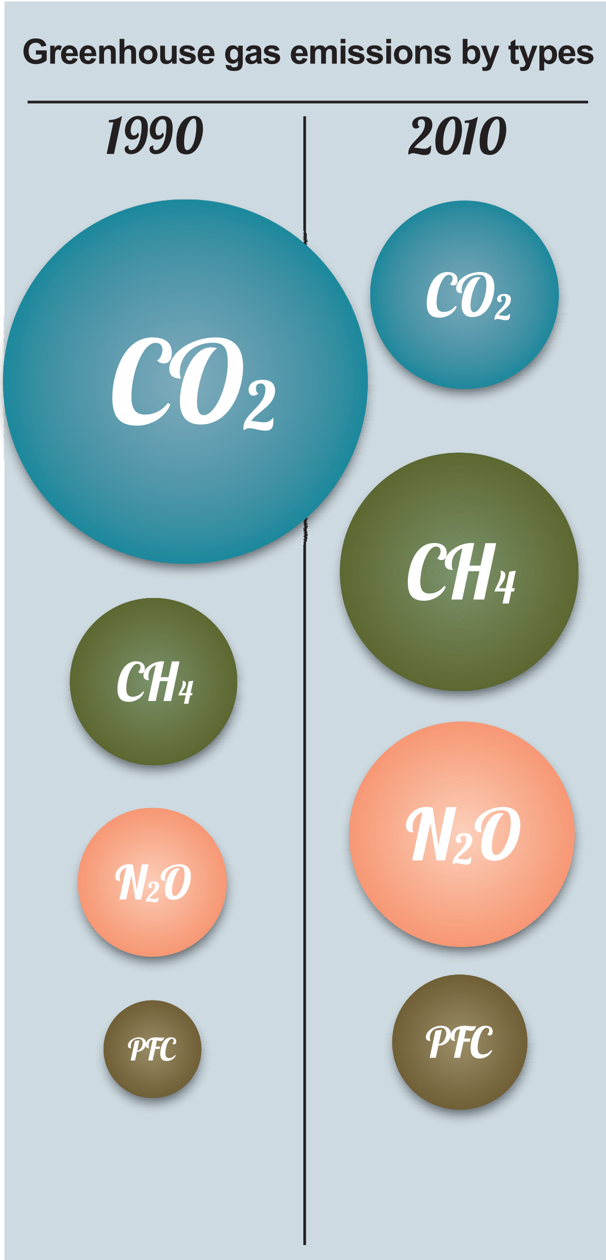
The contribution of the transport sector to CO_2 emissions was at its peak in 1990 at 30%, mainly caused by motor transport. An increase of prices for imported fuel contributed to increased number of vehicles using gas. Emigration of the population in 1990s, civil war, economic and energy crises resulted in considerable reduction of CO_2 emissions. Only in 2000, after the stabilization of the economy, increased emissions in some sub-sectors such as 'aviation' have been observed.

Given the fact that the majority of Tajikistan's population lives in rural areas, the key source of CO_2emissions are 'energy activities' in housing and communal areas, and agriculture. The rural population consumes fossil fuels and biomass for heating residential buildings, for cooking and for running agricultural machinery. The contribution of these activities to CO_2 emissions has increased from 40% in 1990 to 70% after 2000.

The contribution of the industrial sector to CO_2 emissions is as a result of burning fossil fuels for production and other purposes, and from CO_2 flows resulting from chemical reactions.
The main sources of CO_2emissions in the 'Industrial processes' sector are the aluminum, cement and ammonia and, to a smaller extent, iron, steel, lime and caustic soda.

The highest volumes of emissions of 1.5mln tons were observed in 1990. By 1997, this amount has





dropped to 350 thousand tons mainly due to a decline in production. As of 1998, CO_2 emissions increased by 5-20% depending on the type of production. In 2010, CO_2 emissions from the industrial sector rose to 650 thousand tons. The main share of CO_2 emissions in this sector are from the production of metal (50% in 1990, and 80% in 2010).

Methane (CH_4) emissions

The main sources of methane emissions in Tajikistan in 2010 were the agricultural sector (~84%), and waste (~16%). An insignificant volume of methane emissions (less than 1%) came from the energy sector, mainly from coal mining. According to expert assessments, the volume of emissions from the natural gas sector and coal are similar. However in view of sudden reduction of gas consumption and due to insufficient data, the contribution of this source to emissions is low and not covered under national inventory. Total methane emissions in 2010 were 95% of 1990 emissions Methane emissions in agriculture sector mainly take place through gases from animal digestion

(83% in 2010), livestock waste (12% in 2010) and rice cultivation (4% in 2010). The general trends livestock breeding therefore have an impact on emissions. The development of livestock breeding is hampered by a lack of productive pastures, a reduction of forage output and financial constraints of farms.

Methane emissions from solid domestic waste in cities and from industrial and communal waste waters were revised since the number of controlled landfills and waste disposal sites has reduced from 5 to 4 and from 70 and 63 accordingly. Methane emissions in the 'waste' sector in 2010 comprised 26Gg (80% of the 1990 emissions) almost all of which are emissions from solid domestic waste..

Nitrous oxide (N_2O) emissions

The volume of nitrogen monoxide emissions is insignificant. However in CO_2 equivalent terms this gas has a high global warming coefficient. N_2O emissions are observed in the agriculture sector (96%) and in waste management (4%). In the agriculture sector the N_2O emissions result from application of organic and mineral fertilizers containing nitrogen, and also from livestock breeding (through animal waste). N_2O emissions in 2010 are equivalent to 83% 1990.

Perfluorocarbon emissions

In Tajikistan the perfluorocarbon (CF_4 and C_2F_6) emissions mostly come from aluminum production. The absolute volume of perfluorocarbon emissions is insignificant, but their contribution to greenhouse effect is substantial. This is mainly due to their extremely high global warming coefficient with tetrafluorocarbon (CF_4) being 6500 more powerful and hexaflurocarbon (C_2F_6), 9200 more powerful than CO_2 in the atmposhere. From 1990 to 1997, the CF_4 emissions reduced from 0.14 to 0.06 thousand tons. But then in 2010, these emissions increased up to 0.11 thousand tons due to a growth in aluminium production. Thanks to environmental measures, reductions of specific emissions of fluorine hydride and other hazardous substances per product unit have been observed. In 1990 the volume of emissions in CO_2-equivalent comprised 1mln tons and 0,81mln tons in 2010. Due to lack of sample data and other local emission factors, there is high level of uncertainty of these estimates.

3.7. Greenhouse gas emissions by sector

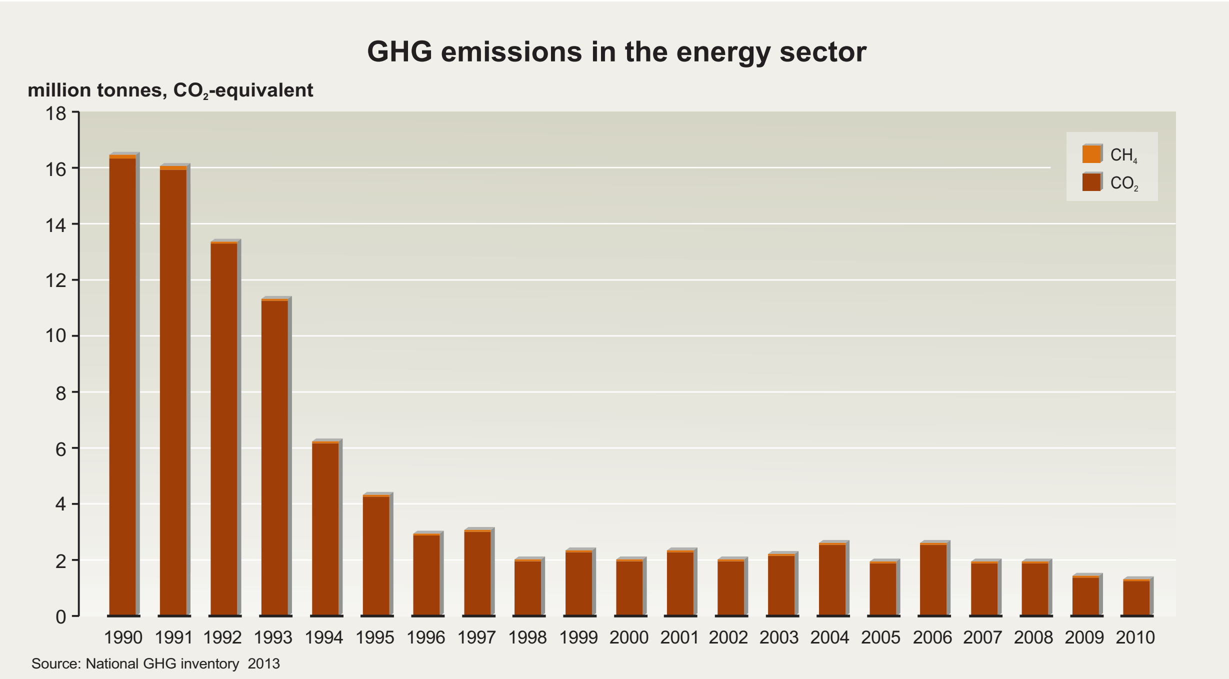
Energy activities

In CO_2 equivalent, the contribution of greenhouse gases from the 'Energy' sector for different years was beteen 14% and 67% of total emissions for the corresponding year. In 2010 GHG emissions in the energy sector was 1.2mln tons or less than 10% than emissions in 1990-1990. During the same year, the International Energy Agency estimated that energy emissions in Tajikistan reached 2.8mln tons per year. (http://www.iea.org/statistics/statisticssearch/report/?country=TAJIKISTAN&product=indicators&year=2010) The difference occurs because of the lack of balance between supply and demand and also due to different calculation and registration methods.

Industrial process

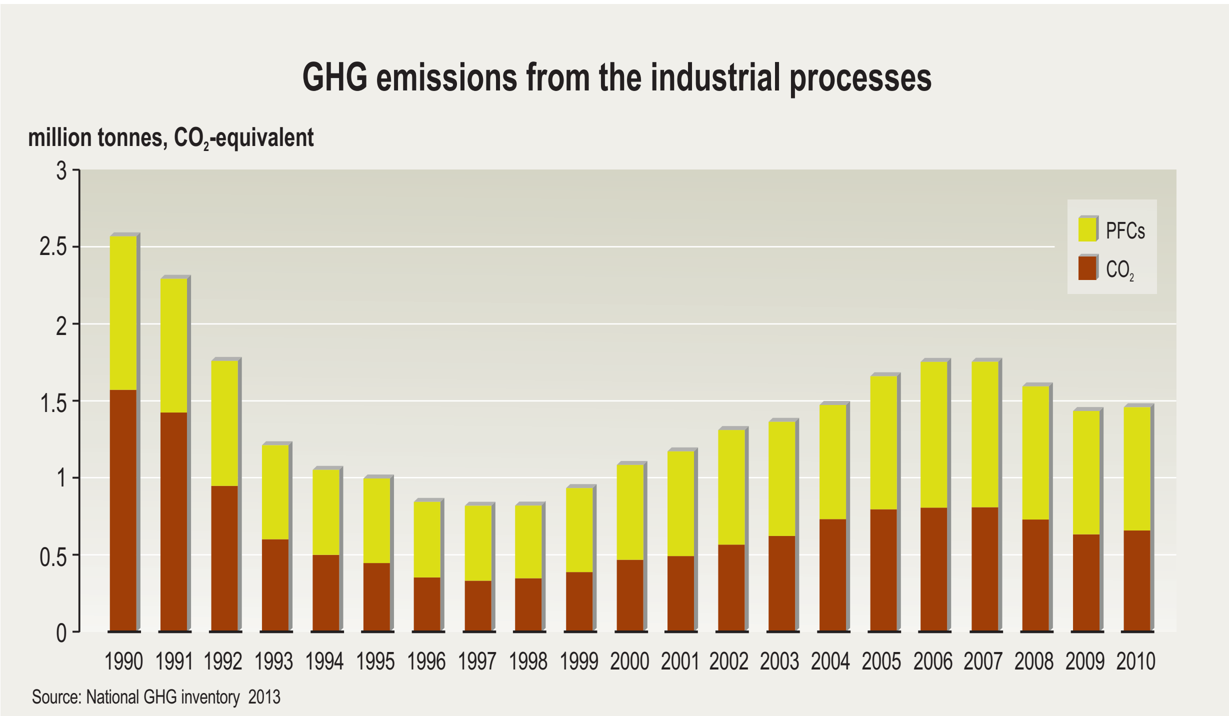
In addition to burning fuel, GHG emissions are also created by non-energy industrial processes where materials transform from one state to another. IPCC methodology prevents double counting of emissions in industry since the emissions resulting from fuel burning are covered under 'Energy'.

The input of GHG emissions from the 'Industrial processes' sector varies from 6 to 20% of total national emissions for different years. In 2010 the emissions in this category were equivalent to 58% of the emissions in 1990. The lowest emission rates were observed in 1996-1998. As for the period covered by the national inventory (2004-2010) the highest levels of emissions occurred in 2007 (814Gg) due to industrial growth. Due to the global economic crisis in 2008 and reduction of import of natural gas, the volume of cement and ammonia production has reduced. Moreover, due to lack of natural gas supply in 2009-2010, ammonia production was discontinued. As a result, compared to 2005, CO_2 emissions in 2010 reduced by 20%.



A review of CO_2 emissions from the 'Industrial processes' sector showed that metal production is the main contributor making up 50% in 1990 and 80% in 2010. Metal production is followed by non-metallic minerals (cement, lime) comprising 39% in 1990 and 20% in 2010. Emissions from production of ammonia in 2005 comprised 10% of total industrial emissions. Due to lack of natural gas in 2009-2010, the enterprises did not function, thus there were no emissions. It must be mentioned that perfluorocarbon emissions in CO_2 equivalent are analogical to the overall CO_2 emissions in the sector.

Aluminum production considerably contributes to industrial GHG emissions due to using large



amounts of anodes (CO_2 emission) electrolysis (perfluorocarbon emissions). According to the World Bank (2012) GHG emissions in aluminum production in Tajikistan can reach 5-10 tons of CO_2-equivalent per ton of produced aluminum, considering the frequency of anode effects 2-2.5 AE/electrolyser/24hrs. Modern technologies allow working with less frequent anode effects. Their reduction is priority direction towards reduction of GHG emissions.

Agriculture

The contribution of GHG emissions from the agriculture sector ranged from 20% to 62% of total national emissions depending on the year. From 2000 agriculture sector was among key sources of emission and 2010 emissions were equivalent to 110% of the 1990 levels.

In the agriculture sector the main GHGs are methane (CH_4) and nitrous oxide (N_2O) with the largest share coming from livestock digestion livestock (80-85%). The smallest proportion comes from methane from animal waste (manure)(~10%). Methane emissions from rice paddles and the burning of agricultural waste do not exceed 8%. Annually the area for rice cultivation varies between 12 and 20 thousand ha. The main rice cultivation regions are Soughd and Khatlon oblasts. In 2010 rice cultivation reached 15 ha. Rice is cultivated in traditional way through regular check dam flooding of rice fields, which creates methane emissions through the anaerobic decomposition of organic substances.

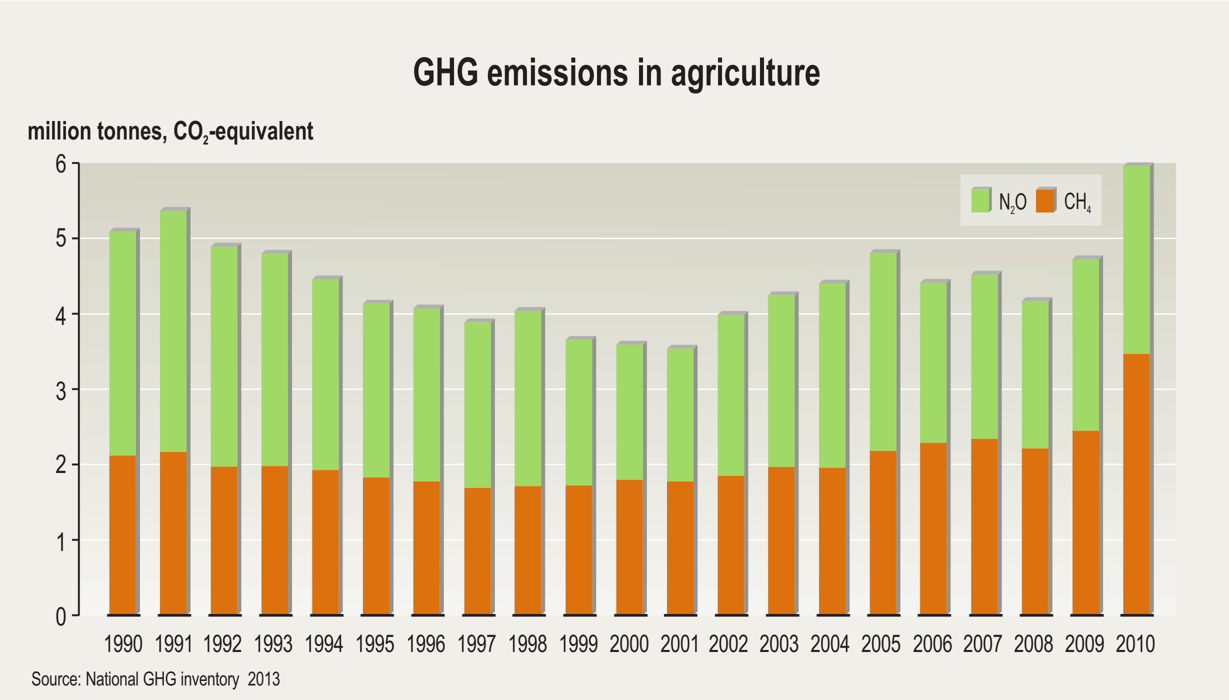
Land Use, Land Use Change and Forest Management

In Tajikistan the natural absorption of carbon dioxide takes place in 'Land Use, Land Use Change and Forest Management' (LULUCFM) as a result of:

- Change (increase) of forests and other wood biomasses;
- Conversion of forests and pasture lands;
- Land use dynamics.

After the collapse of the Soviet Union, the supply of coal and gas were stopped and the power supply to rural population was reduced. As a result, people were compelled to use available wood biomass. The woodlands most frequently used were field shelter belts and woodland belts along the highways and near to communities. Reforestation is 50% what it was compared to 1990 One of the key indicators of forest health is its stand density. With an average norm of 0.5-0.6 in 1990 the share of

Photo. Rice field in the Khatlon region



medium stocking was 50%, but by 2007-2010 it had dropped to 30%. This is mainly as a result of human activities such as forest cutting, as well as animal grazing, fires and an increase of forest pests. According to expert observations, the standing tree crop has declined from 1.3m^3 per person in 1990 to 0.8m^3 per person in 2010. Ongoing reforestation works are insufficient for full reforestation.

Despite a reduction in CO_2 absorption capacity between 1990 and 1999, the situation has improved over the last decade. In other words, as a result of land reforms, changes in land use structure, strengthened land use control, creation of forest ranges and perennial planting, the natural absorption of carbon dioxide first was stabilized and then increased. In 2010 the absorption of CO_2 by tree and shrub plantings reached 0.6mln tons, whilst changes in land use structure resulted in absorption of 1.5mln tons making a total of 2.1mln tons. In 2010 absorption was110% of 1990 equivalent. Since 2005, and especially after 2010 the growth of perennial plants was observed resulting in a further increase of carbon accumulation by the wood biomass.

Waste

For the national inventory, the 'waste' sector covered the following sources: solid domestic waste landfills and complex non-industrial and industrial waste water treatment plants. The waste sector has smallest volume of emissions making up 3-9% of total volume in CO_2-equivalent. GHG emissions in 2010 were 70% of their 1990 equivalent. Between 1991-1999 emissions reduced. There was a considerable reduction of methane emissions of 30% in 1999 compared to 1998 equivalent which was primarily linked to a reduction in the number of disposal sites from 70 to 52, controlled landfills from 5 to 3, and uncontrolled deep landfills from 12 to 7.

Over the last decade, especially between 2005 – 2010 emissions have been increasing. The number of controlled landfills has increased from 3 to 4 (Dushanbe, Khujand, Vahdat, and Tursunzade) whilst the number of uncontrolled landfills with more than a 5m thickness of waste, has reached 7 (B. Ghafurov, Istarafshan, Isfara, Khorog, Somoniyon, Sarband, and Kulyab). The number of shallow landfills with less than a5m thickness of waste has reached 52. In total, there are 63 solid domestic waste landfills and 105 complex waste water treatment plants. Since Tajikistan has no adequate infrastructure for collecting and processing sorted waste, except from individual initiatives on collecting waste paper, waste metal and plastic, all waste is disposed of in landfills.

The major contribution is made by emissions from solid domestic waste (95-97%). An increase in emissions is mainly linked to the growth of the urban population, the volume of waste and number of disposal sites.

Nitrous oxide emissions are insignificant mainly due to the fact that in Tajikistan the volume of protein consumption is low and so is the volume of waste water formation. A comparison of the data from the previous inventories showed no discrepancies or changes.

3.8. Indirect GHG emissions

The main sources of indirect GHG emissions are from burning fossil fuels and industrial activities. During 1990-2010 emissions from different indirect GHG and SO_2 has declined, in a similar way to the main GHGs.

3.9. Key sources of GHG

The key sources of GHG in CO_2-equivalent are those that contribute towards creating 95% of emissions during a specified period. Identification of these main sources and their analysis enables the identification of priorities for an improvement in the quality of the national inventory and the development of measures to reduce the largest emissions.

Key sources of GHG in 2010

	Sector	IPCC source	Gas	CO_2 equivalent (Gg)	%	Cumulative total
4.D	Agriculture	Agriculturalareas (directandindirect emissions)	N_2O	2681.80	29.44	29.44
4.A	Agriculture	Digestion by domestic animals	CH_4	2436.77	26.75	56.18
2.C	Industrial processes	Aluminum production	PFCs	822.74	9.03	65.21
6.A	Waste	Solid domestic waste landfills	CH_4	532.38	5.84	71.06
2.C	Industrial processes	Aluminum production	CO_2	523.56	5.75	76.80
4.B	Agriculture	Animal waste and compost emissions	CH_4	360.01	3.95	80.76
1.A.2	Energy	Industry and construction	CO_2	328.06	3.60	84.36
1.A.4	Energy	Housing and Communal management	CO_2	305.61	3.35	87.71
4.B	Agriculture	Animal waste and compost emissions	N_2O	198.77	2.18	89.89
1.A.3	Energy	Vehicles	CO_2	176.46	1.94	91.83
1.A.3	Energy	Aviation	CO_2	125.16	1.37	93.20
4.C	Agriculture	Rice cultivation	CH_4	119.80	1.31	94.52
6.B	Waste	Waste water	N_2O	112.40	1.23	95.75
2.A	Industrial process	Production of cement	CO_2	102.98	1.13	96.88

3.10. Uncertainty assessment

“Uncertainty” characterizes the level of dispersion and possible deviations of data in comparison with true value. The information on uncertainty enables identification of the priority measures for more accurate assessment of emissions in further inventories and account of the information on uncertainty while planning for GHG emission reduction. The final uncertainty is a combination of uncertainties in coefficients of emissions and uncertainties in data on activities.

Uncertainties are subdivided into three levels. Low level (high reliability) if uncertainty is <10%, medium level if uncertainty is between 10 and 50%, high level if uncertainty is high (low reliability) and is equivalent to > 50%.

The final uncertainty of the present inventory is assessed to be at the medium level. At the same time, insome sectors such as 'Industrial process' the level of uncertainty is low, whilst for other sectors such as 'Agriculture', 'LULUCFM', and 'Waste' the uncertainty level is high. Due to the lack of a robust energy balance and taking into account the most reliable data on fuel consumption, the level of uncertainty in the Energy sector is medium.

3.11. Greenhouse gas emissions scenarios and options for mitigation of consequences

GHG emission scenarios have been developed for different time periods: up to 2020, based on existing macroeconomic predictions and strategic objectives, plans, sector development programmes and the situation up to August 2014; up to 2030, the period to be covered by the new sustainable development strategy of the country and Paris Declaration, and up to 2050, long term indicative predictions. It must be mentioned that the longer the time period the higher the level of uncertainty of emission scenarios and impact of the local and global factors.

GHG emissions in Tajikistan are affected and influenced by the local and regional situations and geopolitical factors, as well as by economic growth, energy and food related policies, the state of industry, transport and agriculture, and also by incentives and measures aimed at limiting and reducing GHG emissions.

Globally, coal and oil remain the drivers of economic growth and the way to meet the energy needs of a population however the importance of natural gas and RES is growing every year. To review the GHG emission scenarios in Tajikistan, a simplified Water Evaluation And Planning System (WEAP) model in combination with forecasts from energy, industry, transport, and agriculture sector development has been used.

In his annual address to Parliament *(Majlisi Oli)* in 2010, the President of RT outlined the main directions for development,in particular, forecasting a 7-9% of annual economic growth rate (GDP) up to 2020. By that time, the population of the country will have reached 10mln people. The population growth forecasts of the United Nations Population Fund (UNFPA) suggest that by 2050 the total population will be 15 mln people.

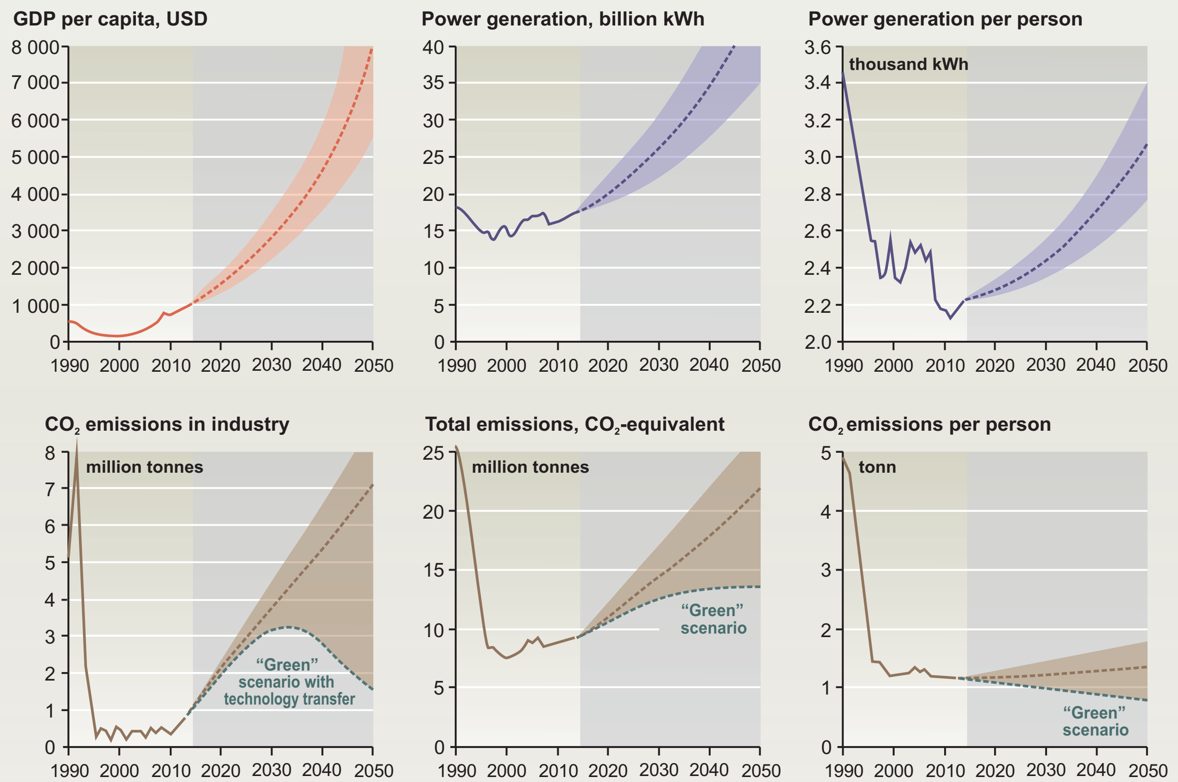
By 2020, it is expected that the first power units of the Roghun HPP will become operational. The HPP will be fully operational by 2030 resulting in greater electricity generation. It is expected that HPP will rise to full power (capacity) by 2030 increasing energy generation by 10-13bln kWh. Taking this into account, the average generation of electricity [mainly from HPPs] may exceed 20-25bln kWh by 2020, 25-30 bln kWh by 2030, and 40-45 bln kWh by 2050.

Due to insufficient fuel to meet the local demand for heating and cooking purposes, people largely use local coal and wood and also the imported oil products and liquid gas. The local demand for energy will increase between 2015-2020 due to continued energy shortages and the high cost of fuels. Thus there is a need to maximize energy saving and this should be regarded as a priority for energy policy. In many countries, the amount of energy used in relation to GDP is declining. As the nature of industry changes from heavy energy intensive production to services and small enterprises the energy intensity of GDP is decreasing. The current energy intensiveness of GDP in Tajikistan is 50% less than in 1991 and by 2020-2030 this will further reduce by a factor of more than two.

Coal mining at Fon Yaghnob, Zidde, Nazar-Ayloq, Miyonoadu and other mines will reach produce 600-800 thousand tons by 2017 and will exceed 1mln tons by 2025. Depending on the status of energy security and the extent of industrial development between 2030-2050, it is predicted that annual coal production and consumption will vary from 1 to 5mln tons. Currently, almost all the coal mined in the country is consumed by the population, industry and new coal based Thermal Power Stations. Investment in oil deposits and and the development of new ones will increase the production of gas to 500mln m^3 by 2015-2020. By 2030-2050 the new gas pipelines from Turkmenistan to China and Afghanistan will be constructed to allow the connection or transit of natural gas through Tajikistan. This development may substantively improve accessibility to gas fuels for the population and for the economy. Moreover, large and deep gas reserves in the south of the country can potentially be exploited and benefit the economy.

There is a high level of uncertainty with regards to the use of fuel for transport and 'sectoral' GHG emissions. This firstly because of the quality and completeness of data on fuel consumption. and secondly, because of the rapid technological progress taking place in the West in the use of

Scenarios of economic development, energy and GHG emissions till 2050



Graphics are based on the targets and scenarios of the state programmes, expert assessments and modelling. Further updates and corrections are possible.

electric vehicles.This might also be a good option for Tajikistan given its rich hydropower resources. By 2020-2030 it is expected that in terms of cost and usability the electric vehicles will be better positioned than traditional vehicles.

In 1991 Tajikistan was consuming around 2.5mln tons of oil products, whilst by 1998-2010 consumption had declined by 5-8 times increasing again between 2011 and 2014. In 2014 a decision was taken to construct a large oil refineryin the south of the country which is expected to result in increased oil extraction, import of raw materials and consumption of oil products. Consumption is expected to reach r 0.5-1mln tons by 2015-2020 and more than 2mln tons by 2030-2050. This estimate also takes into account increases air and railway traffic as well as an increased in the number of vehicles.

Currently there are no power stations or large scale enterprises running on coal or natural gas or coal gas. To address the energy security problems, it is planned that in 2014-2015 new coal based power units with the total capacity of 150-250mW will start operation. The construction of 2-4 large cement plants using coal as an energy source in the south and north of the country will begin in 2015. This will result in an increase of emissions by 1-2mln tons of CO_2 from the energy sector, and by 2-2.5mln tons in industrial sector by 2015-2020. Altogether, emissions will increase by 3-4.5mln tons of CO_2 per year. In addition, an increase of aluminum production to 400 thousand tons is planned by 2020. Thus, the share of emissions in energy and industrial sectors will substantially increase.

In the agriculture sector, an increased use of mineral fertilisers and growth in the numbers of cattle by 10-15% per year is expected. Without mitigation measures, overall GHG emissions will reach 6mln tons of CO_2 equivalent per year in this sector.

The 'Waste' sector contributes the lowest proportion of GHGs in the country [in CO_2-equivalent]. In view of the growth of population and future economic development it is expected that by 2020 the GHG emissions in this sector will increase one and a half times if no action is taken. Considering uncertainty in the future these emissions might be expected to exceed 1mln tons of CO_2 equivalent per year.

In the LULUCFM sector a growth in the volume of CO_2 absorption has been observed since 2000. During the current decade, as a result of changes in land use, improvement of land registration and control, the introduction of effective management methods and an improvement in forests, the volume of CO_2 absorption by soil and wood biomasses has been increasing. In 2010 the CO_2 absorption had reached 110% of their equivalent in 1990, then by 2020 the CO_2 it could be expected that absorption might increase by 120% or 1.8-2mln tons of CO_2 in absolute figures.

4. Climate change impact, vulnerability and adaptation

4.1. Observed and forecasted climate change and hydrologic conditions

According to the 5[th] Assessment Report of IPCC (IPCC AR5, 2013-2014), evidence suggests that starting from 2[nd] half of 20[th] century, the impact of humans on the warming of the climate of the planet was constantly rising mainly as a result of burning of fossil fuels and deforestation. In May 2013, the concentration of one of the main greenhouse gases, CO_2, exceeded the symbolic barrier of 400 ppm and the continued growth of GHG emissions 'heats' the planet. According to NASA (National Aeronautics and Space Administration of the US), Central Asia is one of the regions that has experienced a pronounced warming of its climate since 1950.Therefore not only Tajikistan, but also the other countries of Central Asia are experiencing the impact of climate change in the form of increased temperatures, melting of glaciers and transformation of river flows.

There have been a lot of assessments on climate change and water resources in Tajikistan and in Central Asia over the last 30-70 years, and even 80-90 years. There is a consensus on the characteristics and impacts for some river basins and geographic zones, whilst in others the trends and scenarios are different and remain uncertain. The reasons for these differences is because the different timeframes of assessments undertaken and the fact that the base periods are sometimes unclear to the users/readers or not indicated by authors. The assessment forecasts also vary due to the use of different climate models, differences in resolution, variations in the consideration of local characteristics , and variations in the emission scenarios on which the future of planet's climate systems depends.

Analytical framework and climate change assessment approach

For an objective assessment of climatic changes in Tajikistan's, an analysis of meteorological data from 47 meteorological stations located in different physical and geographical conditions was carried out. From these 47 stations, twenty five stations have regular and reliable observations between 1940 and 2012. Analyses were conducted on a monthly basis. In some stations the missing data was recovered. The most important climatic variables – average, minimum and maximum air temperature, precipitation and snow cover were analysed. Linear trends were estimated. Because monthly data does not show inter-annual variability clearly different statistical and graphical techniques were used to show the changes from one decade to another. Comparison of actual values and mean annual norms (1961-1990) was done. In the case of precipitation changes are given as percentages and for temperature in degrees Celsius. Glacier dynamics are an indirect indicator of inter-annual fluctuations and changes of climate.

Given that air temperatures have increased significantly since the mid 1970s to date, an additional analysis of changes and an assessment of trends for the period 1976 and 2012 was carried out. Unfortunately the quality and quantity of meteorological observations during the last 10-13 years has declined, especially in mountain and high-mountain districts, while the introduction of automatic weather stations has not yet helped to address this problem.

Ground and visual observations of the snow cover in mountains and measurement of precipitations via totalisators and precipitation gauge have considerably reduced which complicates climate change analysis.

To assess climate change, the meteorological stations were divided into three groups by altitude:

- Lowland-plains – up to 1000 masl;
- Mountainous – from 1000 to 2500 masl;
- Highlands – above 2500 masl.

The first category includes valleys and lowland zones up to 1000masl such as the Gissar, Vakhsh, lower Kafernigan, Kulyab valleys as well as the Fergana valley (the part within the Soughd oblast). The Zerafshan valley, mountains of central Tajikistan, mountain valleys of the eastern Pamir and other mountain ranges which are transitional areas between the lowlands and highlands were put in the Mountain category of 1000 - 2500 m.

4.2. Air temperature

Between 1940 and 2012 the temperature of plain areas of Tajikistan rose at an average rate of 0.1-0.2°C per decade. The highest increase of temperature was observed in Dangara town and Dushanbe city, (0.5-0.8°C) since 1940 whilst other areas , such as Khujand experienced a rise of by 0.3°C per decade with the lower increase being due to the impact of irrigation and water reservoirs. In mountainous districts, the average temperature increase comprised 0.3-0.5°C, with exception of some districts where trends are less prominent. In highland areas (above 2500 m), the temperature increased by 0.2-0.4°C.

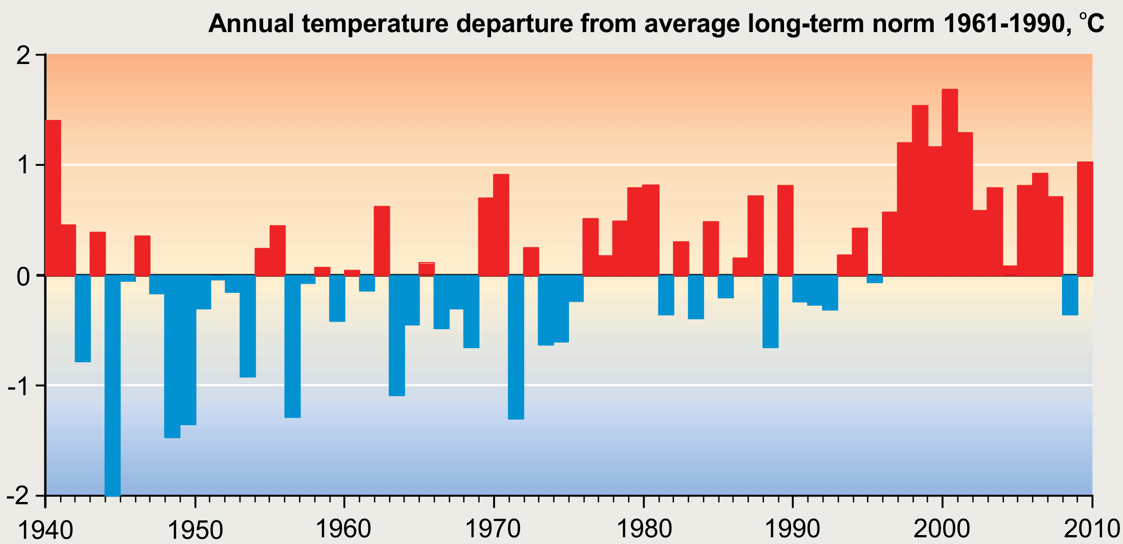
The most recent (1976-2012) warming trend in Tajikistan was an average per decade or +0.15°C in winter, +0.3°C and above in spring, with no change in summer, and +0.2°C in autumn per decade. At high altitudes, the warming trends for valleys and mountainous districts comprised +0.2°C per decade. In highland districts the trends are unknown.

The period of 2001-2010 turned out to be the warmest decade in the history of instrumental observations in Tajikistan. In zones up to 1,000m, the average temperature of the decade was 1ºC above the average; at the altitudes of 1,000 – 2,500 m the average was exceeded by 0.8ºC and in highland zones by 0.2ºC. 2001 was the hottest, with average annual temperature exceeding the average by 1.0-1.6ºC. Similar situations were observed in the plain and mountainous districts in 2004 and 2010.

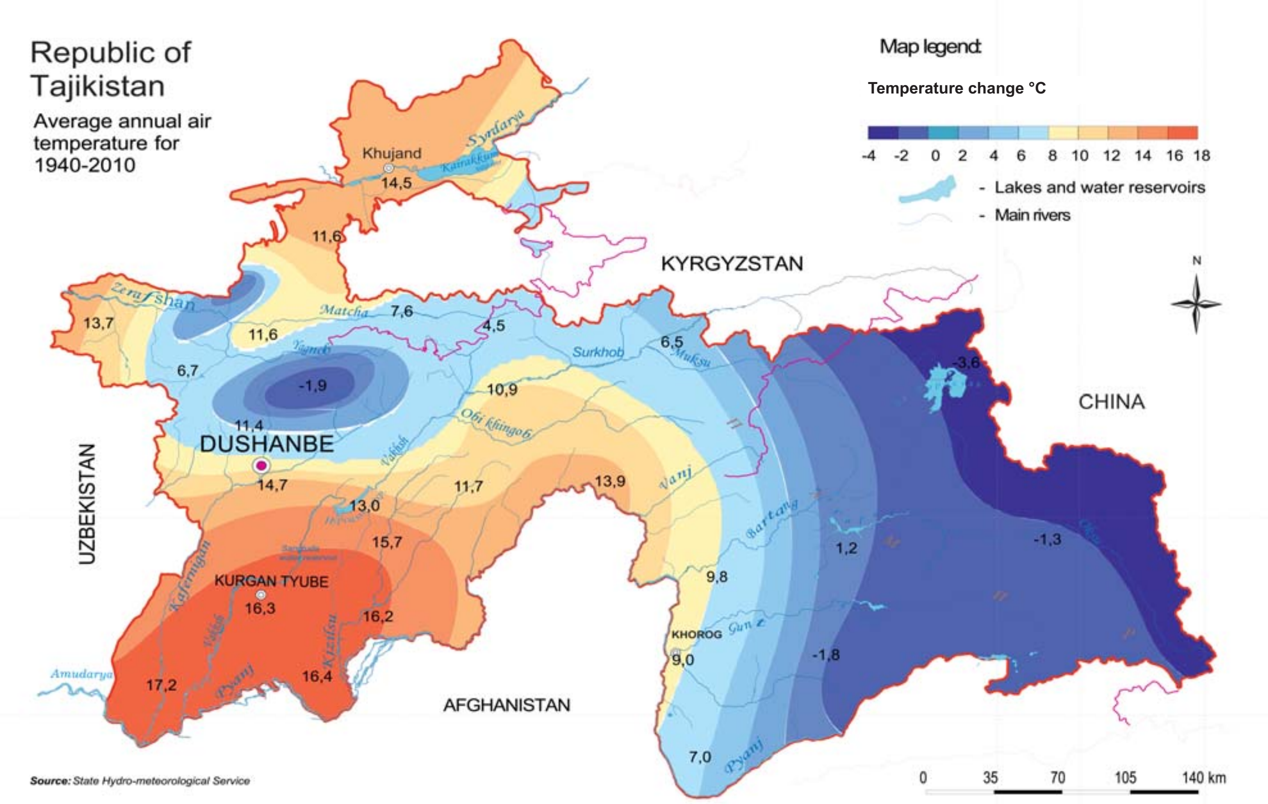
Unstable weather is a distinctive feature of the winter period in Tajikistan whenperiods of cold weather with precipitation alternate with warmer and good weather. The winters of the last decade were warmer, exceeding the average by +0.1-1.1ºC. In winter (January) 2008 there was an intrusion of cold air masses and the average monthly temperature reduced by 8-9ºC. This cold period caused a serious energy and food crises. There were warm winters in 2004 and 2010 with temperature exceeding the average by 2-4ºC.

The spring temperature during the last decade was above the average by 0.1-1.3ºC. In summer the

Change of temperature in Tajikistan



Source: National Hydro-meteorological Service of RT --- www.meteo.tj

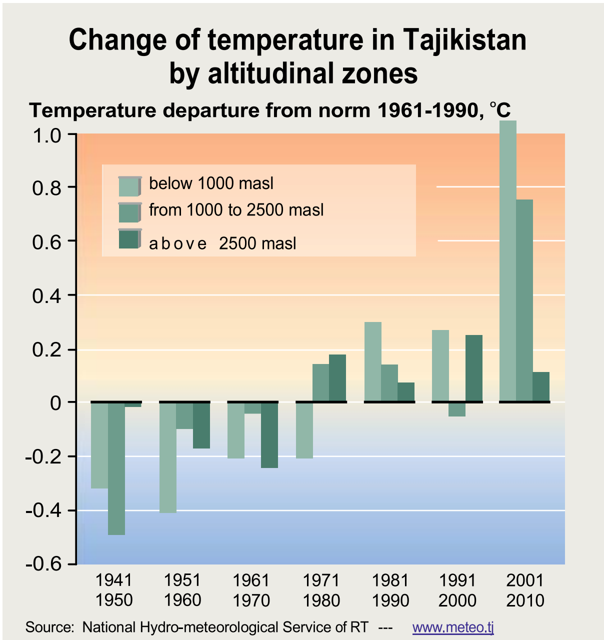


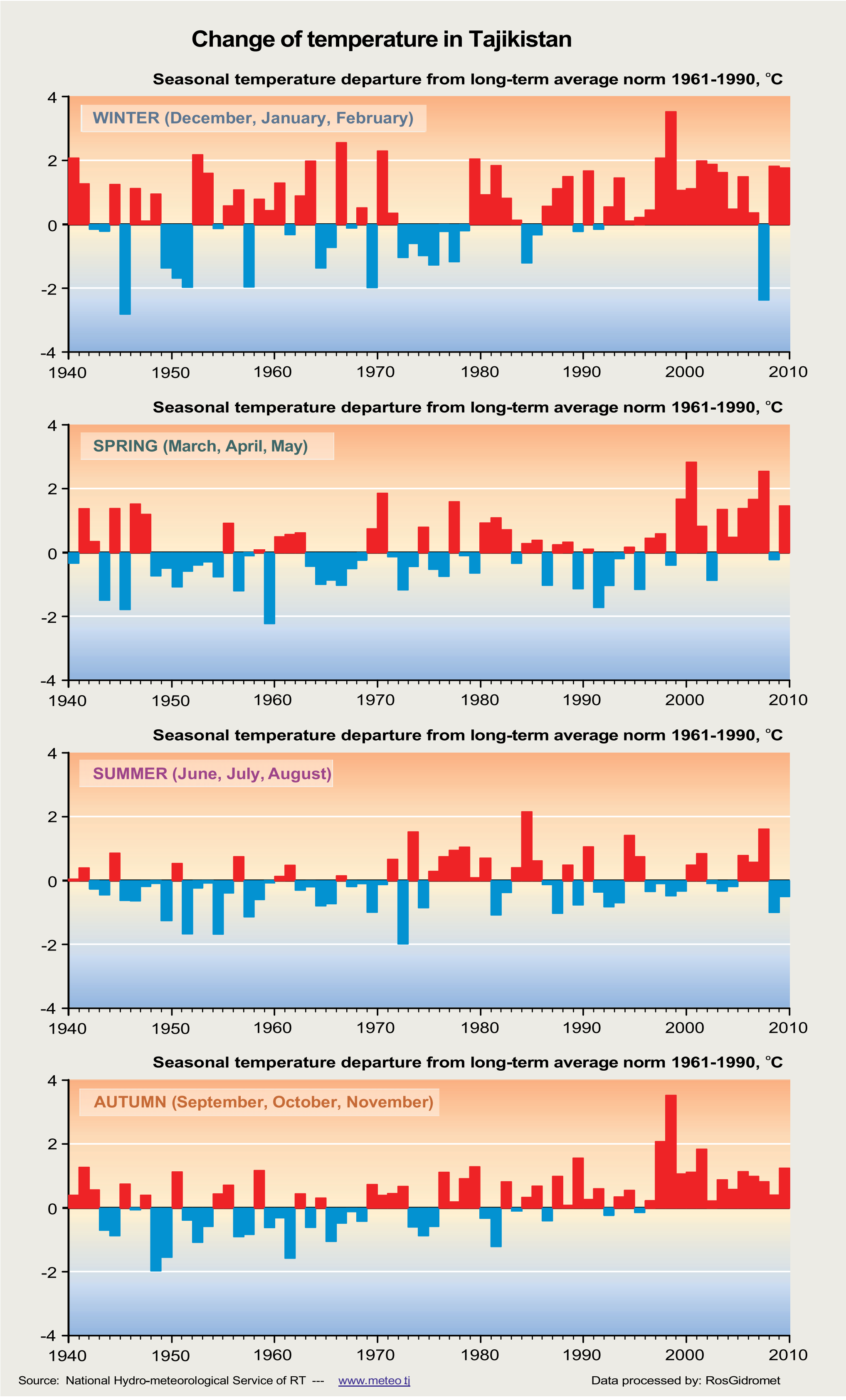
temperature was around the average, while in some highland districts the temperature was below the average. Autumns in the last decade turned out to be warm when temperatures in all highland areas exceeded the average by 0.6-1.1ºC. The warmest autumn was in 2002.

As a result of the warmer climate, there are now 5-10 more frost free days each year. The date when average temperatures are registered above zero spring is now earlier and in autumn is later.

Between 1940 and 2012 there was an increase of average minimum and maximum air temperatures in all highland areas of the country.. Almost everywhere the level of minimum temperature increase is greater than the level of maximum temperature increase. A movement of warm air from southern latitudes and decrease in cold intrusions has had an impact on climate warming in Tajikistan.

In 2013 it was especially hot at the end of July with the air temperature rising to 40-47º in plain areas and 37-44º in mountainous areas. In Darvaz and Isinbai, record maximum temperatures for the month were recorded.



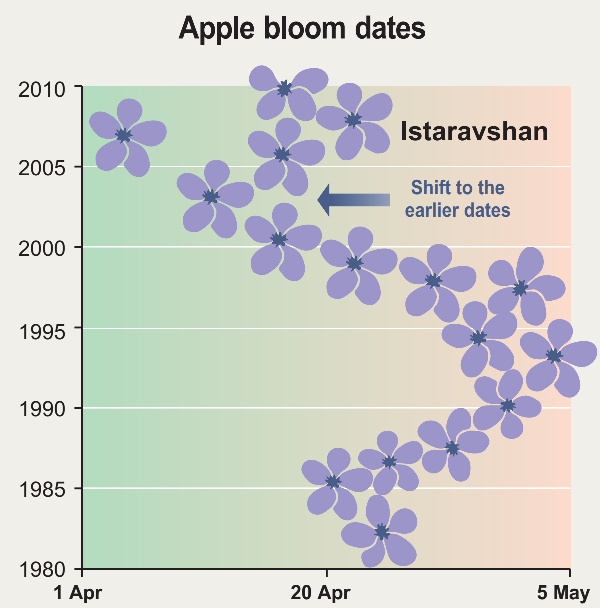

Change of temperature in Tajikistan
Seasonal temperature departure from long-term average norm 1961-1990, °C
WINTER (December, January, February)
Seasonal temperature departure from long-term average norm 1961-1990, °C
SPRING (March, April, May)
Seasonal temperature departure from long-term average norm 1961-1990, °C
SUMMER (June, July, August)
Seasonal temperature departure from long-term average norm 1961-1990, °C
AUTUMN (September, October, November)
4
2
0
-2
-4
1940
1950
1960
1970
1980
1990
2000
2010
Source: National Hydro-meteorological Service of RT --- www.meteo.tj
Data processed by: RosGidromet

Agrometeorology

During the last two decades the number of agro-meteorological observations in Tajikistan have reduced. Nevertheless, in some districts and meteorological stations the observations are made on the development phases of grain and industrial crops, as well as pasture vegetation and the main fruits are carried out.

For the fruiting of many local species of apple trees to occur, the total sum of positive temperatures above 10°C equivalent to1500°C is required. Blossoming begins during the accumulation of temperatures above 6°C till 280°C.

The analyses show that during the last 10-15 years the budding of apple trees in Gissar, Northern Turkestan, the Western Pamir and other agrometeorological districts took place earlier than the expected date. This is possibly linked to the warming that was especially prominent in 2008. Earlier periods of apple ripening are especially prominent in the Western Pamir districts.



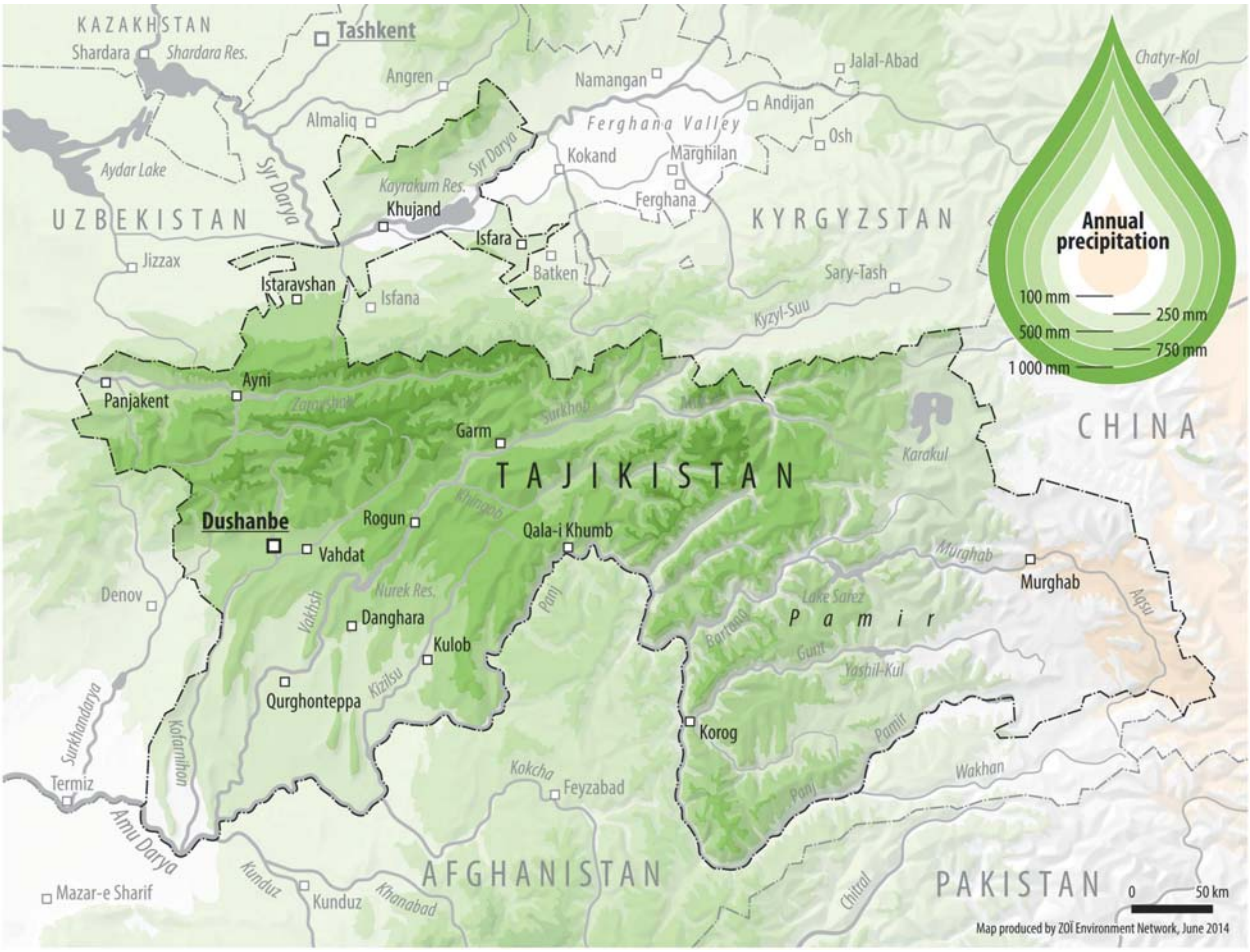
Source: Tajik hydrometeorological service

4.3. Atmospheric precipitations

Between 1940 and 2012 annual precipitation increased by 5-10%. However, the diversity of geographic and climatic zones in Tajikistan creates a varied and complex pattern of change. The driest decade was 1940-1950 which was followed by both dry and humid periods. In some instances, an increase in average precipitation was largely caused by increased precipitation intensity and a reduction in the number of days with precipitation per year. The annual amount of precipitation during the last decade (2000-2010) also was above the annual average, with exception of certain years which resulted in an river discharge.

During the summers of 1976-2012, there was a considerable relative increase in precipitation. However this did not significantly increase the ground moisture content or volume of surface flow, since the volume of the precipitation in summer is small, whilst the high temperatures in the same period meant high surface evaporation rates. During the cold period, precipitation in mountain and high mountain zones increased.. During recent years precipitation has been above the long term annual average. The impact of microclimate in certain mountain districts (mountain pass and canyons) is considerable. In these areas both a decrease and increase of precipitation has been observed.

During the period of instrumental observation the greatest precipitation in Tajikistan was observed in 1969. 1946 was extremely dry with 20% of average precipitation in plain areas, 40% in mountain regions and 80% in the highlands. The driest years of the last decade were 2000-2001 and 2008 when precipitation was 30-50% below the average.. The dynamics of arid conditions and strong precipitations are reviewed in detail in other sections of the TNC.



4.4. Glaciers

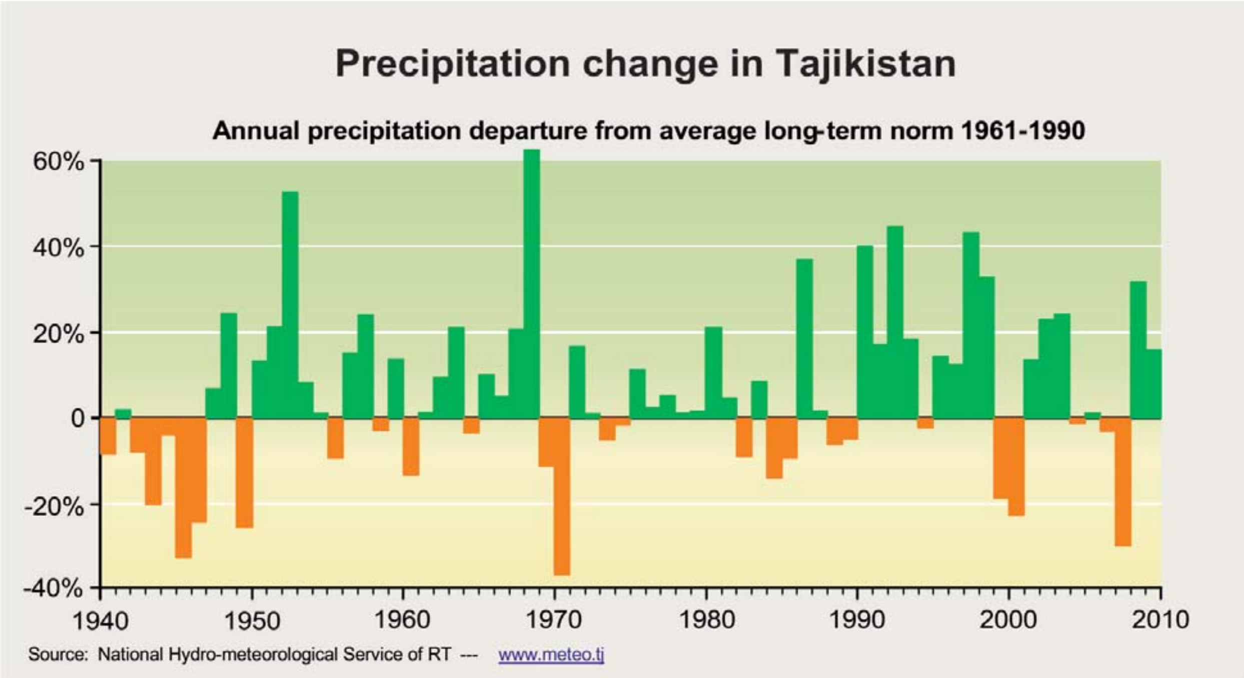
The glaciers and snow reserves of Tajikistan are the main sources of river flow formation andare located in the highlands at and above 2,500masl.

Glaciers and the snow cover are very sensitive to variation in the climate. Even small changes in summer temperature (by 0.5-1°C) can cause visible changes in the firn line (by height) and reduce glaciers by 30% or more.

The dynamics of the area and thickness of glaciers and location of their lobes (tongue) are visual indicators of climate change impact. However, a reduction in the visible surface of glaciers is not only indicator of their degradation since the area of buried glaciers is increasing. Mountain frosts are slower to react to climate warming. The snow cover changes from one year to another.

The use of digital data storage devices and access to high resolution satellite images has enhanced opportunities for exploring glaciers. However data can often be interpreted in different ways and sometimes the difference in assessments are significant. During the period of independence (since 1991), no body of data on glaciers was collected and developed for Tajikistan, although fragmented field and remote research was conducted. Using what data exists, the degradation of glacier cover in the country since the middle of 20th century to date is estimated at 20%. This is mainly due to the melting and disappearance of small glaciers. It is estimated that the volume of glaciers in only 30% of what it was when instrumental measurements started in 1930. The current degradation levels are 0.5-0.8% per year.

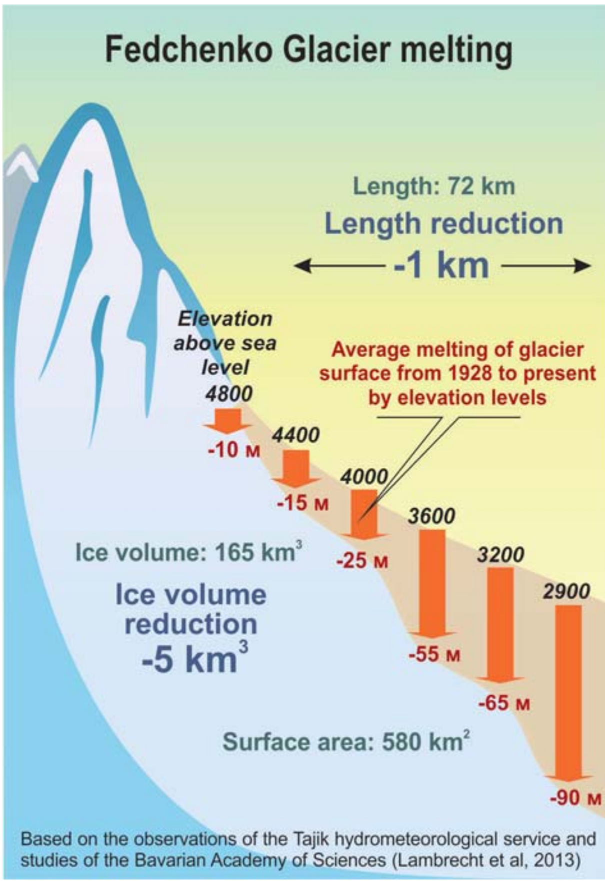
The response of a glacier to climate warming depends on the size, slope exposure, altitude, and



other characteristics. The large areas glaciers in the Pamir and other high altitudes (4,500-7,00masl) did not reduce greatly during the period of observations. For instance, since the early 20th century (the first instrumental measurements were made in 1928) the Fedchenko Glacier (the largest in Tajikistan) has retreated by 1km and lost around 5km^3 of ice. The area of the glacier has reduced by less than 0.5%, it's length by 1.5%, and volume by 3.5%.

At the same time, many smaller glaciers or those located at the lower altitudes have reduced and many of them have melted due to warming. For instance from 1927 to 2010, the Zerafshan glacier has retreated by 2.5km (10% in length), while the small glacier 'Diakhandara' (less than 1km^2) located at the upstream of Karatag river has fully melted.

The Abramov Glacier (area: 22.9 km^2), located in the area of Kyrgyzstan's bordering Tajikistan (upstream of the Vakhsh river) is considered to be representative of glaciers in the Pamir and Gissar-Allai. From the start of observations it has continued to reduce whilst its annual balance was mainly negative with a loss of ice being observed. The glacier has only had a positive balance in 9 of the last 44 years (1969-2012), whilst for a another nine years the negative balance has exceeded 1,000 mm of water equivalent. The worst negative balances were recorded in 1997 and in 2008. From



1978 to 2012, the glacier tongue has retreated by 1.2km, observed negative balance -1000mm of water equivalent, were recorded in 1997 and 2008 Despite a break in observations between 1999 – 2012, scientists have been able to recover the missing data and in August 2011 an automatic meteorological station started operation near the glacier.

From the middle of 20th century till the beginning of 21st century (ie 2003-2010) the area of glaciers in the Vakhsh river basin, including upstream of the river in Kyrgyzstan, has reduced from 3,700 km^2 to 3,200 km^2 (between 7.5% to 10% according to different sources), while the area of glaciers in Pyanj river basin, including feeder glaciers in Afghanistan, has reduced from 3,900 km^2 to 3,600 km^2 or from 8.5% to 15% according to different sources. The current area of glaciers of Gissar-Allai within Tajikistan is approximately 500-550 km^2 which is a reduction of 20-25% during the period covered. This is similar to the trends observed in south-western Pamir.

If the dynamics described above continue and considering the impact of climate change, it is predicted that the area of glaciers could reduce by 40-50% in Vakhsh river basin and by 60-70% in Pyanj river basin. Altogether, this a reduction in the area of glaciers by 3,500 km^2 – 4,000km^2. Estimating the loss in the volume of glaciers is a challenging task given the insufficiency and lack of reliability if the data. In the middle of 20th century, the volume of glaciers in Vakhsh and Pyanj rivers was estimated at more than 400km^3. By the middle of this century, assuming that the temperature will increase by 2°C and that there won't be any changes in the type and amount of precipitation, the volume of ice in upstream of Amudarya river could reduce by 50%. Some models suggest that the temperature increase will exceed 2°C and this will result in even faster melting of glaciers.

In view of the degradation and intensive melting of glaciers, river discharges have increased by 5% and even more in glacier and snow fed rivers. Despite a significant degradation of glaciers such as those in the upstream of the Zerafshan river, water runoff did not reduce. This is due to natural compensatory mechanisms such as an increase in melt waters and permafrost which have significant water reserves and add to the water content of the rivers.

On average, between 1940 and 1990 the glacier zones (including ice and areas of snow melt) have contributed up to 40-45% of annual discharge of the main river basins, namely the Vakhsh, Pyanj and Zerafshan during June – September. During hot and dry years their contribution reached 50-70%. As a result of the active melting of glaciers feeding these rivers, discharge can initially increase. However in the long term, the impact is the opposite: the discharge will reduce due to a depletion of water reserves. Unfavourable changes in the hydrological dynamics of rivers may have serious consequences on society and economy, especially agriculture. Snow and glacier melting intensity in summer period is likely to increase. This will result in formation of glacier lakes and when these lakes burst some may create the threat of strong mudflows. Due to filtration through drift deposits and evaporation, other glacier lakes do not pose serious threats. However, an increase in the volume of meltwaters in the body and base of glaciers enhances the risk of surging, sliding and degradation processes.

The role of glaciers is similar to the role of seasonally regulated water reservoirs which redistribute the annual flow and reduce its variability as they store precipitation in winter and let out water in summer) In this way in dry and hot years the glaciers feed rivers and in cold years with heavy precipitation they store water reserves. Therefore a catastrophic change in the discharge of rivers due to a reduction of glaciers should not be expected. because in many ways, river discharge is defined by the amount and type of precipitation, especially of the snow cover in mountains. However a climate change scenario in which snowfall will reduce and be replaced by more frequent and intensive rains; the temperatures will considerably increase (and hence so will the risk of droughts), and the glaciers will be actively melting, will result in huge challenges.

Photo. Surging of Glacier Medvejiy, 2011 a) overall view, b) the front of glacier tongue.

Photo. Snow cover in the mountains

The challenges and consequences of climate change in both globally and in Tajikistan are likely to increase if global measures on reduction of GHG emissions and on limiting the temperature increase within 2°C by the end of 21st century are not taken.

4.5. Snow cover

Melting of seasonal snow cover plays an important role in formation and nature of river discharge. If the total amount of solid precipitation (and maximum snow reserves) in the mountains is retained then no significant reduction of water resources due to loss of glaciers should be expected.

The main snow reserves in the mountains of Tajikistan are based in areas with an altitude of 2000-4000 masl. In the process of snow cover melting, part of the meltwater evaporates, another part infiltrates into the soil and the restflows into rivers. To predict what proportion takes which flow route requires the monitoring and assessment of water and snow resources in the mountains. During the Soviet period upstream of Zerafshan, Kafernigan, Kizilsi (southern), Vakhsh and Pamir rivers, were monitored using 400 measuring staff visible from the air and and tens of snow measurments were undertaken. Unfortunately during the last 10-15 years the number of observations of the depth of snow cover and assessment of water reserves has reduced. This makes it difficult to objectively assess the dynamics of snowfall.

Data from the limited observations made on snowfields, from the meteorological stations and from satellite images shows that between 2002-2012,the depth of snow cover in the mountains was generally above the annual long term average (with exception of winter of 2007-2008 when the air temperature was very low). The storage of snow cover by the start of the growing season reached 60-80% of the average during the period.. This situation has had a direct impact on rivers discharge, and as a result of the economic sub-sectors of dependent on river flow, namely irrigated farming and hydro-energy. During the winters of 2002-2003 and 2011-2012, snowfalls have exceeded the average which resulted in a record number of avalanches. International research based on satellite data covering the area of snow cover in the Pamir mountains during the last decade show a similar situation.

An increase in air temperature during winter and spring reduces snowfalls, reduces the potential snow reserves, and results in an earlier melting of snow cover.

4.6. Consequences of climate change for hydrological cycle and water resources

A conflict free and sustainable use of water resources is a challenging issue in Central Asia. Without sufficient data or adequate water predictions and water policy reforms, continued tensions can be fuelled by factors such as the legacy of environmental and water problems from Soviet times (outdated and ineffective irrigation systems, land salinisation, the Aral Sea crisis), the growth of the population and as a result an increased demand for food, energy and economic development.

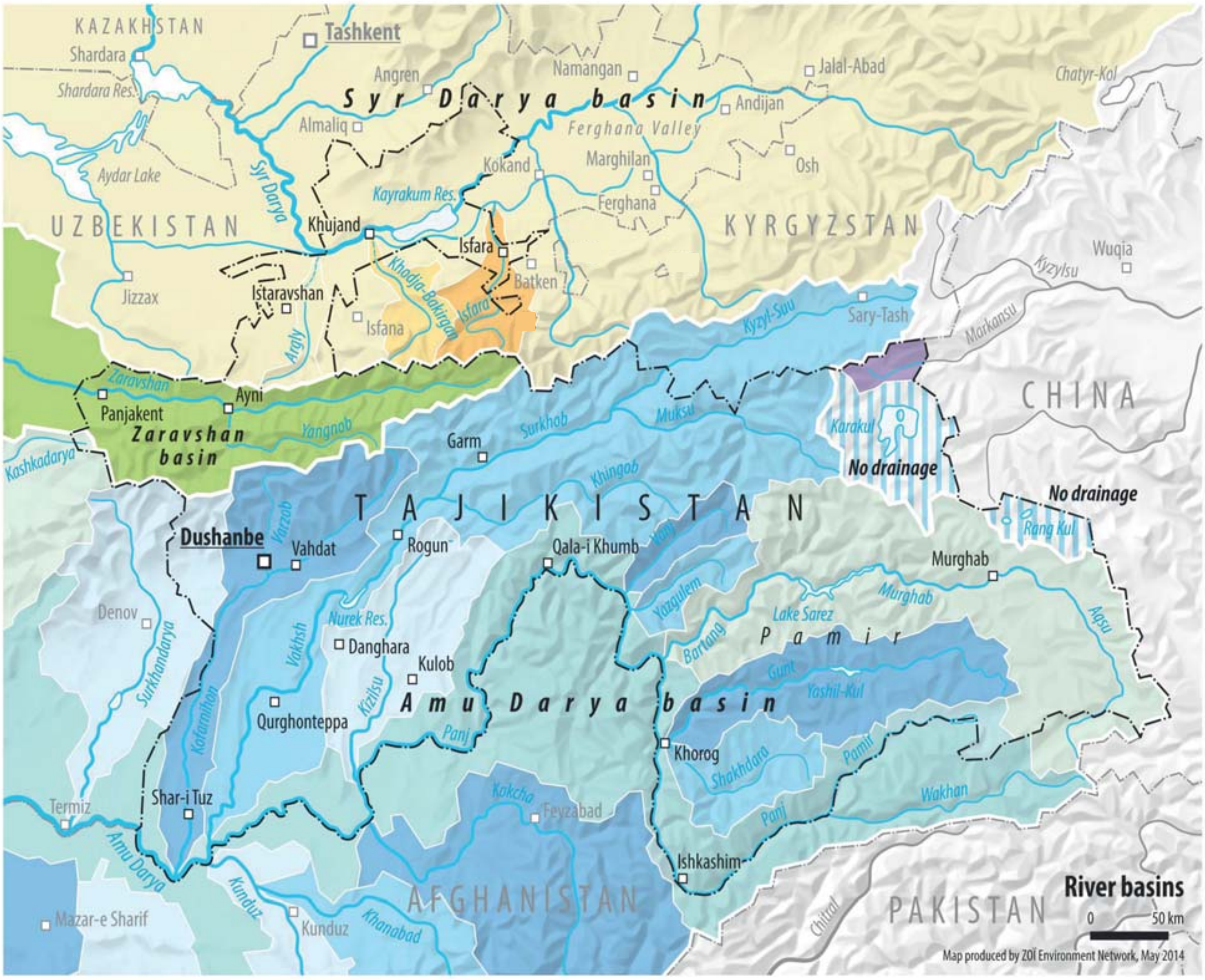
Scenarios and conclusions proposed in the previous National Communications on climate change of all countries of Central Asia indicate that the in the case of warming, the main river regimes can change whilst by the end of 21st century water resources could reduce by 10-20% or more. The importance of the impact of climate change on glaciers and water resources in the region was noted at the World Climate Conference (Geneva, 2009), the World Conference on Climate Change (Copenhagen, 2009), the International Conference on Trans-boundary Water Cooperation (Dushanbe, 2013) and in other forums.

During the 50-80 year period of robust observations, no changes were revealed that exceeded statistical error margins or that changed the predictions related to the annual and interannual discharge of Tajikistan's main rivers. While reviewing the averaged discharge by decade, those between 1971-1980 and 1981-1990 were lower than the average, while the those during the following decades from 1991 to 2010 were above the average as a result of increased precipitation and the melting of glacier ice. The reduced frequency of hydrological observations from 1994 resulting in gaps in the data that makes the calculation of a comprehensive, reliable and full scale assessment of current condition of water resources rather challenging.

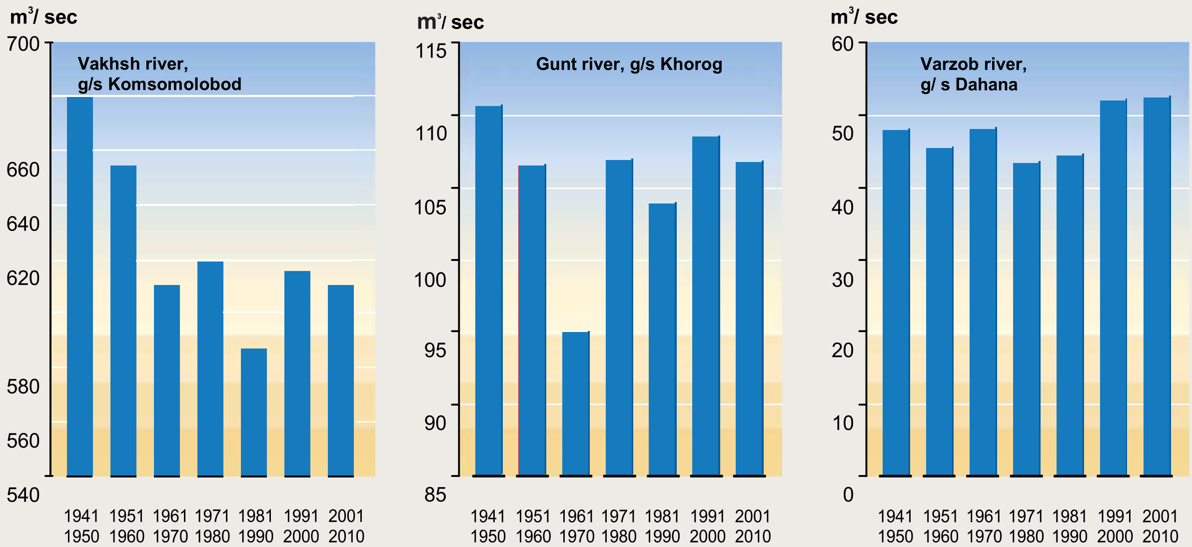
The Kafernigan river (Kofarnihon) is 390km long and is the largest feeder tributary of the Amudarya. The river starts Tajikistan and is fed by snow and glaciers originating from southern slopes of the Gissar range. The average annual discharge of (g/s Tartki) is 162 m^3 per second, while the average annual volume is 5.11km^3. The main tributaries are the Varzob, Elok and Khanak rivers. The highest discharge takes place between May and June. The southern slopes of the Gissar range are favourably orientated to be affected by by humid air masses. The most abundant precipitation take place during winter and spring and reaches up to 2,000mm per year in certain places as compared to the average precipitation of 1,000mm. The depth of snow cover can reach 4-5m (for example at the meteorological station at Kharamkul). A deep snow cover and steep slopes make it an area of frequent snow avalanches and these also play a role in feeding rivers. As a result of a moisture regime of 40-50 l/sec./km^2.of water reaching rivers in the basin discharges are large.

An analysis of annual data covering 1930 to 2012 shows an increase of annual discharge in the Kafernigan river basin especially over the last two decades. The average annual discharge of water in the Varzob river (g/s Dahana) flowing through the Dushanbe, reached 45.5m^3 per second between 1970-1979. Between 1980 and 189 the discharge was below the annual average by 2-7% 14% above the annual averagebetween 1990-1999, and 7% above the annual average between 2000-2009.

A similar situation was also observed in the Kafernigan river where discharge was above the average. 2002-2011 was the period when the river



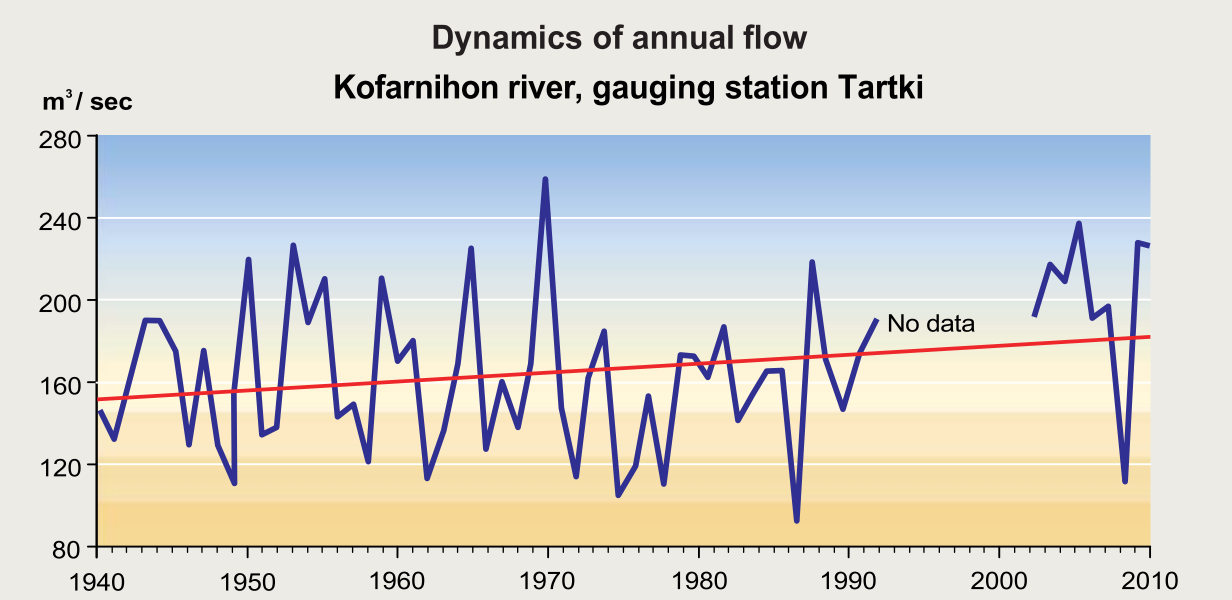
Average water discharge of rivers in Tajikistan by decades



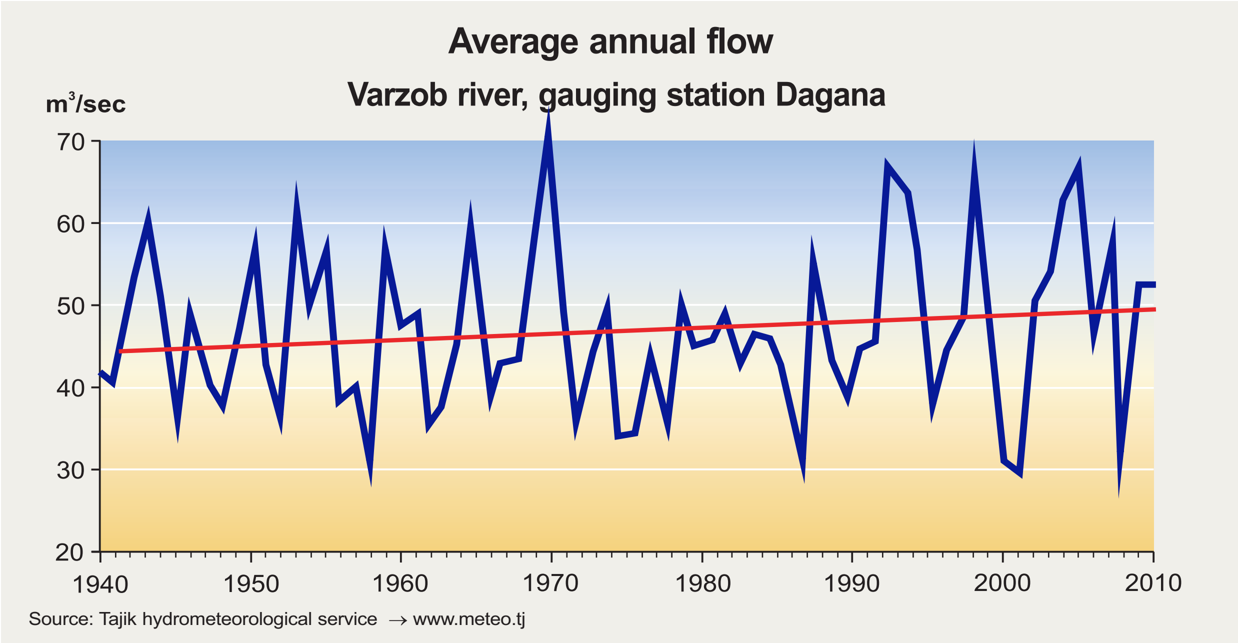
Source: National Hydrometeorological Service of RT – www.meteo.tj had the highest discharge of 193m³/sec for the Kafernigan river, and 52.5m³/sec for the Varzob river. 1990-1999 was the period with the next highest level of discharge. A significant increase in discharge is observed during the warm period of the year, especially in the summer. Previous work (NAP 2003) pointed out an insignificant reduction of discharge up to 1990. However during the last two decades the situation has changed and discharge is increasing.

The ***Vakhsh*** and Pyanjs river form the Amudarya. The Vakhsh river is a tributary of the Alai river in Kyrgyzstan where it is called Kizilsu. The average annual discharge (g/s Komsomolobod) reaches 604m³/sec, while the average annual volume of water reaches 19.1km³. Glaciers play significant role in water regime of the Vakhsh river. The peak of flow falls between July – August. The Muksu river is largely fed by the glaciers especially the Fedchenko and other large glaciers. The total volume of glaciers feeding the river Vakhsh is estimated to be 200-240km³ (average of 220 km³). The flow of the Muksu river is fed by tributaries from both left and right including the Seldara, Balyandkiik, Tanymas, Kaindi, and Sauksai rivers. The Seldara river basin is characterised by high water inputs reaching 26 l/sec/km². The Obikhingov river basin also has high water inputs of 33 l/sec/km² due to favorable orientation of the basin towards moisture-laden air masses. The Sarbogh river joins the Vakhsh (Surkhob) river from the right side of Gissar-Allai and the drainage basin is characterised by high level of flows reaching 40 l/sec/km². A cascade of HPPs, including HPP Nurek and other water reservoirs on the river Vakhsh have considerably changed the natural flow of lower reaches of the river. Increased discharge is observed during winter period (g/a Tigrovaya Balka). This is due to discharge from reservoirs upstream to generate electricity. While in summer period the discharge is reduced due to water conservation for the winter period.

An analysis of annual data between 1940 – 2012 leads to following conclusions: the Vakhsh river discharge has not experienced a significant reduction in flow as the reduction of just 3-5% is within the margin of error for hydrological measurements. Considering that since 1994 there have been fewer and poorer quality hydrological observations in Vakhsh river basin, it is not possible to recover and compare all data series. In addition the tributaries of the Vakash river are very diverse ranging from predominantly glacier fed rivers to basins dominated by permafrost. Therefore an



Source: National Hydrometeorological Service of RT – www.meteo.tj



assessment of Vakhsh river dynamics requires further analysis. Studies carried out by the WB and Asian Development Bank (ADB) on the vulnerability of hydro-energy and water resources in relation to climate change did not reveal any significant issues However, there is a wide variety of possible scenarios in the future that vary by +/- 30% depending on global GHG emission scenarios and climate change. Whilst analysing the period between 1972-2012 (the first power unit of Nurek on the river

Photo. River Vakhsh

Vakhsh started operation in 1972), the discharge over last two decades was close to or slightly above the annual average (615m^3/sec during 1991-2000 and 610m^3/sec during 2001-2010). The monthly variation of discharge was analysed by year and by year by decades without any clear trend being apparent.

The ***Pyanj river*** (Panj) is the longest and largest river of Tajikistan which also also forms the natural state border with Afghanistan. The Pyanj river rises and is fed from a number of areas the largest of which are Pamir, Gunt, Bartang, Yazgulem, Vanj and Kizilsu. From the Afghan side several small rivers join the Pyanj including the Vahan (the source of the Amudarya river) and Kokcha rivers. The Amudarya is formed through the confluence of Pyanj and Vakhsh rivers and is the largest river of Central Asia. Annual average water discharge (g/s Nijniy Pyanj) reaches 1,010m^3/sec, while the average annual volume of flow is 31.9km^3. The peak of the discharge is inJune – August with the maximum discharge being in July. The volume of the rivers in Pyanj river basin depends on precipitation and sate ofsil moisture and the landscape. Thus in the east of Pamir with predominantly desert uplands the flow into the basin is less than 5l/sec/km^2, while in the west of Pamir the flow into the basins of the Vanj and Yazgulyam rivers is more than 20l/sec/km^2. The rivers of the basin are predominantly fed by glaciers and snowfields therefore the discharge and peak of floods coincide with variations in air temperature. The volume of glaciers river Pyanj basin is estimated at 170-200 km^3.

Discharge measurements on the Pyanj river were carried out only for a short time. Existing data does not allow any predictions to be made with confidence. Reliable measurements were carried out on the river Pyanj up until 1990. These measurements recorded a low discharge. To review the flow dynamics of the Pyanj river basin it's main tributaries in Tajikistan were analysed. Between 1970 and 2010 and also for the period 1941 to 2010 there were small and insignificant increases in discharge on the rivers Gunt, Bartang, Vanj, and Kizilsu (southern). The last two decades have been

Photo. River Pyanj

Photo. Zerafshan river

characterised by an increase in discharge, especially in the river Yakhsu/Kizilsu (southern). This river is distinctive from others as the amount of water entering the river is determined determined by rainfall and snowmelt in spring. The river experiences significant floods and mudflows, with those seen in 1998, 2002, 2005, and 2010 being especially devastating. To a large extent, river discharge has increased due to frequent mudflows and floods in the spring period.

In the distant past the ***Zerafshan river*** (Zarafshon) was a tributary of the Amydarya. As a result of the development of irrigation, the two rivers are no longer connected. Thus the Zerafshan river is reviewed as a separate basin. The source area of the riveris largely in Tajikistan, while the densely populated areas with irrigated oases are in Uzbekistan. Before joining the Fondarya the Zerafshan is called the Matcha. The average annual discharge (g/s Dupuli) reaches 154 m^3/sec, while its average annual volume of discharge is 4.9 (5.0)km^3. The peak of discharge is June toAugust, with the maximum in July. The Zerafshan river and its tributaries are fed by glaciers and snow melt. An analysis of if river dynamics for the period 1934 – 1994 did not reveal any significant changes. Between 1995 and 2005 no data was submitted by g/s Dupuli. When data started being produced again between 2005-2010 discharge had reached 200-250 m^3/sec considerably above the average. The hydrological data for the tributaries of the Zerafshan river (the Magiyandarya and Fondarya) do not show any significant trends between 1940-2010 A review of the most recent period i.e 1972-2012 shows a increase in discharge of the Zerafshan river and it's tributary the Magiyandarya.

Because of the over-regulation and use of Sirdarya outside Tajikistan, no assessment of water discharge trends has been undertaken. According to some scientific and official sources from neighboring countries, discharge of the Sirdarya has not significantly changed. Having said that the discharge has increased from some of the

Photo. Consequences of mudflow in the Khoroson area, Khatlon region.

tributaries, notably those fed by glaciers. A brief summary of research the simulation of river flow for the Sirdarya in Tajikistan where HPP Kairakkum is located is provided below

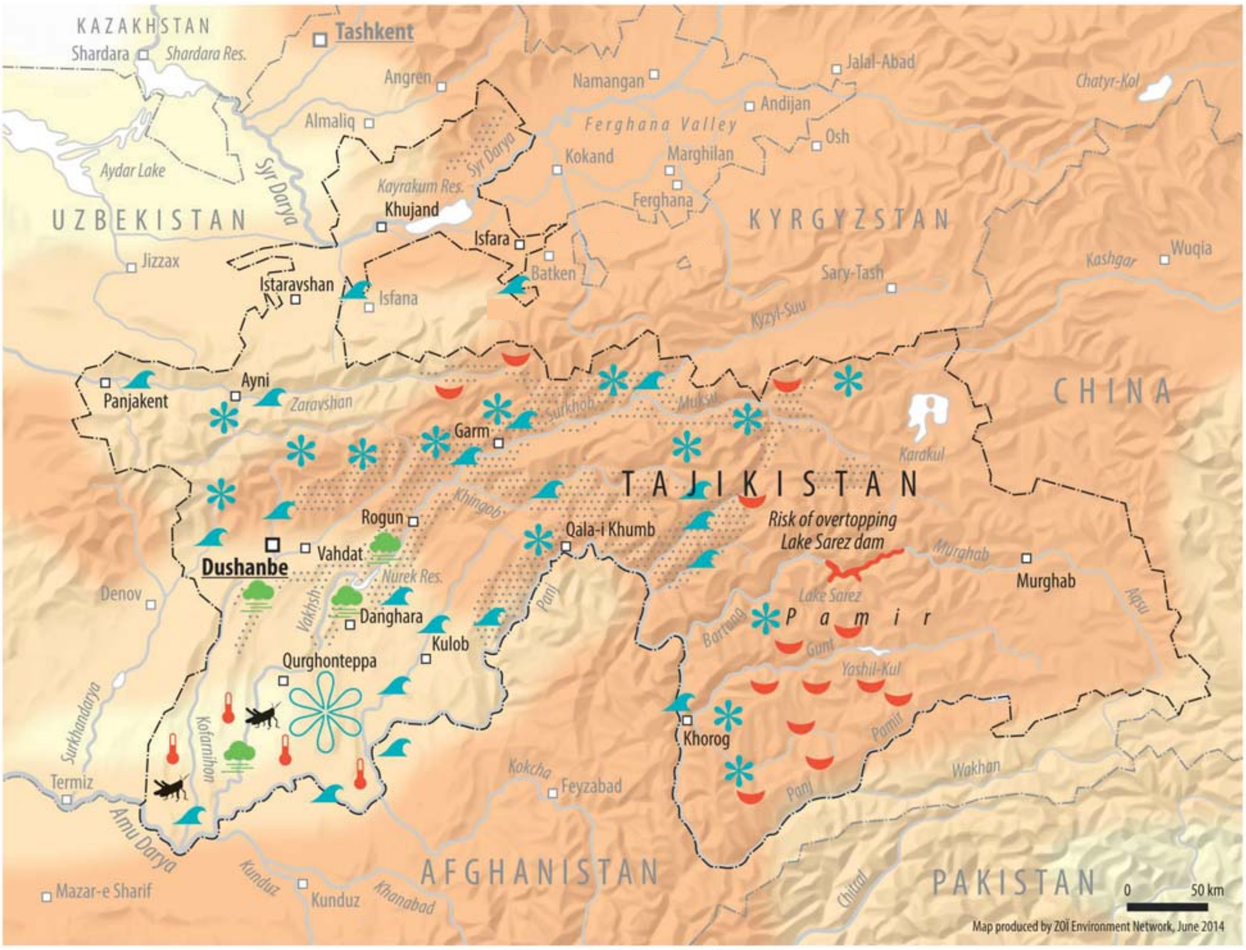
Lakes of Tajikistan are divided into closed and open lakes. The variation of water level of the Karakul lake which is closed and located at 3,915 masl (400 km^2) is linked to climate variation and changes in eastern Pamir. The rise of water level is determined by the increasein water flows resulting from increased air temperatures and melting of frost and glaciers. Instrumental measurements of the lake began in 1969 when an increase in water level of 2m was recorded. According to field studies, the area of the small mountainous lakes of Pamir - Bulunkul, Shorkul and Rangkul - is reducing. Lake Sarez has a high risk of water overflowing as the level of water is slowly increasing probably as a result of melting of glaciers and subsequent increasing flow of water into the lake. Due to lack of data on hydrological regimes of Lake Sarez, providing a comprehensive analysis of the links between water level fluctuation and the geological and hydrometeorological factors is quite difficult. The level of Lake Iskanderkul located in central part of Gissar-Allai has increased over the last 50 years.

4.7. Natural hydrometeorological events

Natural disasters that have taken place in Tajikistan over the last 10-12 years have resulted in about 1,000 deaths and an economic damage exceeding 1bln somonies. The mudflows and floods in 1998, 1999, 2005 and 2010 were the most devastating. More than 3mln people (or half of the countries' population at that time) were affected by the severe drought of 2000-2001.

Around 10 years ago, the UN in Tajikistan supported the creation of a Rapid Emergency Assessment and Coordination Team (REACT) – a multilateral cooperation mechanism of for the assessment of disaster risks and the creation of comprehensive response measures, information exchange, and rational use of technical, financial and human resources. REACT involves more than 30 representatives of state institutions and international organizations and meets regularly, including during any disaster event or period.

Natural hydro-meteorological events (NHE) can result in considerable economic losses and pose threats to the safety of people. Droughts, heavy rainfall, thunder, hail, dust storm, and haze are common to plain areas of Tajikistan but having said



Extreme weather and natural disasters

Seismic risk

- very high
- high
- moderate

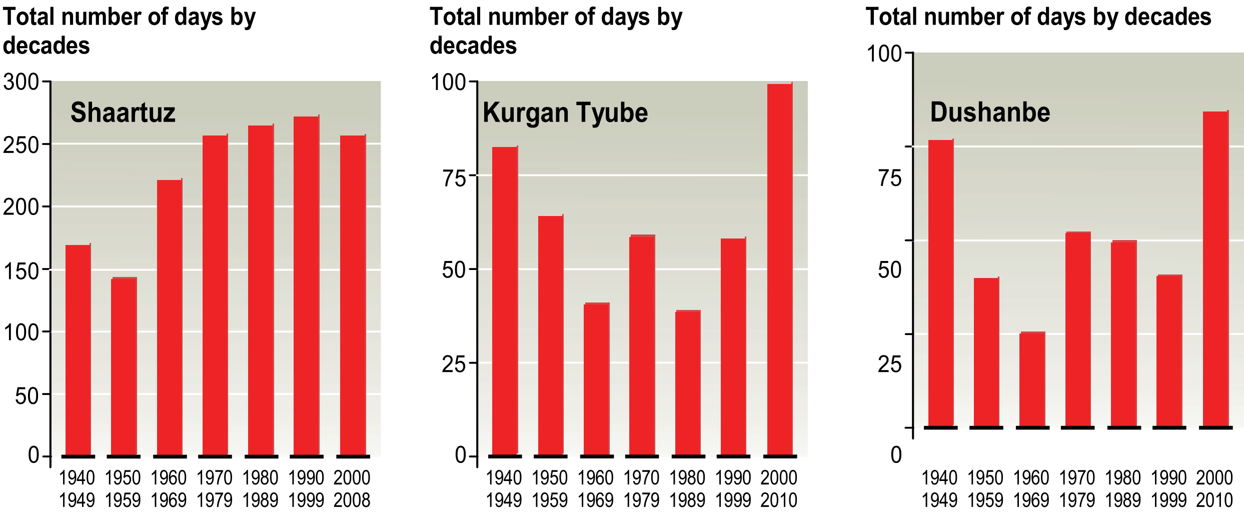
- Risk of landslides
- Risk of flooding and mudflows
- Risk of major avalanches
- Increase in heat waves and number of days with high temperature
- Harsh winters causing compound crisis
- Glacial lakes and lake outburst flood risk areas
- Locust invasions
- Decrease in the number of days with dust storms and hailstorms

that, mountainous areas of the country are more prone to diverse, frequent and devastating events. While developing the TNC, the conditions and frequency of NHEs were analysed in relation so climate-forming factors such as atmospheric circulation processes and the orographic features which strengthen or weaken these processes.The analysis covered the period between 1940 and 2011, for which reliable and well organized of data (with exception of the last decade) is available. Qualified experts started to leave the country in the 1990's and this affected the collection and management of data and as a result the . Thus quality and completeness of observations declined. In view of these circumstances, the data for the last 10-15 years must be viewed with caution.

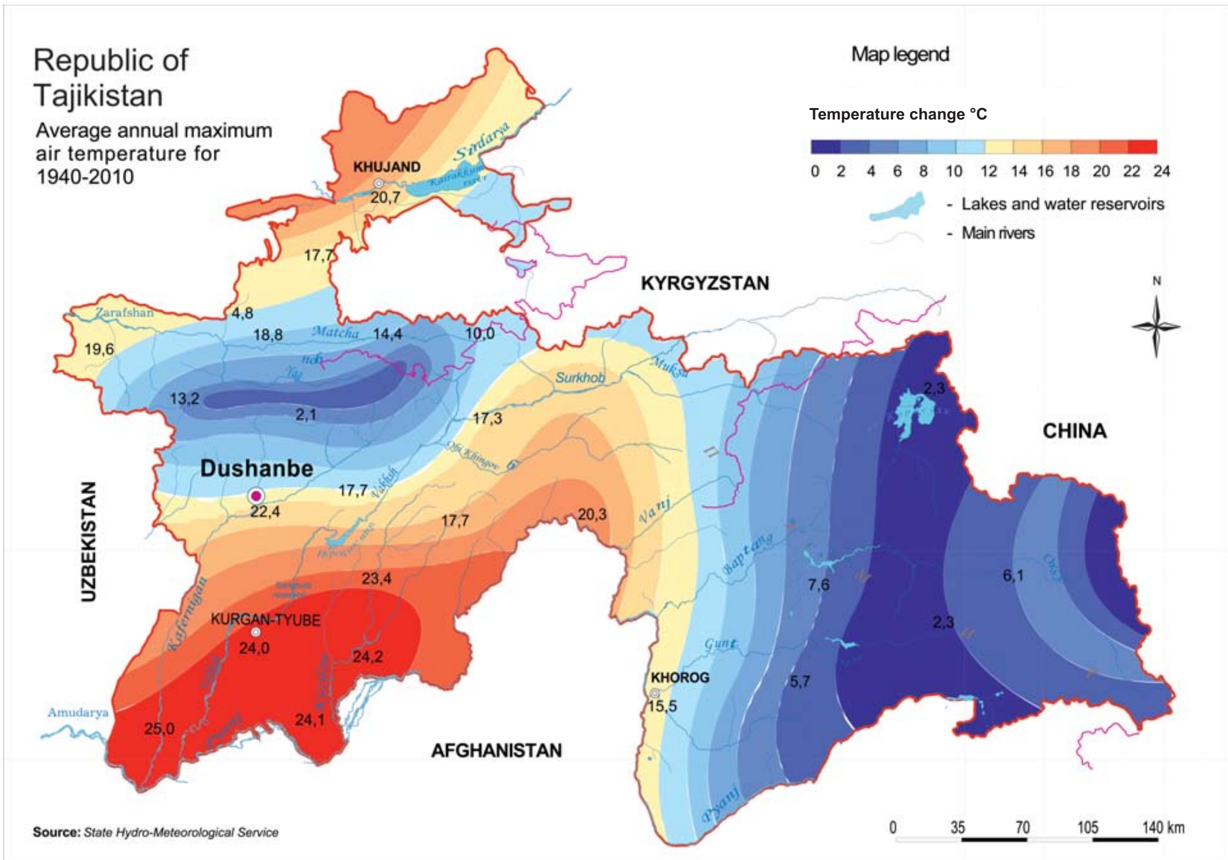
The following types of dangerous weather events were analysed:

1. Temperature of +40°C and above,
2. Events, affecting visibility such as fogs, dust storms and haze,
3. Strong winds,
4. Convection events: heavy precipitation and thunder.

Variability of natural hydrometeorological events
Frequency of days with temperature above +40°C



Source: National Hydro-meteorological Service of RT -- www.meteo.tj



High temperatures

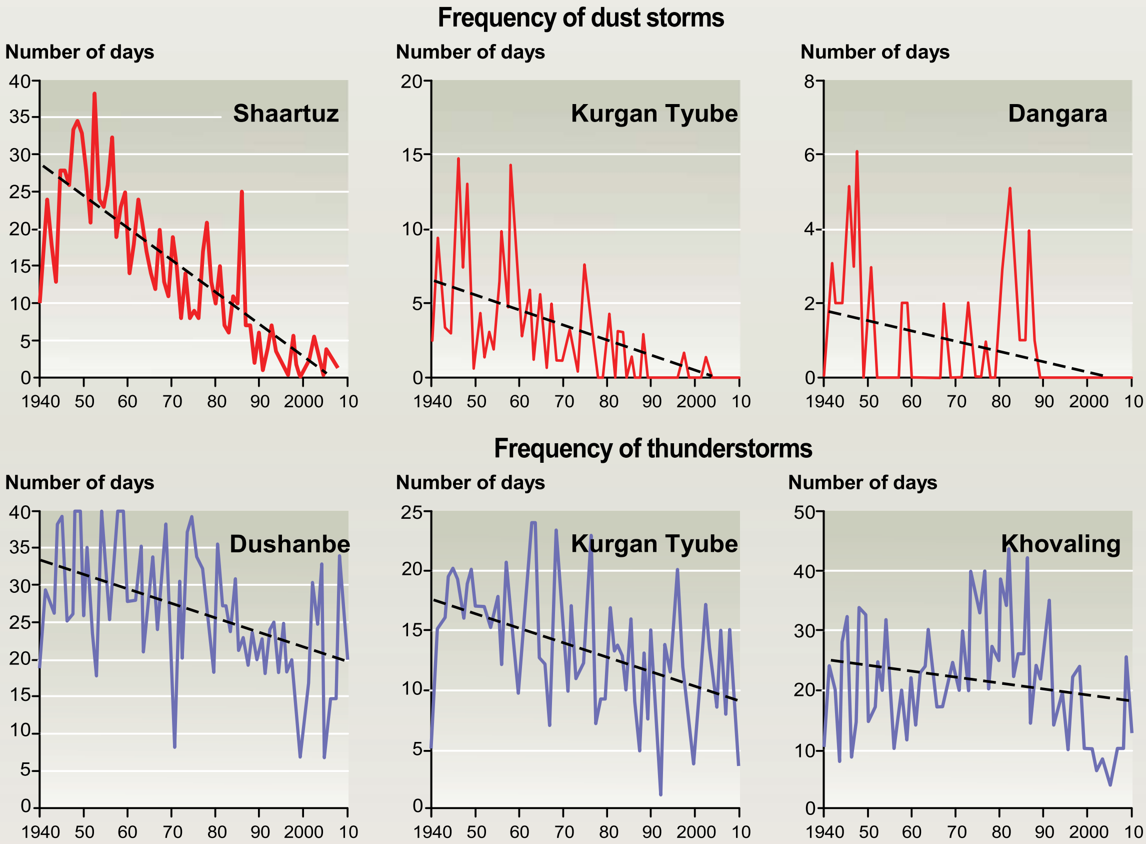
During the period under review, the highest number of days with air temperatures above 40°C in the plain areas of Tajikistan were observed over two decades: 1940-1950 and 2000-2010. The high temperatures during the first decade were mainly due to climatic characteristics, and a reduction in intensive irrigation networks and the area of large water reservoirs. Circulation processes determining the movement of tropical air bringing a strong ground heat dominated these two decades. In particular, 1944 was the year when the absolute maximum temperature rose +47°C and above in many southern districts of Central Asia, including in Tajikistan. The last two decades, especially 2000-2010, were also characterised by increased temperatures and continuous heat. For example, in 1997 Shaartuz experienced a temperature of +40°C 53 continuous days in Shaartuz and Pyanj experienced 26 days of the same temperature. Other high temperature years were 2002 and 2008. Temperatures above +40 degrees were also observed in many lowland districts of the country with exception of areas where land reclamation and the construction of water reservoirs were taking place.

Fogs, dust storms and haze

Fog complicates transport movement. The high humidity during fog events accelerates corrosion and the aging of paint. Fog is mainly observed in cold season of the year during the passage of cold fronts which result in local air cooling during night.

While studying the frequency of fog and the annual variation in fog frequency in both plain (Khujand, Pyanj) and mountain districts (Shahristan) , a tendency towards an increase in the days with advection fog was observed. This is a result of an enhanced role of southern cyclones and advection of warm air masses.

Variability of natural hydrometeorological events



Source: National Hydro-meteorological Service of RT-- www.meteo.tj

Dust storms occur during strong winds when sand and dust rise up leading to reduced visibility. Dust storms can be local and frontal. In southern districts of Central Asia, including in Tajikistan, dust storms occur along the leading edge of fast moving cold fronts or they are associated with warm intrusions related to intensive dust storms from Iran and Afghanistan. In Tajikistan dust storms are mainly observed in southern desert and semi-desert districts, especially in Shaartuz.

As a result of dust storms solid substances remain in the air for a lengthy period forming a haze that has visibility levels of 2-4km or less. In Tajikistan these hazes are observed after cold intrusions and sometimes rise up to 4 000-5 000 m high. Hazes are most frequent during dry summer-autumn period. 1971 was the year with the highest number of days with haze when Dushanbe experienced 80 days of haze and Kurgan Tyube, 94 days. The number of days with dust storms and haze in southern and central Tajikistan has declined because of an increase in irrigated land and reduction of intensity and frequency of intrusions of cold air masses from west and northwest.

Climate warming over the next 50 years might result in global climatic catastrophes. In the arid areas of Tajikistan droughts and desertification are likely and these in turn may lead to more frequent storms in the region and countries neighboring with Central Asia.

Strong winds

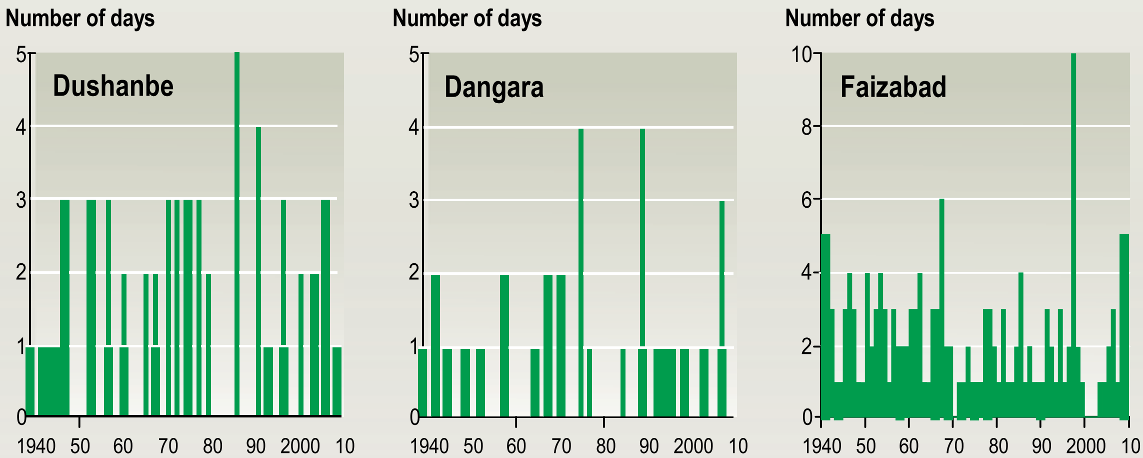
Most of the days with wind speeds equal to or exceeding 15 m/s are observed at meteorological stations in the narrow mountain valleys (such as Khujand, Faizabad), in mountainous passes (such as Anzob) and on highland plateaus (such as the Eastern Pamir). An analysis of dynamics of strong winds revealed that the number of days with western winds decreased as a result of fewer cold western intrusions. The same applied to dust storms. The number of days with eastern and north-eastern winds increased. This shows that fewer tropical air masses are over the country and that the influence of southern cyclones is growing.

Strong precipitations

Heavy precipitation, including rain showers, heavy snowfalls, thunder and hail take place during frontal, thermal and orographic convection. Precipitation becomes most intensive in areas where valleys become narrow and in mountain gorges on the upwind side of the mountain ranges which experience a free flow of cold air masses. In such districts (Dushanbe, Faizabad, Garm, Khovaling, and Shahristan) thunder, hail and heavy

Variability of natural hydrometeorological events

Frequency of days with intensive precipitation above 30 mm per 12 hours



Source: National Hydro-meteorological Service of RT - www.meteo.tj rainfall are all common in spring. Canyon shape valleys (Khorog) and year-round snow and ice covered surfaces (such as the Fedchenko glacier) are orographic factors that weaken the convective movement of air masses. There is an unequal intensity of circulation that determines heavy precipitation with rising or declining frequency by years. The years with maximum or minimum diurnal and semi-diurnal frequency by districts do not match. This is due to considerable influence of orography.

In terms of consequences, heavy precipitation creates the most dangerous events such as sudden rise of water level in the rivers, floods, mudflows and avalanches. Examples of heavy precipitation include snowfall of more than 20mm, or more than 30mm rainfall over a 12 hour period. Continuous rainfall over a period of several hours is usually as a result of a series of intrusions of humid air masses in spring. During this period it is possible for three times the monthly average of precipitation to fall during one night. For many districts of Tajikistan, the most frequent and heavy rainfall was experienced in 1969 and to a lesser extent in 2000. An increase in heavy rain has also been observed in the plain and submontane districts (Dushanbe, Dangara, Faizabad, Khovaling). In many districts, especially in the central mountain districts, the number of days with precipitation of more than 5mm has increased.
Heavy snows are rare in the plain areas and north of Tajikistan and most frequent in mountainous districts above 1,500masl. Snowfalls are extremely rare in the canyon-shaped valleys and east of Pamir. In general there is no clear picture on the frequency of heavy snowfalls.

Thunder storms can cause fires and affect power supply lines. They are especially dangerous for aviation. Air circulation in mountains and valleys determines the frequency of thunder storms.

The meteorological stations located in southern and central Tajikistan (Dushanbe, Kurgan Tyube, Faizabad, Khovaling) with longer term observations have recorded a reduction in the number of thunder storms during the review period, and especially since 1970s. The thunderclouds in these districts are often formed along the front of cold intrusions and arctic air. Therefore a reduction of number of days with thunder is linked to reduction in the number of cold intrusions. The maximum number of days with thunder was recorded in Garm (68 days), while the average number of days with thunder per year in mountain districts varies between 30 and 38 days. The more closed and narrower the mountain valleys and canyons and the higher above sea level and above the snowline, the fewer the number of thunderstorms.

Cold intrusions do not usually reach the high-mountain parts of eastern Tajikistan (Darvoz, Irkht, Bartang) or the canyon-shape valleys, gorges and large glaciers in the Pamir. In these regions therefore thunder processes are rarely determined by cold intrusions. Thunder in the Pamir is often linked to intrusion of moist monsoon air from India and cyclonic systems from the south and southwest. A slight increase of frequency of thunder in valleys of the Pamir can be explained by the fact that thunder processes are linked to the movement of southern cyclones.

Hail storms in Tajikistan were quite frequent between 1941and 1970. Hails of walnut size were observed in May 1966 in Gissar, Darvaz and Karategin valleys. Hail storms can result in the loss of agricultural crops and animals. From 1970 the number of days with hail has declined. Between 1941 and1970, the average number of days with hail in the Gissar valley was 24. In the following decades the frequency reduced by more than two times. The observed reduction of days with hail is linked to a reduction of cold air intrusions and an improvement of the work of anti-hail service.

Mudflows and avalanches

According to field data, the years between 1998-1999 and the year 1969 were the wettest and therefore mudflows caused by heavy precipitations were more frequent. As a result of the mudflows that occurred in 1998 more than 7,000 houses were destroyed and more than 130 people died. During

Photo. Road cleaning from avalanches

the period of drought in 2000-2001 there were almost no floods. The floods and mudflows of 2002, 2003, 2005, 2010 destroyed houses and infrastructure and resulted in loss of human life. The damage from floods in 2010 exceeded 500mln somonies, mainly resulting from floods in the south of the country.

In 2001 and in 2011 the Medvejiy glacier moved without leading to the formation of impounded lake that caused flooding of Vanj river in the past. In 2005 ouburst of glacial lake in the Pamir and Roshtqala districts consequent the mudflows resulted in the deaths of 25 people together with material losses.

The avalanches in 2002-2006 caused the deaths of over 50 people, mainly those in vehicles. In 2010, avalanches blocked strategic highways linking Dushanbe with the north of Tajikistan. An increase or decrease in the risk of avalanches is linked with changes in air temperatures as well as the amount and intensity precipitation in areas above 1,500m.

Drought and dry weather conditions

Drought is one of the dangerous meteorological events and it can result in considerable losses during extreme situations. The drought of 2000-2001 in Tajikistan and in neighboring Central Asian countries is considered as one of the most large scale natural disasters of the last decade in the region. For example, on the Amudarya in Karakalpakstan, access to water halved and many agricultural lands were deprived of water.

A large part of the densely populated areas of Tajikistan lives in arid zones and both less extreme localized drought and extreme droughts that cover large areas are experienced. Over the period under review (the last 70 years) there have been droughts have that have affected the large parts of the country in1940, 1947, 1956, 1971, 1980, 1988, 2000-2001, and 2007-2008. The most extreme droughts occurred in 1971 and 2000-2001. These droughts mostly affect the southern densely populated districts together with the Gissar valley where the highest number of years with average and extreme droughts has been recorded. In case

Photo. The effects of drought

of climate warming it is likely that droughts in Tajikistan will be more intensive and more frequent.

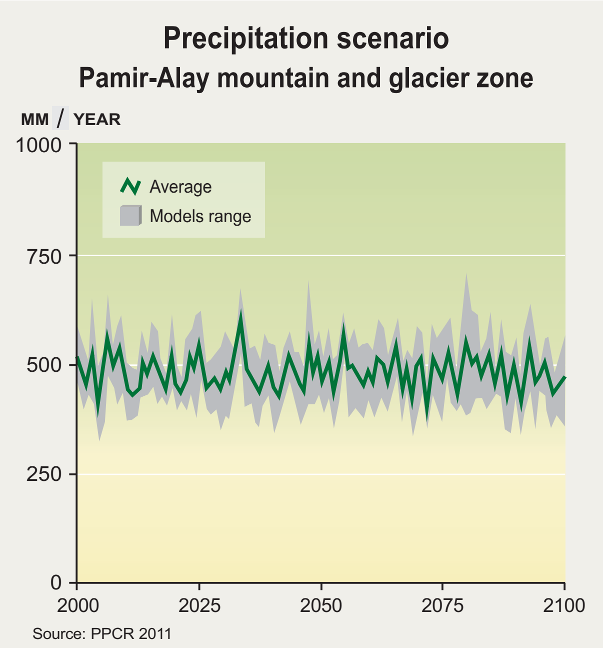
4.8. Climatic scenarios for XXI century

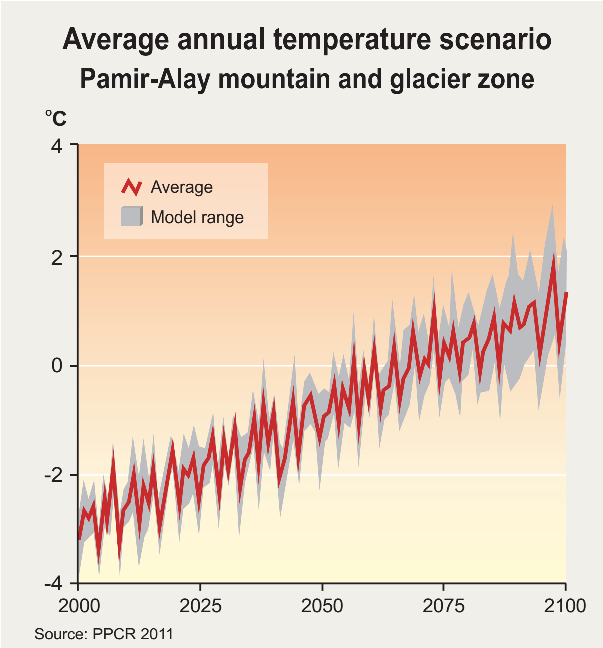
Since the increase of global GHG emissions is continuing despite climate change related efforts, limiting the temperature increase within 2^{0}C is becoming a rather challenging task. A further increase of global temperature may have negative consequences for the environment, economy and health of the population.

Precipitation and temperature scenarios using three climatic models (CCSM3, ECHAM5 and CSIRO) based on 3 emission scenarios (A1B, A2, B1) were studied. The models do not show significant change in precipitation in Vakhsh and Pyanj river basins, however an increased variation in maximum and minimum precipitation will be observed. Thus, it is expected that the nature of precipitation will change with the amount of rainfall increasing and snowfall decreasing. There will be more intensive precipitation events of the type that that usually occur only once in fifty years, especially in Pamir. Geographically, the annual amount of precipitation is likely to decrease in southern Tajikistan and neighboring areas, including Afghanistan; and is likely to increase in mountainous parts of the country.

The amount of precipitation in Tajikistan is likely to increase during summer and winter and may reduce in spring and autumn.

An increase in temperature will be observed in all districts of the country. Winter and summer temperatures in the Pamir and Gindukush mountains will possibly increase at a faster rate than in plain and arid districts. By the end of 21st century warming may have become especially significant exceeding 5°C in southern districts of the country as well as in mountains of central Tajikistan and western Pamir. Diurnal temperature ranges will increase as will the number of heat waves, especially in the lowland districts of southern Tajikistan. The risk of drought will increase due to an increase in total evaporation and earlier snowmelt. So for example in the densely populated Fergana valley the amount of precipita-





tion is predicted to increase by +10mm per year, but evaporations will increase by +70 mm by the middle of 21st century. Given the impact of climate warming, the glacier losses in 21st century will reach 2 km^3 per year on average.

An increase in air temperature and heat-waves will affect livelihoods. Insufficient winter precipitation (snow), especially in the mountainous glacier zone, may change river flow regimes. This, coupled with insufficient precipitation in spring will negatively affect water, energy and food security.

4.9. Assessment of vulnerability, damage and losses resulting from climate change impact and natural hydrometeorological events

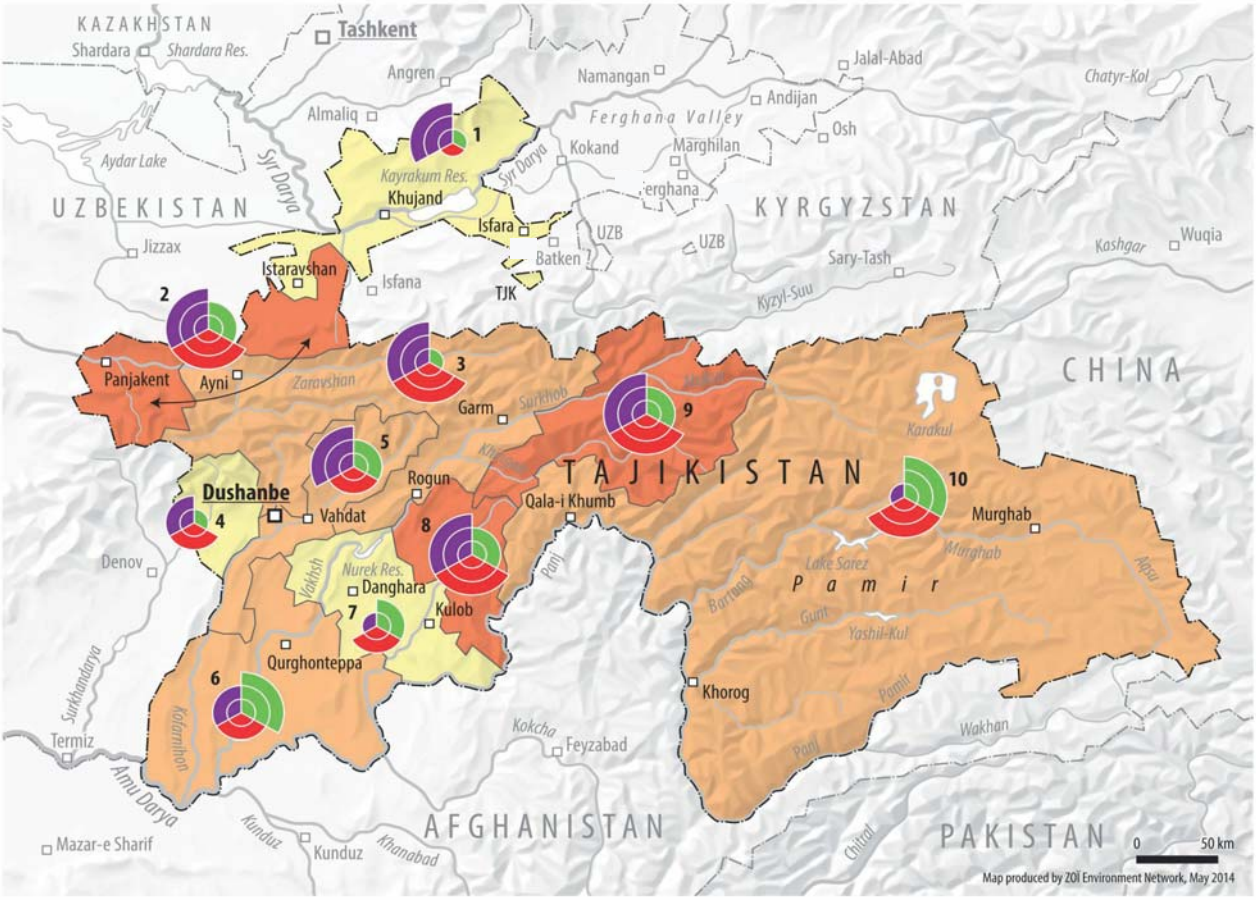
Socio-economic and environmental impacts of climate change can trigger or escalate social tensions due to issues arising from access to and the distribution of water and land resources required for ensuring food and energy security. Large scale natural hydro-meteorological events can also create security issues if they have a direct impact on (a) vital economic sectors, including hydropower and agriculture, (2) vulnerable population groups, and (3) gradual change of climate with stable temperature increase and give rise to negative consequences for food security and living conditions of the population.

The conclusions of the updated vulnerability assessment under the TNC show that the impact of the climate change impact on natural resources, economy and the population is likely to be significant and negative in case of extreme scenarios.

According to the assessment of WB (2008), Tajikistan tops the list of 28 countries of Central and Eastern Europe, Caucasus and Central Asia on the Climate Risk Index being a sensitive country with low adaptation potential.

The negative impact of climate change over the last decade includes floods in Pyanj, Vakhsh, Zerafshan and Kafernigan river basins, desertification of fertile lands in southern districts of the country, land erosion resulting from inadequate irrigation and intensive precipitation, a shortage of water due to droughts, and loss of agricultural crops due to heat and frost. The greatest impact has been felt on dry-land farms and in pasture lands.

Within the country, the central mountainous districts of Tajikistan are considered to be the most vulnerable. This assessment is based on the current and



Households and assets vulnerability to risks associated with climate change

Components of the vulnerability index

[1] Adaptation constrains
[2] Sensitivity
[3] Exposure

low
medium
high

Vulnerability in agro-ecological zones

low
medium
high

[1] Adaptation constrains: low household consumption per capita, share of population with education above secondary, limited income diversification; underdeveloped institutions and social capital

[2] Sensitivity (susceptibility) of assets and livelihoods to climate risks: reliance on agriculture, food insecurity, under 5 mortality, share of population with unprotected water sources, casualties and damage from disasters

[3] Exposure of assets and livelihoods to the impacts of climate change: frequency of extreme temperatures and precipitation events, range of temperature fluctuations, frequency of weather related disasters, other climate factors

Agro-ecological zones

1 North Sughd lowlands
2 South Sughd hills, Pedhzkent-Shakhristan-Ganchi
3 RRS-Sogd: Varzob-Zarafshan-Surkhob
4 West RRS lowland, Tursunzade-Shakrinav-Gissar
5 West RRS hils, Rudaki-Vakhdat
6 South Khatlon lowlands
7 Southeast Khatlon hills
8 NE Khatlon hills
9 East RRS mountains
10 GBAO

Source: World Bank. 2011. Mapping Vulnerability to Climate Change. R. Heltberg and M. Bonch-Osmolovskiy. Policy Research Working Paper # 5554 expected impact of climate change, and also the low potential for adaptation at the local level, including quality of life, education, and income diversification. The more populated plain and mountainous districts in the south of the country (the Khatlon region), as well as communities living in northern slopes of the Zerafshan and Turkestan ranges (Soughd oblast) represent the 2nd level of vulnerability. This assessment was carried out by the WB (2011) and took into consideration the assessment of local experts.

4.9.1. Natural resources

Water resources and glaciers

Both local and international experts note that the problem of water resources in Central Asia is first and foremost a problem of water management and its effective use. The available water resources of the main rivers of the region are almost fully utilized, but there is a huge potential to save water and enhance the efficiency of water consumption in agriculture.

Despite the significant reduction of in the volume and number of glaciers, the annual flow of the medium and large rivers of Central Asia, including the Amudarya and Sirdarya remain stable. Climate change may possibly result in further increase of inter-annual variability of discharge due to the reduced regulatory role of glaciers and the expected growth in the level of precipitation intensity.

Experts from Tajikistan and colleagues from the region consider that there won't be any considerable changes, and especially no reduction of water resources in the next two decades. However, given the continued growth of global GHG concentration and emissions, impact on climate system also grows. Hence, by the middle of 21st century, if not earlier, growth of hazardous events as a result of climate change is likely.

Scenarios of water content

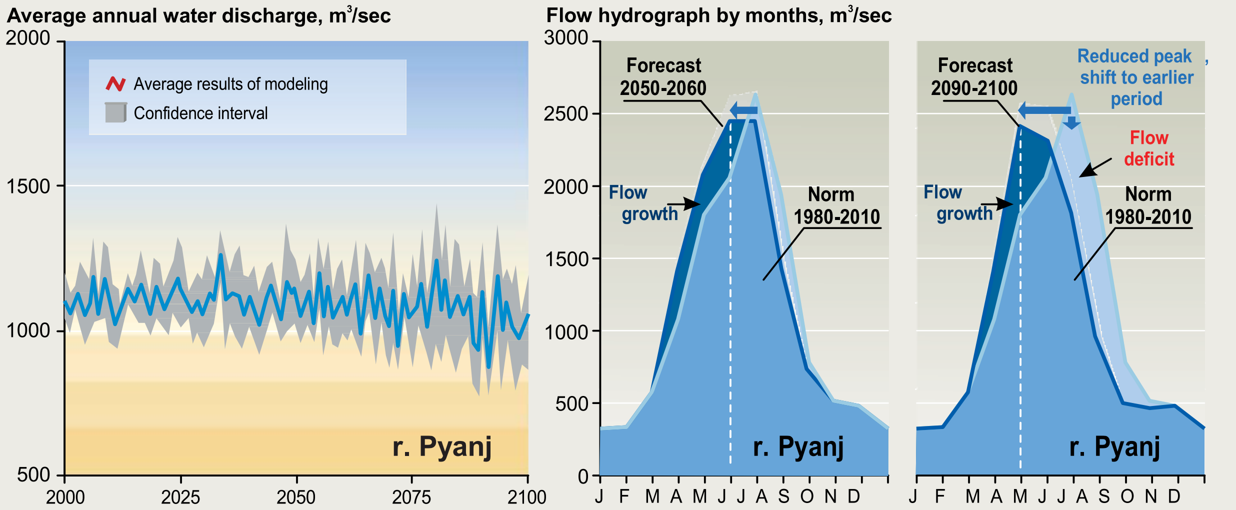
No modelling of the possible variation in the discharge of the main rivers as a result of climate change has been carried out sincethe last TNC. Given that comprehensive research under the PPCR and other regional assessments were completed in the last 5 years, attention was given to an expert analysis of the existing assessments and a comparative analysis of local research with the data of the Fifth Assessment Report of IPCC (2014). There are considerable differences in the climate change scenarios proposed by different research teams and in models which complicates decision making.

Based on the in-depth discussions between national experts, a concensus was reached on the predictioned water discharge of the main rivers of Tajikistan. This can be summarised as follows. It is expected that the peak discharge in non-regulated rivers will shift to earlier months of the year. This will affect the economic sectors dependent on water supply in Tajikistan as well as in downstream counties. By the middle of 21st century river discharge will possibly be reduced in summer and in early autumn, the period during which demand for water from agriculture is highest. Inter-annual variability and an alternation water abundant and dry years is expected. Active melting and loss of glaciers regulating river flow will impact the hydrological regime. The balance of inputs to river flows will change with rain playing a greater role. Some regional assessments indicate that by the middle of 21st century the average annual flow will reduce by 20-30% on the Sirdarya and Amudarya especially in the lower reaches of these rivers. Since Tajikistan is an upstream country, the consequences of climate change in downstream areas were not assessed. Some climatic models forecast a reduction in precipitation in source areas of rivers as a result of continued warming. If this happens it might have catastrophic consequences on water discharge and could also increase the risk of droughts at the regional scale. Previous predictions of surface flows in the Kafernigan river basin and the discharge of rivers in the basin assumed a reduction by 2050. The present assessments support this assumption. The glaciated area of southern slopes of Gissar range [where the Kafernigan river is formed] are very likely to decrease by 50% since the size of majority of glaciers are less than 1km^2.

The slow increase of river discharge in the Western and Eastern Pamir (Pyanj river basin) is likely to continue up until the middle of 21st century. Beyond 2050 the hydrological regime and discharge of rivers in the complex mountsainous area of the Pamir will depend on global measures and regional parameters of climate change. In the case of little or no action being taken, the average temperature in the basin is likely to increase from -0.7°C to 1.4-3.0°C by the middle to end of the 21st century, while the volume of glaciers will reduce by 50-70%. This will reducte and shift the peak of summer flows from July to May-June.

The scenarios of possible changes of discharge in the Vakhsh river basin are of special area of interest since they impact on irrigation potential and operation of the cascade of HPPs on the river which in turn will have an impact on national economy. Increasing regulation of the Vakhsh river flows and

Water content scenarios for big rivers in Tajikistan
Pyanj river, g/s Nijniy Pyanj

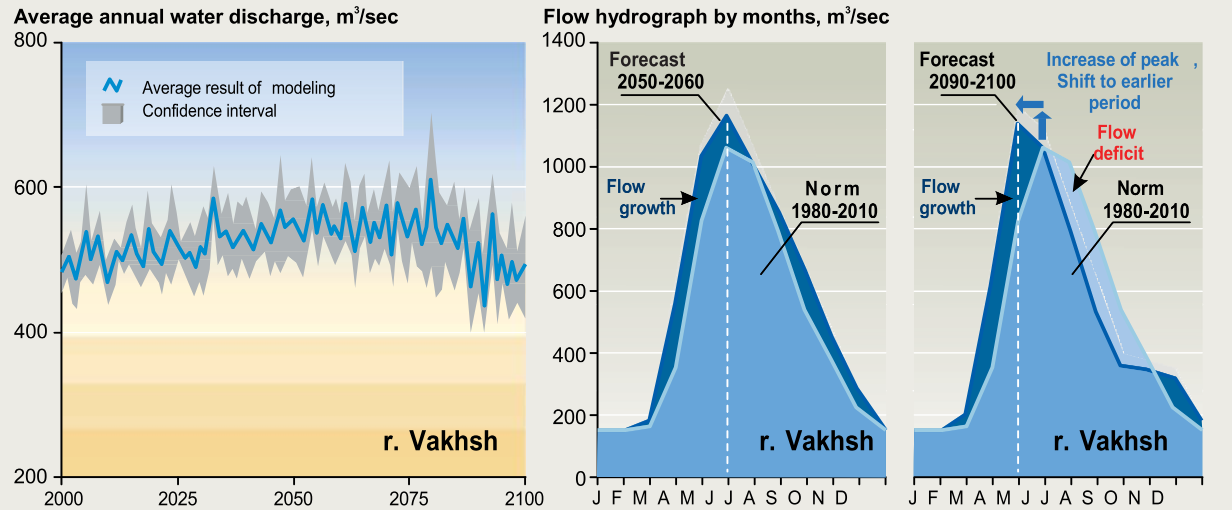


Source: PPCR, 2011

ongoing construction of the HPP Roghun will allow an evening out of the high and low flow years. The years with extreme climate and hydrological conditions, in view of their impact on infrastructure and irrigation, are not favourable to HPPs, reservoirs and other infrastructure. In the absence of regional coordination, extreme years will affect all countries within the basin.

Some models predict an increase in the flows in Vakhsh river by the middle of 21st century, and some by the end of 21st century. Some of the models and predictions suggest a reduction of surface and river flow by 10-20% and more. However the general conlcusions from an analysis of the more up to date models is that there will be an increase in precipiations and icemelt and a consequent increase of flow by 5-10% by the middle of

Water content scenarios for major rivers in Tajikistan
Vakhsh river, g/s Komsomolobod



Source: PPCR, 2011

21st century and even more by the end of the century. The average annual temperature in the Vakhsh river basin might increase from current 3.3°C to 5.6-6.9°C by the middle to end of 21st century, while the volume of glaciers are likely to reduce by approximately half. The peak river disacharge is likely to increase and move from June to May whilst there will be a decrease in the summer and autumn seasons. This level of uncertainty complicates development of concrete response measures to address the expected impact of climate change. At the same time, development strategies must be climate change resilient and aim to bring the uncertainties and the impact to minimum.

The predictions of discharge from the Zerafshan river basin suggest that the glaciated area of the basin will reduce by 20-25% by the middle of 21st century, whilst the volume of ice will reduce by one third or more. Both these changes are likely to impact on the river flow regime. By the middle of the century the Zerafshan glaciers may retreat by 4-5 km.

Heavy rainfall and consequently floods will become more frequent and it is predicted that the maximum discharge from a one in a 100 year flood will increase the maximum from 12,400 to 16,100m^3/sec on the Pyanj river (g/a Nijniy Pyanj), and from 6,000 to 9,700m^3/sec on the Vakhsh river (g/a Komsomolobod). The design of hydraulic structures will need to be reconsidered as a result The increased soil erosion and consequent increase in amount of suspended load and sedimentation processes will affect reservoirs. Therefore undertaking the reconstruction of dams and reservoirs as well as strengthening soil and forest protection measures should be a high priority.

Ecosystems

As of 1st January 2014 the area of protected areas in the country was 3.1mln ha (22% of country's territory – the highest ratio in Central Asia), including the Tajik National Park with the total area of 2.6mln ha, four conservation areas (Zapovednik) with total area of 173 thousand ha, more than 10 Nature Reserves (Zakaznik) with total area of 313 thousand ha, two Natural Parks with the area of 7 thousand ha, five wetlands (listed in the Ramsar Convention) and one UNESCO world heritage site. The protected areas of Tajikistan serve as the basis for the conservation of bio-diversity and historical-cultural heritage. They also play an important role in the study of the impact of climate change at different altitudes and in different climatic zones and how the impact of climate change on nature can be reduced.

The impact of climate change on wild nature is diverse. For instance, scientists link the reduction of habitat of the very rare marmot Menzbira (*Marmota menzbieri*), included to Red Book, in Kuramin range (Northern Tajikistan) and it's growth population with climate change. According to local people and observations from a series of expeditions, vegetation cover and type has changed in the periglacial zones and areas where glaciers are degrading. This is quite likely related to climate change.

Weather conditions also affect the number of insect pests and insects transmitting infectious diseases. In the southern districts of Tajikistan, an outbreak of cotton budworm halved the cotton harvest. The size of the locust affected areas has also increased. In 2007 locusts destroyed 35 thousand ha of crops and caused considerable damage. The State Unitary Enterprise to fight locusts was formed as a result. Both a lack of, and inefficient prevention measures coupled with specific weather conditions were the main factors creating favourable a environment for pest reproduction. There is an issue of regional cooperation to fight locust infestation especially with the Northern provinces of Afghanistan,. The annual cost of fighting locusts in Tajikistan is about 5mln somonies (equivalent to 1mln USD).

Over the last decade, due to warming and insufficient forest protection activities, the area of forest prone to plant pest and diseases has increased. The main forest pests include Turkestan peacock moth, pistachio seedeater, seed worm, silkworm, and powdery mildew. The forests of southern Tajikistan are prone to a high risk of fire threats,

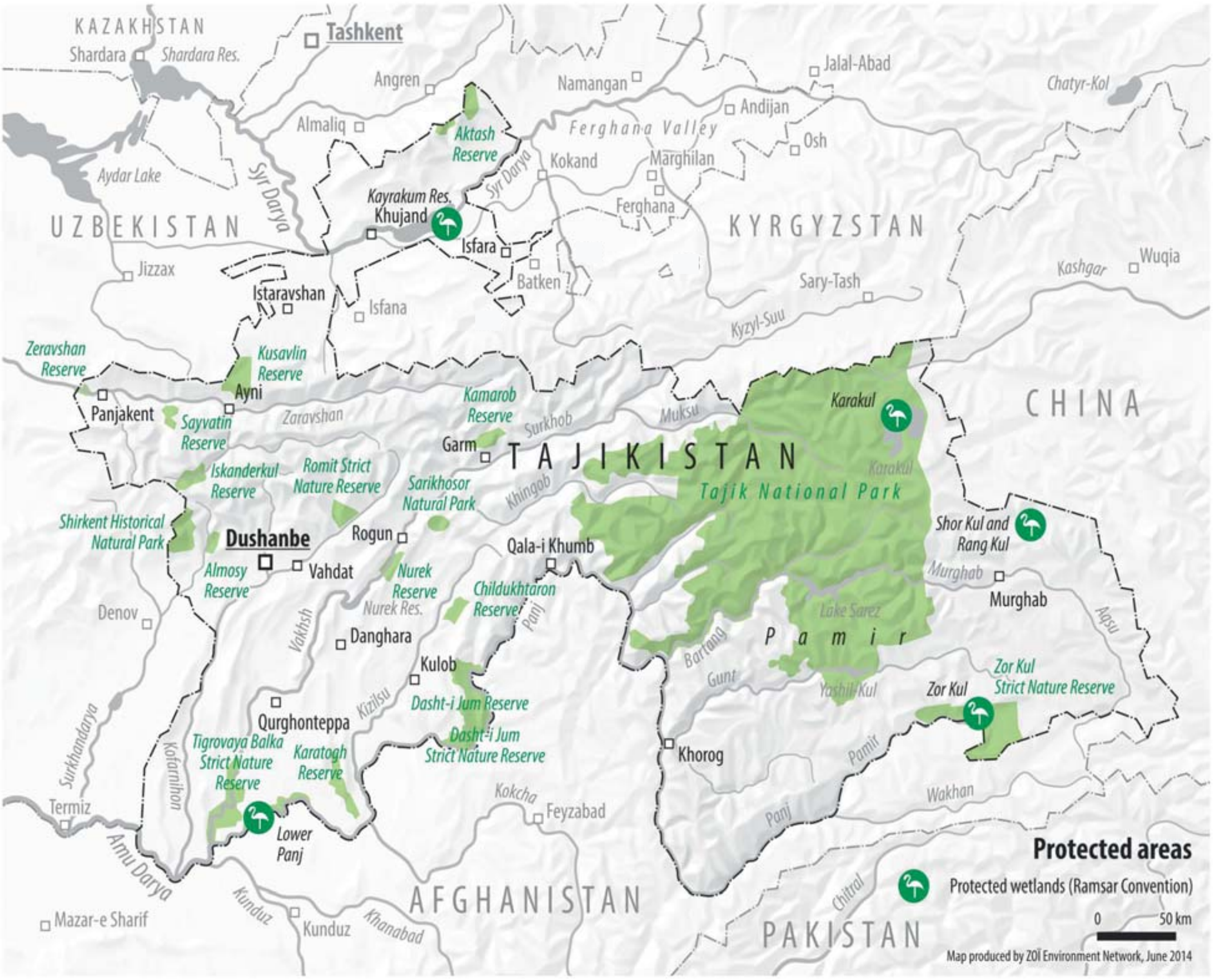


Photo. Forest fire beds

especially during the hot and dry summer periods. Pistachio and almond woodlands, as well as floodplain forests are the most prone to fire threats. There is an increased risk of forest fires, which can affect and cause damage to considerable parts of forest areas. People are the main reason for fire forests, however the hot and dry weather creates favourable environment for occurrence and spread of forest fires.

Given the energy deficits during the extremely cold winter of 2007-2008, the population was compelled to cut trees growing in the mountain forests, along the river banks and in settlements. Given the continued frost in the southern districts of the country where the forest cover is not adjusted to quick freezing condition, subtropical fruit trees such as fig and lemon, as well as broadleaf ornamental plants and coniferous woody species were badly affected. The date-plum, pomegranate and vines were also affected in almost in all parts of the country.

Degradation of pastures is a widespread problem and manifests itself in different ways but primarily through an increase in the proportion of 'non-grazable' grass and decline in the productivity of pastures by 15-25%. In east Pamir, the situation of the alpine pastures is catastrophic where due to a lack of energy resources, the population has started the massive uprooting of teresken resulting in desertification of more than 1 thousand ha of pastures. In the context of climate change the productivity of mountain pastures may reduce. With the progressive drying climate in the southern districts of the country where farming is well developed, increasing desertification processes poses a growing threat to farming and requires response measures.

4.9.2. Economic sub-sectors

Hydroenergy production

Previous vulnerability assessments of the hydro-energy sector on river Vakhsh has shown that the water dynamics has not significantly affected hydro-energy plants. Floods caused by the rainstorms of May 1993 resulted in damage to the ongoing construction of HPP Roghun, while in 2002 a landslide threatened to the HPP Baypazi dam.

The expected increase of temperature and precipitation coupled with natural hydro-meteorological events may have different impacts on the hydro-energy sector. The future water balance of the HPPs and reservoirs, namely HPP Kairakkum on the Sirdarya river and HPP Nurek on Vakhsh river to a large extent depends on the scenarios and models of climate change and hydrology. All the models under 'warm and humid' climate change scenarios show an increased river discharge, while under 'hot and dry' scenario the opposite is true.

The predictions for the HPP Kairakkum vary significantly from an increase in the flow of the Sirdarya river by 20-30% and increased power generation (the 'warm and humid' scenario) to considerable decrease of flow and reduction in power generation by the end of 21st century. As for the cascade of HPPs on Vakhsh river the predictions of an increased flow vary by 5-50% (an average of 30%) under the 'warm and humid' scenario and a variation in power generation potential of up to ±50% by the end of 21st century under other scenarios.The most negative scenario is the 'hot and dry' model. The models shows that heavier precipitation and an earlier start to the snowmelt may cause a short, but significant increase in the river flow and also increase in the risk of flooding. Despite the increase in suspended loads and silting of reservoirs it is possible that the 'warm and humid' scenario will be accompanied by more frequent and intensive precipitations. This will further effect soil erosion and increase siltation. Climate change will result in an increased frequency and intensity of extreme floods but as yet no quantitative assessment of possible changes has been made.

At HPP Kairakkum there is a need to increase the volume of water in the reservoir and improve the infrastructure to be able to receive surplus water flow, and also increase the capacity of the HPP as part of the planned modernisation. The annual power generation and flood protection of the cascade of HPPs on Vakhsh river can be enhanced through the construction of dams in the upstream parts of the river. De-silting measures are relevant for all HPPs. Preventive measures on the protection of catchment areas from erosion and run-off are required as well as is the desilting of reservoirs and construction of new ones with the sufficient capacity to cope with sedimentation and the dry periods. It must be mentioned that the HPP Kairakkum was constructed not only for generation of power but also to provide irrigation for downstream districts. Therefore adaptation measures should be viewed in a broader context. The change of river flow will possibly require all basin countries to revisit the operation regime of the reservoirs taking into account the main parameters such as hydro-energy, agriculture and water ecosystems.

The demand for cheap and 'green' energy is increasing and so is the need to construct new HPPs and reservoirs. Given the climate change related trends and the speed of socio-economic development, energy related problems in Tajikistan and in neighbouring countries will grow if projects of regional importance are not implemented and if measures on integration and diversification of energy systems are not undertaken.

Agriculture and water management

The yield of food crops and commercial plants depends on the condition and the extent of land degradation, appropriate sowing time, temperature, the use of fertilisers, reliability of water supply systems, quality of seeds and technologies used. Equally important are (a) the type of land ownership and sense of responsibility, (b) the material and technical base of the Dekhkan Farms, (c) debts and access to financial – credit opportunities to use new technologies and to increase the harvest. Insufficient extension services, agrometeorological forecasts and insurance services also have an impact agricultural productivity and the performance of agricultural sector. In Tajikistan, the vulnerability of agriculture sector to climate change, and the capacity for adaptation should be viewed after a consideration of above factors. Given the diversity of agro-climatic conditions and types of farms, it is important to differentiate between national and local circumstances, impact and measures.

The participatory vulnerability assessment carried out by UNDP (2012) in different parts of the country revealed that the main climate change related concern and adaptation priorities of the population included; improving access to clean drinking water, increasing the effectiveness and reliability of irrigation systems, better access to high quality seeds and sustainable land management practices. Reliable access to energy in rural areas is also among the top priorities. Studies carried out by NGOs have resulted in similar findings.

The production of grain, vegetables and fruits represent the key source of income and livelihoods for many mountain communities of Tajikistan. The modelling of climate change in and its impact on agriculture in local mountain communities is a challenging task. One of the internationally recognised approaches (using the climate models and agricultural crops in DIVA-GIS, MARSIM, DSSAT),that was tested in number of districts of Tajikistan during 2012-2014, is utilisation of site-analogues based on a homogenous data series. The models were applied using climate conditions expected at the project sites by 2050. The research carried out on local varieties of wheat and barley showed that under a temperature increase of 3-3,7^{0}C and a slow increase in precipitation, and taking into account the soil and genetic coefficients , the agro-climatic zones for agricultural crops will move up by 550-600m. For instance in the Sachiyon and Hoja-Alisha villages (at 69.9500 E, 37.9166 N) and located at 1,400masl, Shurabad villages in 2005 (at 70.025 E, 37.846 N) located at 2,000masl. it is suggested that wheat productivity could decrease or increase by 10-30%, depending on the variety of wheat and land management approaches.

The productivity of the key export crop, namely cotton, to large extent depends on agro-technical measures and accessibility to irrigation water. As compared to other agricultural crops, cotton plants are able to cope with higher temperatures and high soil salinity. Therefore cotton production will be profitable under hot conditions.

The following hydro-meteorological events and related processes cause considerable damage to the agricultural sector:

- High air temperatures followed by dry hot winds and droughts;
- Unusually low temperature and continuous cold weather;
- Intensive rain and hailstorms;
- Mudflows and floods;
- Pests and diseases.

The vulnerability assessment of UNDP (2012) revealed that the population in different parts of the country find drought to be the most devastating consequence of climate change at present and in the future. Extreme temperatures combined with droughts hamper the growing of plants and reduce the amount of accessible water which results in considerable losses to dry-land crops and pastures, as well as causing a rise in the price for goods as was the case in 2000-2001 and in 2008. Droughts and extreme temperatures also impact on hydropower generation capacity. A deficit of water may enhance tensions at the local level, increase migration and increase the incidence of diseases. The impact of climate change on agriculture can be seen through any of the events listed above and will gradually affect the sowing time, demand for irrigation water, productivity indicators and quality of agricultural goods.

Since the main share of agricultural goods are produced on irrigated lands, it is important to understand the consequences of climate change on water management before taking appropriate measures. Since the 1970s a growing maximum evaporation, especially in summer toautumn period, and an increased aridity have been observed in more districts. Thus, the deficit of water resources for irrigation is likely to increase in view of predicted reduction in the volume of glaciers, precipitation in the form of snow, and of flow of the main rivers in summer-autumn period, together with the likely increase of biological demand of plants for water due to increased temperature and transpiration. According to the views of the population summarised in the UNDP vulnerability assessment of (2012), floods, mudflows, and landslides cause significant damage to local infrastructure (roads, small dams, channels, houses) and can cause a deterioration in sanitary – epidemiological situation such as the flushing of waste, and clogging of drains.

Due to the increased intensity of rains, loss of soil and erosional processes the sediment load of rivers will increase which will result in further sedimentation of irrigation channels, reservoir pumping stations and reservoirs. The current efficiency of irrigation systems is low and may be further aggravated by the water problem.

A sudden increase of air temperature along with intensive snowmelt in mountains adds to the frequency of destructive floods and mudflows. Catastrophic floods caused by intensive precipitation as well as sudden increases of temperature and snowmelt in southern Tajikistan in 2005 and in 2010 resulted in damage of water and other infrastructure equivalent to 50-100mln USD and also considerable losses in Afghanistan.

Transport and industrial security

Until recently, the main highways (roads of importance to the Republic) connecting Dushanbe,the capital of Tajikistan, with the north (Soughd oblast) and east (GBAO) were closed for 4-6 months a year due to the significant accumulations of snow on the passes and mountain slopes and high risk of avalanches and ice. A total of 100-170 km of roads of can be closed in this way. In the past, the problem of transport isolation was addressed by driving through neighboring countries, namely Uzbekistan and Kyrgyzstan and/or via air connection. Due to complication of border and customs related issues and increased cost of air-transport services, the situation has changed and become critical.

However, positive developments have taken place over the last decade. Tunnels, new roads and

Photo. Rockslide on the road Dushanbe - Khorog.

bridges connecting all corners of the country at any time of the year have been and are being constructed. The has reduced the length of dangerous roads and improved fuel consumption has enhanced road safety and convenience though there are still roads prone to landslides, rock falls, and mudflows. Engineering protection measures are being implemented on these sections. These examples demonstrate both ways of reduce the transport (and other) sector's vulnerability to dangerous hydro-meteorological events and simultaneously reduce specific impact on climate system.

Tajikistan's industry, especially mining for metal, is vulnerable to dangerous geological (landslides, earthquakes, rock falls) and hydro-meteorological (floods, mudflows) events. Since the country is located in the upstream areas of large river basins, environmental and technical safety of tailings and other infrastructure is of both local and regional importance. The example of neighbouring Kyrgyzstan which has many abandoned uranium mines in the mountains and also current mining operations in the in highlands highlights their vulnerability to natural disasters, erosion and impact of melting of mountain frost. In Tajikistan most of the mining waste is from the Soviet period and current operational mines are based in the Soughd oblast (Zerafshan and Sirdarya river basins). The plans of the Government and interest of investors in mining raw minerals, means that there is a need to take into account the problem of climate change in the design of mountain based projects, to ensure their long-term environmental security.

4.9.3. Human health

The vulnerability assessment of public health in Tajikistan and adaptation to climate change was carried out in line with WHO guidelines (2005). According to the conclusions of Tajikistan's First and Second National Communications on climate change, the predicted increase in air temperature and precipitation will contribute to an increased range and risk of communicable diseases, including malaria, intestinal infections, and parasitic infections. Climate warming, longer periods of hot weather, floods and droughts may negatively affect the quality of drinking water and contribute to outbreaks of infectious and other diseases, including dysentery, typhoid, hepatitis A, salmonellosis, cholera and lambliasis.

The rate of acute intestinal infections in Tajikistan is 10 times higher than in Europe. Half of the cases are of an epidemic nature and children are most prone due to their age and social status. The most common acute intestinal infection among children (under 14 years of age) is bacillary dysentery with the highest prevalence being among the children under 2 years. From 1990 the prevalence of diarrhea has also increased and affected 1000-3000 per 100 thousand people - the highest rate in Central Asia. Up to 80% of cases are among children under 14, while the maximum prevalence is among children under 2 years.

Warm weather increases the risk of microbial contamination of water in open reservoirs. The wastewater treatment facilities serving urban settlements of Tajikistan are ineffective due to a shortage of equipment and poor processes of waste water purification. . In many rural settlements these facilities are non-existent and as a result, the water often contains a lot of pathogenic germs. Degraded water ecosystems are not able clean themselves as they should and therefore improvement of the environment, especially river ecosystems and reservoirs used for drinking water is the key to reducing health related risks and disease. At the same time, improving the control and quality of drinking water at the in the water supply systems is a priority.

The situation is exacerbated by the fact that in the autumn-winter season energy is supplied to many facilities for only 6 hours a day and thus hampering the reliable operation of water systems. Out of 700 operational pipelines, 100 receive water from open reservoirs without prior purification and decontamination. Due to lack of sanitary protection areas and disinfection equipment, almost half of the pipelines do not meet the sanitary and hygiene requirements. The epidemiological situation was complicated due to the Civil War in early 1990 resulting in an outmigration of qualified specialists and a subsequent decline in levels of sanitation at the level of household level.

The proportion of the population of Tajikistan with access to safe drinking water reduced from 63% in 1991 to 55% in 2012. In rural areas the coverage is even lower, reaching 35%. This is one of the main causes of the vulnerability of people to water borne diseases. The other reason is the construction of toilets, animal sheds, hen houses, and other buildings and facilities with contaminated water runoffs near to open reservoirs and water protective zones as well as other violation of sanitary standards. More than 90% of the urban population of the country and almost the same proportion of rural population have toilets. But only 30% of the city population and less than 1% of rural population have toilets connected to the sewage systems. The rest use pit latrines which often cause contamination of surface and underground waters. With climate warming and the impact of floods, the risk of the spread of water borne infectious diseases will increase.

The impact of heat waves due to climate warming can affect death rate of the vulnerable population groups (children, elderly). The increase of temperature and subsequent drought in 2000-2001 one of the main factors causing the growth of population mortality.

Disease morbidity and climatic factors

The incidence of the main groups disease among the population of Tajikistan between 2001-2010 shows that the general rates are declining. However the reason is not that people are healthier but that people visit the health service less often and that the level of diagnosis is not adequate. This complicates any analysis of the relationships between disease, mortality and climatic factors.

Around 65-75% of annual number of typhoid cases occur during the warmer periods of the year, e.g. in July – October. During the hotter years the mortality rates of typhoid is 2-3 times above the average. In 1996 there was an epidemic of typhoid in the

Khatlon oblast and in 1997 in Dushanbe when the mortality rate reached 200-500 cases per 100 thousand people, mainly among children. According to experts, this was related to artificial factors rather than those determined by climate. The main reasons for the outbreaks were poor management of drinking water quality as a result of poor water purification and wastewater treatment, poor sanitary conditions, an insufficient number of health professionals (doctors), and a delayed implementation of anti-epidemic measures. Another outbreak of typhoid occurred in 2003 partially related to an increase temperature during the previous 2-3 years when the sanitary-epidemiological measures were not sufficiently implemented.

While detecting the virus of hepatitis «A», it was discovered that the water factor for this disease is as important as it is for typhoid. The occurrence of hepatitis outbreaks is related to the consumption of low quality water which is contaminated with viruses as result of sewage leaks into reservoirs and their entry into water supply network after intensive rainfall and floods.

In the First and Second National Communications of Tajikistan on climate change it was noted that there is a high risk of the incidence of malaria increasing as a result of climate change, absence of adaptation measures and poor control of the spread of mosquitoes .Due to targeted measures over the last 10 years, the incidence of malaria has started to stabilise, especially after the after epidemic of 1997-1998 and now has considerably improved. Moreover, no cases of deaths malaria have been registered. The World Health Organisation, governments of donor countries and Global Fund to fight HIV/AIDS, Tuberculosis and Malaria have played a significant role in this regard. However the risks remain high due to lack of information on the malaria situation in neighbouring Afghanistan, the entry of infected mosquitoes from Afghanistan to southern districts of Tajikistan, the low level of awareness on the prevention of malaria and protection from mosquito bites, as well as climatic conditions favourable for mosquito breeding.

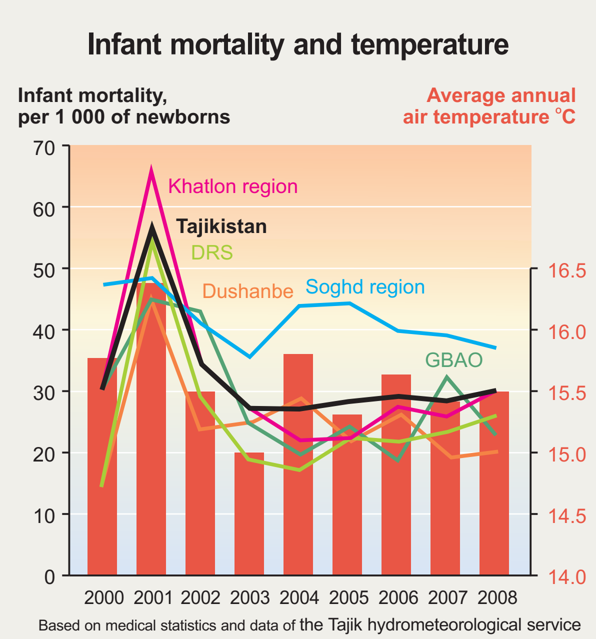
In Tajikistan malaria is generally transmitted through mosquitoes *Anopheles superpictus* and *Anopheles pulcherrimus*, whilst in southern districts of the country cases of tropical malaria have been recorded. The peak of disease incidence occurs between June and October and coincides with the large scale ppearance of mosquitoes at temperatures of above 25ºC. The Khatlon oblast is most prone to malaria due to its proximity to Afghanistan, weather conditions and agricultural activities that enhance the risk of transmission.

Reproductive health

The WHO defines health as the state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. Given the high rate of population growth and high migration rates among able bodied male population of Tajikistan, as well as taking into account the impact of climate change and especially of heat waves, the Third National Communication of Tajikistan includes an innovative analysis of reproductive health related to climate change and identifies threshold temperatures.

The term reproductive health is well known among specialists, however might not be understandable for wider audience. The term is applied in the context of family planning, ability to reproduce (child birth) and access to health services enabling the woman to safely undergo the period of pregnancy and delivery to give birth to a healthy child.

The main causes of maternal mortality in Tajikistan are: obstetrical bleeding, gestosis, extra-genital diseases (anemia, weight deficit, enlarged thyroid body, kidney diseases), abortion related complications, and septic complications. The low index of women's health is in many ways determined by the quality of nutrition: 50% of pregnant women are anaemic, 47% have goitre. The rate of miscarriage is also high (30%) which confirms the low index of women's health. Between 2000-2008 maternal mortality reduced by two times from 44 to 22 per 100 thousand new borns. UNICEF studies on the causes of maternal and child health revealed high



figures of maternal and child health exceeding official statistics by 4 times. This shows that the country's system of data collection and analysis on this subject is not adequate and is related to the non-registration of births and infant deaths of as well as the use of the Soviet method of defining live births. According to studies, in 2002 infant mortality was 80 per 1 thousand life-births but only 20 per 1000 according to medical statistics. Moreover, in rural areas the rate was considerably higher than in urban areas. The problem is that ensuring safe maternity in many cases is constrained due to low qualification of health professionals and scarcity of resources. Home deliveries comprise 20% and even more in mountain districts and take place without attendance of health professional.

Hot temperatures and especially heat waves during summer impact on not only the most vulnerable, e.g. elderly people and rural workers. The vulnerability assessment of reproductive health in Tajikistan has showed, that during heat waves complications in pregnancy and delivery are insignificant in an urban settlement with better quality and a greater capacity of health systems and below the free air temperature below +32°C outside the buildings. Between +33ºC to +36ºC there was an increased range of complications and above +37ºC the number of complications becomes significant even in the capital Dushanbe. It is therefore evident that heat waves and high temperatures have an impact on reproductive health. In rural areas, especially in southern districts of the country, the impact of high temperatures can be even higher, yet the quality of health services is lower.

Among the maternal health problems fetal illnesses, early neonatal mortality, increased risk of infectious diseases during and after delivery, and delivery complications are registered. The threshold at which problems become more common in Dushanbe is +37ºC, which is by 3ºC lower than the current meteorological definition of a hot period (+40ºC). A threshold value is important to ensure safe reproductive health and to take required risk mitigation measures. It is noted that during the years with extremely hot summer temperatures, reproductive health problems are more frequent.

As part of an analysis of the dynamics of infant mortality in relation to average annual temperature it was revealed that in 2001 both increased temperatures and mortality took place. This is of relevance given that heat is accompanied with drought and under these conditions women and children are affected by a number of stress factors requiring the attention of health professionals and the family.

In winter period most women give birth after 13.00hrs with maximum number of births being between 16.00 and 18.00hrs. The number of births from 13.00 to 21.00hrs in winter is higher than in summer, and in summer the deliveries more often take place during the first half of the day. It is likely that this is some form of self-preservation mechanism developed by vulnerable women in labour (suffering from eclampsia, gestosis) since in the summer the morning temperature (before 13.00hrs) is more comfortable than the afternoon or evening temperature. During winter the most comfortable temperature occurs during the 2nd half of the day (after 13.00hrs). In the light of this development of measures for the protection maternal health in the context of climate change, are required.

Infant, child and maternal mortality are important indicators of the socio-economic welfare of the country and effectiveness of the health system. These indicators reflect progress made against Millennium Development Goals. Unfortunately Tajikistan is lagging behind other countries and one of the main reasons for this is the fact that the measures aimed at reducing infant and child mortality do not take into account the climatic features and climate change trends.

4.10. Adaptation and development of resilience to climate change

The main measures of the Government of Tajikistan at the macroeconomic and political levels are focused on economic growth, welfare of the population, poverty reduction, diversification of economy, means of communication, and political stability. Altogether these measures the provide basis for developing climate change resilience.

Economic growth during recent years was sustained due to the stability and development of industrial and agricultural sectors, increased volume of trade and enhanced service sector, as well as labour migrants' remittances. Altogether these have enhanced the purchasing power of the population.

In the context of the economic crises, difficult geopolitical circumstances and climate change the basis for implementing adaptation measures include maintaining macroeconomic stability and enhancing the welfare of the population, especially the poorest part of the population.

The main directions for enhancing the resilience of macroeconomic, socio-economic and political spheres to climate change and the impact of extreme hydro-meteorological event include:

- Maintain stability and enhance public administration;
- Introduce of e-governance to enhance the performance of state institutions; reduce the level of corruption and administrative barriers; improve of information exchange and the access of users to key information, including information on climate change;
- Develop the economic sector through modernisation and diversification;
- Support the private sector; improve the investment climate and transport development;
- Ensure effective social protection for the population; support the stable development of labour market and the development of human capital;
- Enhance access to and quality of education and health;
- Ensure participation of all stakeholders in the planning and implementation of climate change measures;
- Improve water and food security;
- Meet fuel and energy demands, achieve energy independence and improve energy security;

Application of the principles of a 'green' economy and the creation of 'green' jobs must become a strategic priority. The thematic sections below indicate the main needs and priority measures on climate change adaptation and resilience.

Energy and climate

In Tajikistan, ensuring energy independence, reducing the vulnerability of hydroenergy to extreme events and long-term consequences, reducing the 'carbon footprint' and optimizing the use of fuel and energy resources is possible through:

- Development of hydro-energy potential and increase the reliability coefficient taking into account the consequences of climate change (an increase of maximum floods and a reduction of flow);
- Construction of new energy generation units and modernization of existing equipment to meet the energy deficit;
- Construction of small HPPs and the development of other renewable energy sources in high-mountain and difficult to access rural areas;
- Ensure reliable power supply in rural areas, including for water supply purposes;

Climate change scenarios, and options for adaptation and mitigation in Tajikistan

Climate change projections

Change in annual temperature by the 2050s
Model: Ensemble Average, SRES emission scenario: A2

+3 °C

intensity

Change in annual precipitation by the 2050s in %
Model: Ensemble Average, SRES emission scenario: A2

-5 0 +5

decrease increase

Projects and initiatives aiming at climate change adaptation and mitigation

- Solar energy
- Wind energy
- Sustainable agrobiodiversity
- Disaster risk reduction
- Modernization of hydropower infrastructure in the face of climate change
- Urban transport and buildings climate initiatives
- Forestry development
- Preventing deforestation
- Projected increase in water flow and hydrological extremes
- River bank and infrastructure protection against floods

Source: participatory mapping exercise, conducted by UNITAR, Dushanbe, February 2014

- Construction of new power transmission lines within the country to increase access of the population to energy. Construction of new power transmission lines to export hydro-energy outside the country.
- Diversification of the fuel-energy balance through the use of local types of fuel and renewable energy sources;
- Modernization of energy units and reconstruction of centralised heating;
- Extend the service lifespan of operational reservoirs and the construction/reconstruction of HPPs and dams with taking into consideration the impact climate change on water resources and the peak of water consumption in the rivers;
- Reduction in the energy-intensiveness of the economy;
- Enhance energy efficiency and energy saving in energy production, industry, construction and agriculture sectors as well as at the household level;
- Stimulate and provide incentives for the use of gas fuels (liquid) in transport;
- Improve the level of control and measurement of thermal and electrical energy;

The country's plans for development of the fuel and energy sector for the period 2015-2020 envisages an increased volume of mining and consumption of fossil fuels. On one hand this is important for energy security. On the other hand, undoubtedly, this will result in increase of GHG emissions. To balance the impact of energy sector on the climate system, the use of RES must exceed the consumption rate of fossil fuels.

The following measures are recommended to ensure widespread application of RES:

- To create Centres for research and dissemination of experience on the use of RES as well as their introduction and demonstration. The Centres could also provide training for qualified professionals and the general population, as well as raise awareness on environmentally friendly energy;
- To create production units and to start assembling and producing experimental and commercial RES equipment;
- To provide training for the qualification of RES professionals;
- To start the production of bio-fuel based on topinambur;
- To conduct awareness campaigns via the mass media and also through the dissemination of brochures, leaflets, posters and local level seminars on RES, the availability of RES devices as well as their economic and environmental benefits;

In the energy sector there is a need to enhance regulatory and legal frameworks, conduct institutional reforms, improve transparency and accountability, and resolve the issue of energy related crimes or offences. An important step will be to create an independent regulatory body in the energy sector. The policy on tariffs needs to be enhanced and must not only focus on covering the production, transmission and distribution costs, but should also enable the creation of opportunities for investment to modernise the existing energy plants, and construct new ones. Any revision of tariffs will require consultation with the energy consumers including the general public, vulnerable communities and target groups. In addition to improving the tariff systems, there is a need to attract private sector investment and this in turn requires improving access to credit. To develop RES and improve energy efficiency at the local level, the creation of National Fund to support renewable energy and energy-efficiency is proposed.

Energy independence for the country and local communities depends on the timely completion of the priority projects 2030 which include rehabilitation of HPPs Nurek and Kairakkum, construction of HPP Roghun and small HPPs, construction of new TPPs, as well as expansion of energy exchange and trade at the regional level.

Agriculture and climate

The largest contribution to GHG in Tajikistan comes from the agrarian sector. Compared to other sectors, agriculture is more affected by the impact of extreme events and is more vulnerable to climate change (rainstorms, droughts, floods, continuous high and low temperatures, frosts, locust and other pest outbreaks). Thus, the agriculture sector requires careful attention and comprehensive measures to bring about sustainable, competitive, and environmentally friendly production, adapted to climate change. The other priority is to ensure food security. Given that more than 70% of the population lives in rural areas and is engaged in smallholding and agribusiness, there is a great potential for developing organic land management, livestock breeding, and gardening.

Development of agriculture, including the private sector producing agricultural products, depends on the extent to which the following core issues are addressed:

- Contradictions and shortcomings in the implementation of land reform and in land management;
- Access to financial resources and credits;
- Access to agricultural extension services, including information and knowledge;
- Development of infrastructure.

Adaptation of the agriculture sector and mitigation measures including a wide range of activities which directly and indirectly impact the end result and enable introduction and implementation of the principles of 'green economy' in agriculture sector.

- Development of policies focused on transition from the state “controlling” to the state to “stimulating” and an improvement in the of legal and regulatory frameworks and taxations in agriculture sector with consideration of importance and vulnerability of agriculture sector to climate change;
- Enhance the responsibility of state bodies, including local governments for ensuring that land use rights are not violated and exclude the government from intervening in production or business related decisions of agricultural producers;
- Enhance state control in ensuring the safety of agricultural goods (based on *Codex Alimentarius*);
- Development of organic land management as well as certification and incentive systems for producers;
- Selection and introduction of drought-resistant grains, legumes and other cultures;
- Enhance the effective use of water resources in agriculture;
- Create an insurance fund f for the agricultural sector during emergency situations and in the context of climate change, improve existing and construct new storage facilities for crop and livestock products;
- Development of breeds and seed varieties in the context of climate change;
- Improve the epizootic situation, pest and disease control in the context of climate change. ;
- Raise awareness and access of rural population, farmers and other parties in the agriculture sector to information on climate change;

As other countries of Central Asia, Tajikistan is characterised by a high level of water consumption in the agricultural sector. However, the use of outdated and relatively primitive irrigation and drainage technologies has a positive side as it means that the the country can reduce water consumption and ensure rational use of water resources through implementation of economic, technological and environmental measures and reforms. The main ones include:

- Wide application of the principles of Integrated Water Resource Management;
- Gradual transition to the management of water resources based on hydrological basins rather than administrative units;
- Creation of Basin Committees and Boards;
- Countrywide development of Water User Associations;
- Increase the efficiency of irrigation channels through lining, especially inspectors where the loss of water is highest;
- Application of differentiated water tariffs and incentives for saving water and the

gradual increase of energy tariffs to fully cover the operational cost of irrigation systems;
- Differentiation of water tariffs and supply depending on specific conditions;
- Construction of reservoirs in narrow mountain gorges for energy generation, water storage as well as for the control of mudflows and flood risk.
- Development of norms and provision of minimum environmental flows;
- Conservation and expansion of forest area and density in river catchment areas.

Cotton is the main export oriented agricultural crop. The economic status of cotton growing districts, as well as their tax revenues and the income of farmers depends on the effectiveness of cotton production. Reforms in the cotton sector must be focused on ensuring access to credit and other financial resources, improving cotton growing and technologies for the application of mineral fertilisers, the use of improved and early ripening varieties, as well as enhancing the reliability and effectiveness of irrigation and reclamation system operations. By 2015 – 2020 the above measures, along with others, will enable an improvement of cotton yields up to 30 c/ha without an increase in area or additional water and energy consumption.

Improving livestock productivity is a vital measure to ensure food security. However livestock productivity is also related to climate change since the GHG emissions are related to the development of the sector. The problems related to livestock breeding can be addressed through improving feed resources, breeding pedigree stoc , the expansion of veterinary services, creation of modern abatoirs, and reducing the risk of existing problems.

A greater emphasis should be given to growing alfalfa and other fodder plants in rotation. . This will not only benefit livestock breeding, but also land management, since crop rotation increases soil fertility and gives greater yields.

During the study and other field level activities, nongovernmental and public organizations of Tajikistan, including the Youth Ecological Centre which plays a very active role in climate change area, identified that reducing community vulnerability and ensuring sustainable management of natural resources in the context of climate change requires more effective community based approach with adaptation measures being implemented by the communities themselves. Community based adaptation measures also contribute to poverty reduction and they are low-cost and easy to replicate with the most successful measures being accessible methods to improve soil productivity, crop rotation, bio-drainage, the use of compost, low/no till, combined cropping, and improvement of access to energy and water. In the context of the arid climate of south-western Tajikisran (Kabadiyan, Shaartuz, Nosir Khisrav districts) traditional measures of moisture conservation and control of the temperature regime of the soil through mulching, accumulation of rainwater for irrigation, planting of saxauls (*Haloxylon ammodendron*) and elaeagnus (*Elaeagrus*) for soil consolidation, a crescent lunate method of planting and other agro-technical innovations contributeto a reduction in soil erosion and enhance resilience to climate related stresses. The creation of fruit tree nurseries with local and highly adapted species of grape, almond, pomegranate, apricots and etc. encourage people to grow the saplings in their gardens. Given the above, the climate change adaptation measures at the local level may include:

<u>Farmers' income and harvest protection:</u>

- Crop protection from natural hydro-meteoroligical disasters and increase of incomes through increasing the number of crops per year through the wide introduction of green housing;
- Crop protection from diseases and pests, preferably through biological methods;
- Introduction of drought-resistant cultures and consideration of agro-climatic conditions;
- Enhance the reliability of agricultural insurance, create seed emergency

reserves and self-help farmer groups with savings funds to address and reduce the impacts of natural disasters;

Measures for effective use of energy and resources:

- Increase the use of energy efficiency of stoves and reduce the consumption of solid fuels;
- Increase the heat-insulation of homes, construct energy efficient public buildings;
- Introduce water saving technologies of irrigation, retention and use of rain water;
- Enhance effective waste management and composting.

Improving access to renewable energy sources:

- Increase the use of solar, biogas, and wind energy, as well as micro-HPPs;
- Rationalise of the use of solar power (dryers, greenhouses).

Improvement of land and water resource management and conservation of agro-biodiversity:

- Control erosion and salinisation of soil, improve soil fertility and moisture conservancy;
- Enhance the effectiveness of land management and introduce new technologies and organic farming;
- Conserve local cultivars and crop species, create nurseries and micro-reserves;
- Introduce Community based agro-forestry;

Industry, transport and climate

In the context of climate change, safety in industry and transport given the mountainous landscape of Tajikistan and natural disasters plays an important role. According to experts, industry and transport are those sectors that will be play a lead role in causing an increase of GHG emissions in the near future. The vulnerability of the mining industry and transport sector can be reduced through a combination of the following measures:

- Take into account climate change predictions and possible consequences whilst planning the construction of new or reconstruction of existing facilities and roads, piplelines and other linear structures;
- Build protection infrastructure and enhance the criteria for long-term functionality;
- Reduce risks through the construction of tunnels, reduction of the length of the routes and pipe-lines in potentially hazardous areas;
- Reduce energy and emission specific consumption in industry and transport sectors;

Health and climate

Local scientists and practitioners have revealed new aspects of vulnerability to climate change related to human health and safety. The problems related to weather conditions and climate change increase the risk of malaria and typhoid transmission, the quality of drinking water in cities especially during intensive rains.

Below is the list of activities aimed at the further improvement of the public health system and improvement of reproductive health in the context of climate change:

- Enhancement staffing and improvement of the drug supply to public health facilities as well as the diagnosis of health risks;
- Ensure timely prenatal hospitalisation of pregnant women from high risk groups;
- Provision of supplementary vitamins and improvement of the nutrition of pregnant women, especially those suffering from anemia, weight deficit and insufficient weight gain;
- Prevention and treatment of complications in pregnancy though day surgeries;
- Provision quality antenatal care and creation of optimal microclimates in hot periods of the year for pregnant women and women in labour;
- Formation of family planning centres and support of women after labour complications;
- Monitoring of negative pregnancy and birth outcomes in hot period of the year;
- Improvement of epidemiological monitoring in the context of climate change;

- Development of guidelines for reproductive health management in line with WHO recommendations;
- Conduct seminars, round tables and conferences to raise the awareness of health professionals on impact of climate change on health, especially during pregnancy and labour during the hot climate and heat waves;
- Development and adoption of a programme on maternal and child health in the context of hot climate and global warming;

Implementation of the above measures to improve maternal and child health will enable improvements in indicators of obstetrics care to encourage a reduction perinatal child and maternal mortality and mortality in regions with high birth rates and hot climate. It is necessary to encourage the application of simple, but reliable methods of health care and the use of technologies that are appropriate and affordable.

The following measures are required to reduce the risk of dangerous infections and diseases related to climate change and extreme natural phenomena and to enhance the control system:

- Enhance the systems of epidemiological monitoring and control, including laboratory facilities, water quality monitoring, and the creation of a database on infectious waterborne diseases;
- Improving the sanitary conditions of water sources and water catchment basins used for drinking;
- Implement forest improvement activities in the upper water catchments and reduce the burden on water ecosystems;
- Prevent the contamination of water sources with chemicals, microorganisms and viruses, and manage water sources more effectively
- Enhance drinking and waste water treatment technologies and improve the condition of water supply and sewage networks;
- Provide for the effective mechanical, biological and chemical treatment of waste water;
- Raise the awareness of the population of the importance of the hygienic on use of water;
- Conduct refresher courses on public health and climate change for the public health workers;

Vulnerable community groups and climate change

The main indicators of vulnerability such as poverty and child mortality have improved over the years, although they are still high compared to other countries. The level of income of the rural population remains low. The Dekhkans (individual farmers) usually have small farms and use outdated technology. They are not able to choose markets for their products independently. An adaptation measure at the community level is to increase and diversify household incomes and improve welfare, based on the principles of sustainable development.

Diversification is a common risk reduction measure and should be done in two levels: (1) diversification of income sources to reduce financial risks, and (2) diversification of agricultural products to reduce the negative effect of climate change and extreme weather.

Another important approach to adaptation is to intensify and enhance the efficient use of resources, especially land and water. To achieve this, agricultural service provision, including access to quality seeds and appropriate cultivars, agricultural machinery, access to financial resources (credit), and also access to quality extension services all need to be enhanced.

A final adaptation measure is crop protection and insurance from the negative consequences of extreme weather conditions given that Tajikistan is a mountainous country with frequent natural disasters, especially floods, mudflows, heavy precipitation and drought.

The combination of climate change adaptation and risk mitigation measures at the community level may include:

- Protection of crops from natural hydro-meteorological events, as well as from pests and diseases;
- The introduction of new cultivation technologies (including passive greenhouses) with greater resilience to climate change and lesser water and energy intensiveness;
- Increased energy-efficiency of stoves and -insulation of houses to reduce the negative impact of sudden cold periods, as well as a reduction of energy consumption and GHG emissions;
- Improved water collection and storage for household needs and for irrigation;
- Increase the level and scale of the use of solar energy (introduction of solar dryers, greenhouses, photovoltaic panels);
- Enhance opportunities for organic farming;
- Protection of agro-biodiversity and genetic resources (local cultivars and wild congeners);
- Agroforestry, measures for the control of soil erosion and improvement of soil fertility;

The above list of activities could have wider benefits, that include an improvement of the socio-economic situation and welfare of the poor sections of the population segments, as well as strengthening of local capacity.

Conservation of ecosystems in the context of climate change

Climate change threatens the loss and degradation of Tajikistan's biodiversity. Reclamation of lands on steep mountain slopes, deforestation, and excessive livestock grazing have all resulted in reduction in the resilience of mountain ecosystems. Equally vulnerable are the water ecosystems that have been impacted by weather conditions and human factors. The following measures are required to preserve and build the resilience of ecosystems:

- Reduce/resolve the problems related to the increased anthropogenic load on ecosystems, including pollution of environment, overexploitation of natural resources, loss and fragmentation of habitat and the impact of invasive foreign species;
- Wider application of bio-methods of plant protection;
- Reduce climate change related stress, especially of water and mountain ecosystems through the rational management of water resources, forests and pastures;
- Strengthen the network of specially protected nature conservation areas through improving (a) the operation and maintenance of corridors for the natural migration of wild animals, (b) ecological networks, and also (3) the special protection of standard natural zones;
- Revive degraded ecosystems and their functions.

A large proportion of the population in Tajikistan is dependent on the goods and services of natural ecosystems. To enhance the adaptation potential, the following are recommended:

- Stimulate the development of sustainable tourism, including eco- and agro-tourism;
- Create a database of genetic resources including rare and endangered species, cultivars of horticultural crops, small fruit and gourds as well as local animal species;
- Raise the awareness of the population about the preservation of agro-biodiversity and vulnerable ecosystems, through thematic seminars, exhibitions and lectures;

Forests cover 3% of country's territory, but play an important role for animals and for humans. Forest planting is the most effective way of reforestation and forest management. The main species used in the forest ranges are pistachios, almonds, poplar and spruce. The development of private and community based forest management, reforestation and the expansion of forest shelter belts are promising areas of intervention.

5. Climate change policies and measures

On the 13th December 1997 the Government of the Republic of Tajikistan adopted the decree on 'Tajikistan's joining the United Nations Framework Convention on Climate Change' and on the 7th January 1998 Tajikistan signed the Convention as 'non-Annex I Party'. Tajikistan signed and ratified the Kyoto Protocol on 21 October 2008 as the 'Non-Annex 1 Party of UNFCCC and Annex B of the Protocol'.

Tajikistan is convinced that the intentions and commitments of countries on the reduction of GHG emissions must be implemented by all Convention Parties taking into consideration their level of specific emissions, socio-economic conditions, development needs, geographic location, and the availability of financial resources and technologies. Tajikistan is the mountainous and landlocked country highly vulnerable to climate change. The territory and glaciers of Tajikistan play an important role in the creation of water resources for the whole of Central Asia. Therefore, Tajikistan maintains the position that the world community must pay more attention to impact of climate change on glaciers, water resources, the impact of NHEs, and adaptation measures. The importance of the conservation of glaciers and the sources of water as well as the creation of an international fund was highlighted by the President of RT at high level summits and meetings between 2009-2013.

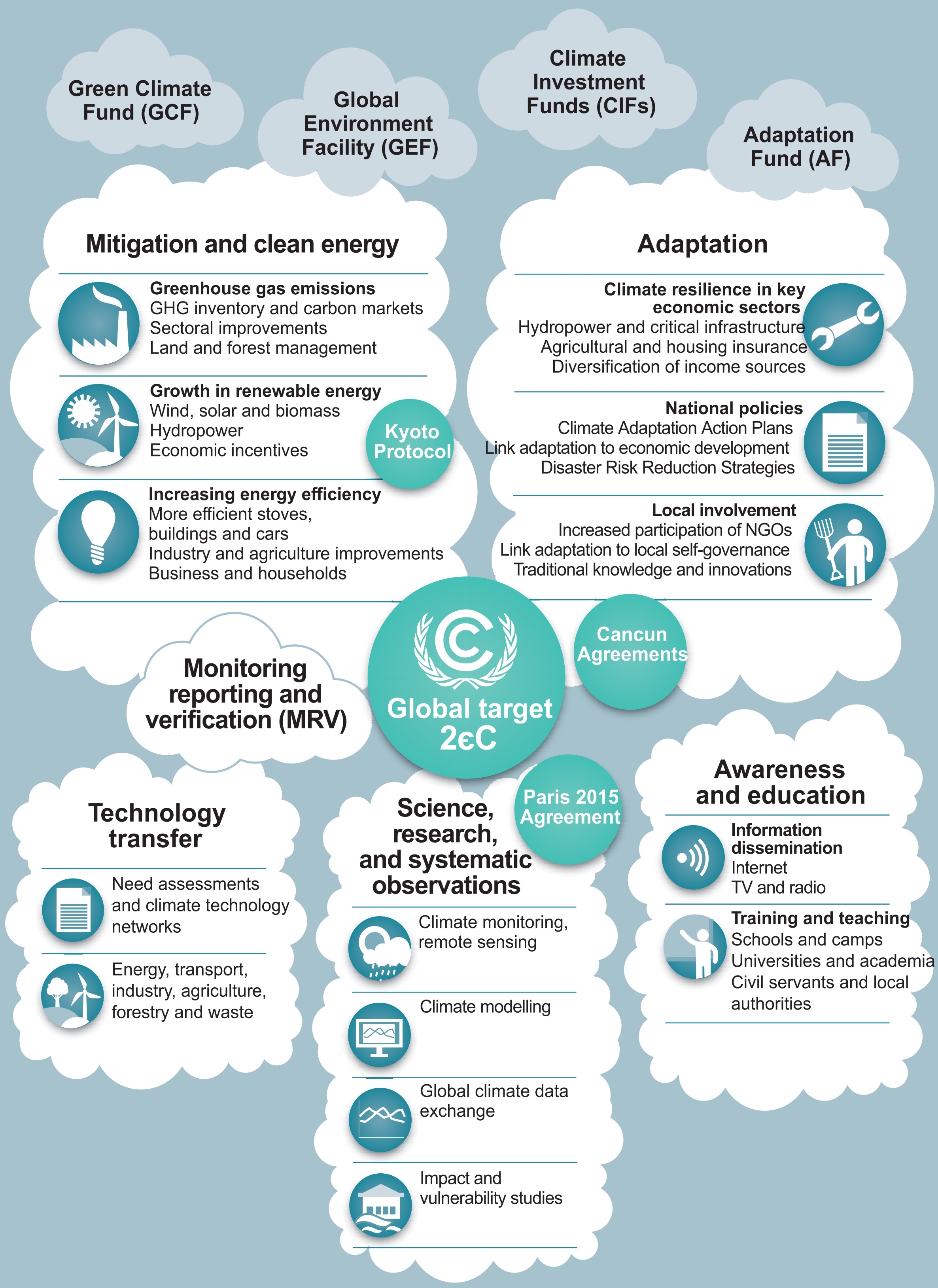
To implement UNFCCC commitments and strengthen climate protection measures, to date Tajikistan has prepared three National Communications on climate change, and also developed and in 2003 approved a National Action Plan (NAP) on climate risk mitigation.. Given that more than 10 years have passed since approval of NAP, the document requires revision to consider new developments and future commitments. Also, there is a need to develop and approve the National Strategy and Action Plan on climate change adaptation and to integrate as far as possible, the climate policy and priorities into sector plans and development strategies.

Tajikistan is in step with the world community on greening the economy by encouraging the rational management of natural resources, low-carbon development and investment in resource-efficient, energy-efficient technologies and RES. This is supported by environmental programmes and reforms in legislation and management bodies, the implementation of climate change measures, including in the energy, transport, agriculture and forest management sectors.

Given that by 2015 a new global mechanism to implement the objectives of the Convention is expected to be developed, the country is actively discussing the needs and opportunities and will make efforts to ensure a substantive contribution to the reduction of anthropogenic impact on the climate system of the planet. Tajikistan views the development of RES potential, particularly of hydro-energy, as the main way to reduce GHG emissions. Given the recent high rate of forest and soil degradation as well as insufficient forest cover for regulating the climate, controlling soil erosion and protecting watersheds, Tajikistan will pay efforts to increase the planting forests, forest protection and reforestation, as well soil protection and restoration of soils. Given budgetary constraints and a high rate of poverty, Tajikistan relies on the support of the world community to address these problems.

Climate change adaptation measures are also of high priority. Mountain ecosystems and the glaciers of Pamir as a source of water represent not only the wealth of the country, but of the entire region.

UNFCCC and countries – main areas of action



5.1. Main state programmes, strategies, plans, actions, laws and by-laws

A number of sector and ecological normative acts, programmes, and action plans directly and indirectly related to climate change have been adopted. These include:

- The National Action Plan of RT on Climate Change (adopted in 2003) was the first document of such a strategic nature in the Central Asian region and thanks to the support of donors and the efforts of local communities, private and governmental initiatives. it's implementation has been relatively successful It is expected that NAP will be updated in 2014-2015 to reflect new developments, knowledge, experience and progress, as well as global negotiations and commitments on UNFCCC;
- National Action Plan of RT on Environmental protection (adopted in 2006) envisages and recommends a wide range of measures and reforms through state and donor funding. The planned completion period is coming to end and thus updating of the plan will be required;
- State ecological programme and State programme of environmental education until 2020, subject to timely implementation, will support the improvement of the environmental situation and awareness of the population and managers on ecological problems and priorities. Aspects of climate change, water and energy as well as protection of ozone layer are reflected in both documents.
- A coherent programme on the use of RES up to 2015 envisages a set of measures for creation of a production and service base, as well a and infrastructure to enable the wide introduction and use of solar, wind, biomass, water, and geothermal energy sources and provide training for RES professionals;
- The programme on the construction of small power stations up to 2020 envisages the building of around 200 small HPPs supported by the state budget, donor funds and private investments;
- The concept of the development of a fuel and energy complex up to 2015 (adopted in 2002) reviews the situation in the energy sector and circumstances preventing the development of the sector. It also defines directions for the future;
- The Strategy on water supply and sanitation up to 2015 and the Programme on the improvement of clean drinking water supply until 2020 are aimed at halving by 2015 the people with no access to water supply and sanitation services;
- The National strategy on disaster risk management (2010) implemented by the Committee on Emergency Situations and Civil Defense of RT envisages institutional development, assessment and management of disaster risks, preparedness to emergency situations and response, raising awareness and education of the population. Linked to the Strategy is the State Programme on river bank protection for the period of 2011-2015.
- The Living Standards Improvement Strategy for 2013 – 2015 is currently being implemented;
- The Agricultural Reform programmes of RT for 2012 – 2020;
- Other state programmes, related to climate change include: the State programme on forest management and game husbandry up to 2015, the State programme on specially protected nature conservation areas up to 2015, and the State programme on monitoring and conservation of glaciers till 2020.

The key laws related to climate change problems are:

- The Law of RT on the power industry (2000);
- The Law of RT on transport (2000);
- The Law of RT on ecological expertise (2012);
- The Law of RT on environmental protection (2011);
- The Law of RT on environmental education (2010);

- The Law of RT on the use of renewable energy sources (2010)
- The Law of RT on environmental information (2011);
- The Law of RT on energy saving and energy efficiency (2013)

Taking into account the importance of global environmental problems and their close links with local conditions and the environmental situation, the country has joined and ratified a number of important international treaties including:

- Vienna Convention for the protection of ozone layer (1996);
- Montreal Protocol on substances that deplete the ozone layer (1997), and amendments;
- UN Convention on biological diversity (1997);
- UN Convention to combat desertification (1997);
- UN Framework Convention on climate change (1998);
- Ramsar Convention on wetlands of international importance (2000);
- Bonn Convention on the conservation of migratory species of wild animals (2000);
- Aarhus Convention on access to information, public participation in decision making and access to justice in environmental matters (2001);

5.2. Policy and measures bringing the negative consequences of climate change to a minimum and strengthening local communities

Energy production and consumption

Measures that are recommended for widespread use in Tajikistan include: enhancing energy-efficiency in the industrial and transport sector as well asin residential and non-residential buildings (especially the improvement of heat-insulation); active use of renewable energy; the application of economic instruments such as carbon/energy taxes; getting rid of or reducing in subsidies on fossil fuels and the introduction of and transition to 'green' technologies .

Modernization of energy management, such as heat supply systems and power transmission lines include improving the insulation of old heat supply systems using modern technologies. This will allow a reduction of losses by at least 2-3 times (15%). Losses during power transmission as result of technical upgrades or enhancing network density through construction of additional lines increase reliability of power supply.

The practical application of new construction norms in Tajikistan envisages the use of energy-efficient materials and technologies in housing construction. Energy consumption can be reduced through:

- improving building structure and location,
- improving insulation and making buildings air tight
- using modern materials for the construction of walls, roofs, floors and windows,
- using of highly-efficient heating systems, ventilation, air conditioning and water-heating units,
- installation of hot-water and heat supply meters;
- use of modern lighting systems and household appliances.

The development of RES with the support of communities: from dissemination of best practices at the local level to the support and promotion of state measures on RES.

Transport is one of the main energy consumers and source of GHG emissions. The transition to more economic models of motor vehicles depends on the price of fuel which in turn requires more prudent use of private motor-vehicles. If relevant taxes and regulations are introduced, then after 10-20 years more than half of the motor vehicles in the country will meet the current levels of internationally recognised environmental emission standards. The development of public transport and buses running on gas in the cities is relevant.

Industry

The main policy directions for reducing the negative impact of climate change in industrial sector include:

- The introduction of innovative resource-saving as well as environmentally safe and effective technologies through a technological platform, with active participation of the government, business community, education and science organizations, public and non-commercial organizations;
- The attraction of investment to ensure a and effective use of natural resources by industries, the reduction of negative impact on environment, and production of ecologically clean goods;
- The introduction of resource saving technologies;
- Create a system of benefits and incentives to encourage a wide introduction of energy-saving management methods;
- Implement measures to increase energy-efficiency, introduction of energy-saving technologies, reduction of energy-intensive industrial production, transition to the use of modern energy-saving equipment;
- Application of the 'dry-mix process' for the production of cement during the review of projects for construction of new cement plants;
- Introduction of energy-saving technologies during the production of lime which allows a reduction in fuel consumption by 50%;
- Introduction of modern technologies for waste processing and recycling.

Agriculture, land use change and forest management

The following factors must be taken into account during the formulation of sectoral policies:

- Increase the volume of local production of the main foodstuffs for the population of the country (in line with recommended consumption norms);
- Implement measures to enhance competitiveness of domestic products to reduce dependency on imports;
- Create conditions for prevention of crises situations through the development of early warning systems, implementation of prevention measures, and development of an insurance system for agriculture sector.

There is a need to improve the reclamation of irrigated lands to increase agricultural production. This is a challenge in places where saline lands are irrigated. In such areas leaching take places a result of irrigation and it is obvious that these lands will be the first to suffer from a reduction of water resources. Countries with such lands should have strategic plans in place in case changes happen earlier than predicted.. The following measures are recommended:

- The development of a long-term strategy for the widespread introduction of water-saving technologies of irrigation;
- Plan the construction units for the production of water-saving technologies;
- Increase energy efficiency of irrigation pumping stations, and improve the channels through lining and other structural measures to reduce losses of water and energy;
- The development and introduction of water retaining technologies when ploughing and sowing
- Encourage the growing of agricultural crops suited to drier conditions
- The development and introduction of water-saving technologies in the context of climate change.
- The introduction of financial incentives and regulations to improve land use planning, retention of carbon in soil, and the effective use of minerals and irrigation.

According to current legislation there is a need to regulate lands belonging to the forest fund which at the disposal of agriculture and used as pastures.

It will also be important to ensure sustainable forest management (the control of pests, fires, and illegal woodcutting as well as continuous reforestation measures).

Waste management

The key priority for waste management is the introduction of new waste processing technologies for secondary use of waste as physical and energy resources, and to ensure waste-free production. Therefore economic incentives should be developed to encourage the development of low waste technologies and processing of secondary raw materials.

Increasing the volume and proportion of solid household and city waste that is processed should be encouraged through the construction waste management enterprises in the largest cities of the country, namely in Dushanbe and in Khujand. Economic incentives should be developed to encourage the population to take part in waste separation. According to research, reducing carbon dioxide equivalent emissions by 1 ton from processed waste, is the same as 4.8 tons of CO_2 equivalents for paper, 1.8 tons of CO_2 equivalent for plastic, 1.8 tons of CO_2 equivalent for metal, and 13 tons of CO_2equivalent for aluminum. In addition, the production of compost from one ton organic waste reduces emissions of CO_2 equivalent by one ton. The improvement of the sanitary-hygiene and environmental situation requires solid household and municipal waste to be optimised and also systems developed for capturing methane emissions.

5.3. International support to Tajikistan

Considerable support to Tajikistan on climate change, water, energy and other related problems has been provided by the Government of Switzerland. In particular support was given to reconstruct the water supply systems in different towns and rural districts and also to enhance the reliability of electricity generation and transmission. Targeted support was also given in the assessment and reduction of disaster risks and considerable support was provided in reforming the health system. Through the joint efforts of scientists and students from Tajikistan and Switzerland research was carried out in the Pamir and methods of land use (WOCAT) were documented. With the active support of Switzerland partnerships and cooperation on sustainable development of mountain areas are developing through the University of Central Asia In addition Switzerland represents the interests of Central Asia and Azerbaijan at the GEF and is the member of Management Board. The Government of Switzerland conducts annual GEF related consultations with all countries.

A project on reducing the risk of overflow from lake Sarez was implemented by the WB in partnership with the Aga Khan Foundation and with funding fromt he Government of Switzerland between 2000-2006. Within the framework of the project the 'Sarez' Centre was created and operates under the auspices of CoES. The project also established a monitoring and early warning system to inform the population about the threat of floods in case of over flow from the lake.

With the support of Switzerland, 30 priority gauging stations and meteorological stations in river formation catchment areas have been renovated and re-equipped, along with now stakes and snow routes. The capacity of the hydrological department to work with satellite images and cooperate with the Regional Centre on Hydrology under IFSAS has been strengthened. Automated systems (Hydropro, GE-1) for digitization and support of hydrological databases and yearbooks have been introduced. Support was provided for the calibration of equipment.

In addition to the above, in 2009 a regional study on the state and development of hydro meteorological services was carried out by the WB. As a result of this survey, the WB has allocated 12mln USD to Tajikistan for the large scale modernization of observation networks and enhancement of services.

In 2010 the PPCR was launched under leadership of WB and the volume of funding before the development of TNC reached 150mln USD. The WB project 'Environmental Land Management and Rural Livelihoods' has benefited more than 20 thousand households (more than 120 thousand people), through the distribution of small grants for local measures on climate change adaptation. The

'Emergency Food Security and Seed Imports' project of World Bank has supported food production, the reduction of crop loss and diversification of agriculture. Another WB project supports the improvement of drinking water supply in towns.

The ADB has attracted investment for (a) the modernization and renovation of the energy infrastructure, including HPP Nurek, (b) the regional project CASA-1000, and (c) a project on improving the financing for RES and micro-financing of energy efficiency measures. ADB is also focused on enhancing the performance of the cotton sector, improvement of transport communication, and modernization of irrigation infrastructure.
The European Bank for Reconstruction and Development (EBRD) has provided vital support for the renovation of HPP Kairakkum for enhancing the overall resilience of HPP systems to climate change.

Implementation of a European Union (EU) project on technical assistance on climate change issues has strengthened capacity through the development of legislation on the Clean Development Mechanism and also created recommendations on the improvement of institutional and technical capacities of the country to participate in UNFCCC mechanisms. Currently, Tajikistan takes part in a number of regional programmes funded by EU, including those on energy, natural resource management, trans-boundary water resources and the high level dialogue on environment and climate change. Tajikistan is interested in studying the experience of the EU in (a) planning adaptation measures, (2) enhancing energy efficiency, (3) encouraging the wide application of RES in the housing and commercial sectors, and (4) participation in emission trading.

With the support of the US Agency for International Cooperation (USAID) in Central Asian countries, including in Tajikistan, a number of automatic meteorological stations have been installed and support was provided to farmers on the use of modern agricultural technologies and water management.

In 2008 the programme 'Water Unites' financed by the Government of Germany was launched. Within the programme the 'CAWa' project was implemented by the German organizations between 2009-2014. The project aimed at (a) improving knowledge, together with the quality and accessibility of data on glaciers and water resources, and (b) the development and impact assessment of a regional climate change model 'REMO'. The project supported the installation automatic meteorological stations in Zerafshan and Aivaj. Installation of automatic hydrological stations is also envisaged. At the 'Abramova' glacier (Kyrgyzstan) derelict meteorological station was replaced by a complex automatic station which now provides data on water discharge of the Vakhsh river. At the time of TNC formulation the station was undergoing testing. The Government of Germany and EU are providing significant support to CA countries, including Tajikistan, in enhancing the management of water resources.

During the International Year of Forests (2012) with the support of German Technical Cooperation (*GZ*) 6 thousand forest trees were planted and irrigation channels constructed in the Ishkashim district.

Given the energy and fuel deficits of the 1990s local forests were devastated. Reforestation measures are highly important to increase the absorption of carbon emissions and afforestation projects have taken place in in 30 villages of the Pamir. The programmes of the GIZ on sustainable use of natural resources, improvement of forest and pasture management have been financed by EU to help the country to improve its environmental performance in specific areas.

China and Iran are also actively partnering with Tajikistan in the sphere of (a) investment in energy, industry and transport infrastructure, and (b) support and development of hydro-meteorological observations.

The United Nations Development Programme (UNDP) and Global Environmental Facility (GEF) jointly with the Ministry of Transport, Ministry of Energy and Water Resources and other state institutions implement projects aimed at reducing GHG emissions, the improvement of public transport management and access to services, and expanding use of RES. Training programmes on the establishment of small HPPs were developed and training provided. Local production of equipment for small HPPs is being set up. In Dushanbe projects on establishing specific lanes for public transport use, improvement of public transport management systems as well as for promoting bike transport are envisaged. A projects on the ozone layer and phasing out the use of ozone depleting substances is being implemented. These and other projects have been implemented over the last 15 years. UNDP as the partner of 'Environment and Security' (EnvSec) initiative implements a regional project on climate risk management that also covers Tajikistan. With the support of the project, an expedition to the Pamir was organized in 2011. During the expedition, local and international experts surveyed the different types of glaciers, including Medvejiy. Microfinance funds have been created to enhance incomes, food security and resilience to climate stress.

The Small Grants Programme (SGP) financed by GEF and managed by UNDP is implemented under the slogan 'Thing globally, act locally!' The SGP views global environmental challenges in the context of Tajikistan and applies local approaches themes such as biodiversity, climate risk mitigation, combating land degradation, and eliminating the use of POP. During 3 years of implementation in Tajikistan, 45 projects costing more than 1mln USD have been approved. Almost half the projects have been aimed at addressing energy issues, including energy-efficient stoves, solar panels and heaters, and insulation of social buildings and households.

The United Nations Environmental Programme (UNEP) supports the participation of Tajikistan in global and regional initiatives such as 'Green Economy', 'Environment and Security', 'Poverty and Environment', and the 'Central Asian Youth Network'.

The Norwegian Society on the Protection of the Environment with the support of a network of local NGOs and schools is implementing successful the 'SPARE' programme focused on young people. This is an energy saving programme and covers all regions and big cities of the country. The programme helps to analyze and find local solutions (technologies, lifestyle, consumption) to climate change problems.

5.4. Gender, reproductive health and climate change

The impact of climate change does not only threaten lives and deprive livelihoods, but also widens the gap between the rich and poor and increases the inequalities between women and men. Gender equality and opportunities in the context of climate change are among the key issues of concern covered by the UNFCCC. Strategies on climate change and risk mitigation cannot be successful without the participation of women. Therefore negotiation processes and documentary outcomes need to reflect gender equality issues in all areas including adaptation, risk mitigation, knowledge transfer, and so on.

During the development of the TNC issues associated with pregnancy, giving birth and care after birth in the context of climate change were studied and measures to improve reproductive health developed. Based on an analysis of 19 thousand pregnancies the impact of extreme climatic events outcomes were identified., a threshold temperature was defined and climate change adaptation measures were developed.

This research is relevant not only for Tajikistan, but also for other countries where the climate change trends and gender equality problems are pronounced. The relationships between pregnancy and labour complications and temperature that have been highlighted by the research and the identification of a threshold temperature for pregnant women and women in labour has allowed the development of recommendations to reduce mortality and of pregnant women, women in labour and infants.

The results of this research will help in developing a new direction in gender and reproductive health and will serve as the basis for developing a Strategy on health in the context of climate change. An International Award 'Sodrujestvo debyutov' (Commonwealth Debuts) founded by the Council for Humanitarian Cooperation of the Member States of the CIS and the Intergovernmental Foundation for Educational, Scientific and Cultural Cooperation was issued for this work indicating the importance of the research subject. The award was given to a Tajik Doctor, Ms Dilorom Kayumova by the President of Turkmenistan, Mr G. Berdimukhamedov during the VII Forum of Clerisy which took place in Ashgabad on 15-16 October 2012.

The fact that Tajik female researchers are able to achieve such results is thanks to the Government of the country which considers the empowerment of women to be a priority direction for social policy. The adoption of the Decree of the Presidents of RT on measures to enhance the status of women in society demonstrates trust towards women, recognition of their responsibility, as well as their courage and professionalism. To implement the above Decree, the 'National strategy for strengthening of the role of women in the Republic of Tajikistan for the period of 2011-2020' was developed as a legal base and is being implemented.

6. Research and systematic observations

6.1. Scientific research and knowledge development

During the Soviet times detailed studies on climate and meteorology, agro-meteorology, hydrology and natural hydro-meteorological events were carried out. Based on the outcomes of this research, reference books, atlases and collections of data were published. Over the last 10 years, studies of climate change, river flow, trends in natural disasters , as well climate risk assessments have been undertaken To develop this National Communication on climate change for UNFCCC, expert groups carried out a number of innovative surveys/research on the impact and consequence of climate change.

In line with the Strategy of the Government of Tajikistan in science and technology for 2007-2015, the following activities are being carried out by the Academy of Science of RT:

- A study on the impact of anthropogenic and technogenic components of climate change on biodiversity, natural eco-systems and agricultural crops;
- Physiological-biochemical adaptation and regulatory mechanisms of the resilience of living organisms to the impact of stress.

At the Institute of Botanics, Physiology and Genetics of plants research is being carried out on 'The impact of climate change induced stress factors on the physiological and biochemical growth of wheat in Tajikistan' and 'The impact of climate change on the growth, development and productivity of wheat in Tajikistan' .

At the Pamir Biological Institute under the Academy of Science of RT, a study is being on 'The Physiological and biochemical aspects of plant adaptation to climate change in the high mountains of Pamir'.

It's worth mentioning that to support the implementation of the state programmes, scientific research on climate change is being carried out not only at academic institutions, but also at the various other research institutes. Following the Decree of the Government of RT (ref #587 as of 27 November 2007), the Ministry of Health and Social Protection of RT issued a decree (ref #449 as of 16 August 2008) one of the major points of which was to institute a study on the impact of climate change on reproductive health.

Following the tasks assigned by the Government, large scale scientific expeditions have been organized:

- The first Tajik Antarctic expedition (2008-2009) as part of the International Polar Year;
- The first international scientific expedition (2011) to study the state of glaciers and environmental situation on upstream sections of the Vakhsh and Pyanj rivers. Representatives from Central Asia and Russia took part in this expedition.

In 2011 a new surge of the glacier Medvejiy took place moving by 800m. After conducting a comparative analysis of the results of the expedition, it revealed that the trends in the change of climate and glacier degradation in uplands of Tajikistan and the Antarctic are similar. The results were reported at the meeting of World Meteorological Organization on the cryosphere and posted on the web (http://www.unmultimedia.org/radio/russian/archives/98071). The reports highlight the global importance of the expedition.

Following the results of Pamir and Antarctic expeditions, an event was organized during the International Conference on Water Cooperation (Dushanbe, August 2013). Simultaneously an information campaign was carried out to raise awareness about the state of glaciers of Pamir and Antarctic.

Between 2001 and 2006 a study on dynamics of glacier budgets of Tajikistan was conducted by the Scientific Research Centre of Mapping and Geodesy 'Tojikkoinot' using cartographic, aerial-images and satellite data for 1949, 1975, and 1985 until 2005. It revealed that areas covered by glaciers reduced within the range of 5-10% to 25-30%.

Photo. International expedition to the Glacier Medvejiy, Glaciological group 2011

Between 2003 and 2010, international and local experts implemented the 'TajHaz' project to assess and monitor those glacier lakes of the Pamir-Allaithat have the potential for overspill. The results of the assessment are available only to project stakeholders. GIS data was handed over to Committee of Emergency Situations and Civil Defense of RT.

Between 2008 and 2013 experts from Germany and Tajikistan undertook an analysis of the benthic deposits of the closed lake Karakul to study the paleo-climate of the Pamir.

The Global Land Ice Measurements from Space (GLIMS) is International Project and Partnership which aims to assess and map global glacier cover based on the modern satellite data for 2000-2010 using a unified approach.GLIMS is coordinated by the Geological Service of the United States (USGS). The Institute of Geography of the Russian Academy of Science serves as the Regional Centre for GLIMS. The project covered major proportion of the glaciated area of the Pamir, however the data requires further revisions.

Work carried out on creation of a regional climate change model within the framework of CAWa project also deserves attention. Training was provided for local experts and work was undertaken modelling the data

Within the framework of the TNC project, three monographs for scientists and wide range of specialists on climate change issues have been published together with guidelines on natural hydro-meteorological events in line with strategic plan of WMO and the Decree of the Government of RT (ref #394 as of 1 October 2004) have been produced for the specialists of all economic sub-sectors of RT were developed.

Recommendations to enhance the potential of scientific institutions on climate change issues.

Scientific institutions, jointly with the institutes of higher education must develop research on climate change issues and include of students and young scientists in their work.

To develop the potential of science institutes on climate change, the following is required:

- Training of qualified professionals;
- Developing new directions of research on climate change;

Photo. Books on climate change published within TNC project (www.meteo.tj)

- Attract state budget and international funding for scientific work on studying the impact of climate change;
- Under the academic and sector research institutes, create new scientific departments focused on climate change issues
- Enhance international cooperation on scientific aspects of climate change and attract Tajik experts to the work of IPCC

6.2. Systematic observations

The State Agency on Hydrometeorology (Tajik Hydromet) supports a wide network of systematic observations of climate. The observed and predicted data is used to meet the needs of the economy, the population and government bodies for hydro-meteorological and climatic information. The density of any network of sites depends on both the existing and planned use of a territory and a consideration of population density. The ideal density for gauging stations as well as meteorological stations is 1 per 1000 km^2.

In the territory of Tajikistan the first meteorological stations were created at the end of 19th century, and include Khujand (1866), Ura-Tyube (1873), Murgab (1892), and Khorog (1898).The peak of network development was in the 1970/80s when there were 70-75 meteorological station sand 100-136 gauging stations. After the collapse of the Soviet Union, the network has reduced but has remained stable over the last 15 years at 57 meteorological stations and 86 gauging stations, including 10 stations which have records going back for r almost 100 years and 28 stations that are included in the system of international exchange of meteorological information. The network also includes sites for the observation of environmental pollution.

For a number of technical reasons, including a lack of specialists in 5 meteorological stations and 10 gauging stations are temporarily not working, the level of automation remains low. As of May 2014 automatic meteorological and hydrological stations are functioning in the country however the low numbers of automated observations as well as

Photo. Staff of the Hydromet from the regions of Tajikistan at the meeting in Dushanbe, 2013

limitations in data processing and transmission, reduces the volume of incoming data and complicates analysis. To enhance efficiency and reduce the cost and the time required for data collection at the hydro-meteorological stations there is a need for widespread automation of meteorological and gauging stations as well as snow gauges. There is also a need for more observations, and the use of of satellite and computer based data and products.

The current systematic observations do not fully meet international quality standards and do not provide complete observations. This complicates participation in the Global system of climate observations and other global networks. The equipment is in a very poor condition and only a small proportion of the country is covered. Meteorological coverage is 40%, but no aerological and actinometric observations are carried out. Fiver percent of the country is covered by agro-meteorological observations, 27% by hydrological and general environmental monitoring takes place over 30%. Observations of snow-cover have considerably reduced and in mountain and remote districts precipitation gauges do not exist. In many stations observations on deep soil temperature have stopped or been reduced and automatic data recorders for precipitation and temperature are not used. There is an urgent need to train specialists and build up the staffing, especially of those specialised in aerology, agrometeorology, actinometry, hydrology and those able to repair hydro-meteorological equipment.

Meteorological observations are conducted in standard meteorological periods (24 hours) and include the measurement of temperature, air humidity, pressure, precipitations, types and amount of cloud, visibility range, direction and speed of wind as well as atmospheric events and processes. Data on current temperature is reported to the Hydro-meteorological Centre. Data transmission takes place via mobile service and radio.

Tajikistan is the member of Interstate Hydro-meteorological network of CIS countries to which data from 14 meteorological stations and 11 gauging stations is transmitted. Six stations are part

Photo. Gauging Stations Kizil-Kishlak at the Syrdarya river

of the World Weather Information Service of the WMO and three stations (Dushanbe, Kurgan Tyube and Khorog) are included in the Global Climate Observing System of WMO.

Development of agriculture and food security depends on agro-meteorological services and predications. Agro-meteorological observations guide an assessment of the impact of weather on the growth and condition of crops, pastures, pests and diseases and development of recommendations on implementing agricultural activities. These predictions help to reduce the risk of crop losses resulting from frost, drought and rainfall. Up until 1990 agro-meteorological observations were conducted at 56 meteorological stations gauging stations and included measurements of temperature and humidity of the -top soil, observations on the condition of agricultural crops and their productivity, as well as phrenological phases. As of 2013/2014 there are three times fewer stations undertaking agrometeorological observations less than 20 stations), while the data collected limited to visual observations of the crop development phases and meteorological conditions. No grazing surveys are carried out.

Actinometric observations of solar radiation and aerological observations of atmospheric weather conditions at the altitudes of up to 40km, important for weather forecasts and aviation, have not been carried out over the ast 20 years due to lack of and breakdown of equipment.

Hydrological observations are required for collecting data on river and lake regimes, conducting state and inter-state measurements and the assessment of human impact on water resources. The mountains of Tajikistan serve as the 'water towers' of Central Asia and therefore measurement and prediction of of water resources is of high practical and political importance. Until 1991 hydrological observations were carried out at 11 stations and 138 posts. As a result hydrological predications were provided on a monthly, decadal and seasonal basis for five river basins.. Annual hydrological yearbooks were regularly published. Currently, there are 97 sites for hydrological observations of which 85 are operational sites and half of which measure water levels and discharge. Observations on turbidity and evaporation are not carried out. Aerovisual observations on the snow level and condition of snow cover are rare, while the number of ground observations are three times fewer and do not include measurement of the water equivalent of snow. Despite these problems, hydrological predictions are met by 80-95%. Snow and avalanche observations cover the Varzob and Gunt river basins whilst in the remaining territory these observations are limited to the registration of catastrophic avalanches.

Observations on the contamination of surface waters are carried out on 4 river basins on a quarterly basis, namely in the Vakhsh, Kafernigan, Zerafshan and Qaratag. A reduced level monitoring of atmospheric air pollution is undertaken in 4 towns, namely in Dushanbe, Kurgan Tyube, Tursunzade and Khujand.

Before the collapse of USSR, the data coming from the stations of Tajikistan were sent to SANIGMI in Tashkent (as well as to Data Centre in RosGidromet) for statistical analysis, quality control and transmission to electronic devices and monthly publication. Currently, this work is carried out by the National HMS of Tajikistan using their own resources. Part of data derived from the Tajik observation network is not processed and hard copies are stored in archives. The data from Soviet times and the period of independence is partially available in electronic format and currently cannot be used due to unresolved technical problems. It is expected that through the WB project on modernisation of HMS these problems will be addressed. The installation of automatic snow gauges in Vakhsh and Pyanj river basins is envisaged. Also, at the sites where meteorological stations were closed and are based in hard to access districts, installation of automatic stations is planned.

Despite the fact that by area and volume, the area of glaciers in Tajikistan is the largest in Central Asia and is well studied using satellite images and field surveys, the observation of fixed land stations of glaciers, especially measurement of weight balance, have been episodic and short-term. Only at hydro-meteorological observatory named after A. Gorbunov at the Fedchenko glacier (4169 m) have glacier characteristics been measured and climate assessment made. This was for period between 1933-1995.

Staffing is also of high relevance. The Hydro-meteorological service has a limited number of specialists, especially in the sphere of hydrology and glaciology. Training for these specialisms is not provided in Tajikistan. During Soviet times almost all specialists were trained in specialised higher education institutions and technical colleges of the USSR based in Odessa, St Petersburg, Moscow and Tashkent. A series of lectures has been delivered at the Tajik National University and College, yet the quality of training for specialists remains low. During 2012-2013 students were sent to Russia for studies.

The low salary is one of the main reasons for the turnover of qualified staff. If this problem is not resolved, then technical and consultative support being provided by the donors and the staff, will not be used effectively..

6.3. Capacity development needs

Priority areas for capacity development include the optimisation and compatibility of existing and new equipment and supplies, maintaining the operation of the observation systems, enhancing access to data, reducing the duplication of activities and enhancing the return on investments made into equipment, communication and staffing. Resource intensive projects focused on information and technical as well as institutional development will be more effective when the state and the implementing partners ensure sustainability of initiated efforts.

Staffing is the most acute problem. Without adequate wages for professional staff and local experts, the technical and institutional support provided will not have a long term impact since human resources and sustainable financing play a key role in this regard.

Training and internships for young specialists is strategically important and a precondition for the successful implementation of the planned mid- and long term activities. Although science based and fundamental principles are being retained, new developments such as the introduction of new technologies, enhancement of approaches, globalization and computer based measurements are developing from year to year. It is important to keep up to date and invest in specialists and human capital, whilst at the same time assessing and using the expertise of experienced experts.

Expanding the network and enhancing the quality of hydro-meteorological observations in highland areas (including measurement of snow cover in different river basins and highland areas, as well as application of automatic stations) are key preconditions for a complete analysis of trends in climate change and the response of glaciers.

Automation of observations, especially in the areas where river and glaciers are formed, is a promising direction. However there is a limited expertise in the introduction and application of automatic weather and gauging stations as well as their integration to regular network of observations. The functioning of AMS-s is complicated by incompatibility of equipment and some observations, as well as by calibration requirements and the condition (safety, maintenance) of stations.

Although a good information exchange with the National HMS-s of Central Asia is taking place within the framework of bilateral agreements, users access to hydro-meteorological information within and outside the country is limited. With the development of services to customers, especially local and international scientific communities, this problem is gradually being addressed. The WB project on the modernization and improvement of the hydro-meteorological network and services is also aimed at addressing these problems.

The highmountain hydrometeorological observatory at the Fedchenko glacier that had a long and continuous period of complex climate and glacier observations has not been functioning for more than 15 years. This negatively affects quality of predictions on the discharge of the Amudarya river basin. The automatic meteorological station installed in 2004 continues to transmit data, however it requires calibration and integration into the information exchange system. The key station at the Abramova glacier (in Kyrgyzstan, bordering with Tajikistan) was destroyed in August 1999 during a militant attack on the southern districts of Kyrgyzstan. Under the CAWa project a new monitoring station suitable for assessing the glacier mass balance, making images and conducting meteorological observations was established in 2013. In the long run, the data from the given meteorological station will be useful for Tajikistan and other countries.

Of special interest in studying the interrelationships between glaciation and climate are the glaciers of between 2-15 km^2 in area. This is the optimal area for conducting representative field surveys with minimal moron surface.as the impact of local factors on small glaciers is too dominant. The larger glaciers reflect macroclimatic conditions of the region. Having said that analysis of larger glaciers is a resource intensive and technically complex exercise.

Areas of permafrost and rock streams remain understudied. Given that they potentially contain considerable water reserves, observation of permafrost in highlands has a significant importance. Along with glaciers and permafrost, the dynamics of highland lakes such as Karakul and Sarez can be viewed as indicators of variability, climate change and discharge. According to experts, it is important that a modern inventory of glaciers is carried out which will include and assessment of the volume and thickness of ice The researchers and organizations must be more open and cooperative in ensuring accuracy and quality of data.

The primary data from key meteorological and hydrological stations and objects of glaciological research must be stored in electronic databases in line with international norms and standards.

Studies of the paleo-climatic conditions during the last century and millennium based on an analysis of ice cores, vegetation, and benthal deposits enable a comparison of the current anthropogenic changes of climate with the recent past. Initiatives on paleo-climatic and geo-botanical monitoring of mountainous districts need to be supported.

Educational (popular science) expeditions and conferences involving concerned public organizations and journalists provide good opportunities for enhancing public interest and understanding the problems related to climate change and glacier melt. Joint expeditions can result in enhanced local potential, consolidate local and international knowledge and resources, as well as improve experience and information exchange. Data from voluntary observations (for instance alpinists' reports on mountain hiking) was earlier used by the glaciologists. It would be helpful to enhance using these kind of data sources and promote the flow of such information to fill the data gaps as well as to involve communities and other stakeholders into this process.

Developing partnerships with Afghanistan for joint hydrological observations, assessment of glaciers and impact of climate change on trans-boundary basin of river Pyanj could contribute to improvement of the quality of prognosis and planning adaptation measures.

7. Education, training and public awareness

Since publication of the First National Communication and the adoption of the NAP on climate change, significant progress has been made in raising the level of public awareness and the activity of mass media on climate change related issues. This includes higher and technical education. Ten yoears ago, Only 10% of respondents were aware of climate change issues whereas the current level of awareness ranges between 40-80% (60% on average), depending on location, age and occupation.

Nevertheless, compared to other regions of the world, the overall level of awareness and understanding of climate change is low and varies from region to region. Analysis shows that the residents of Dushanbe city, as well as Soughd and Khatlon oblasts are better informed than the residents of the central mountainous districts of the country.

In Tajikistan almost all awareness raising activities on climate change are implemented implemented by international organizations and NGOs. Existing publications as well as information in Tajik language are insufficient.

7.1 Education system and access to knowledge

Under a UNDP project on environmental learning, resource centres were established to develop training modules on climate change issues targeting schools and higher education institutions.+
In general, climate change issues are not included in the curriculum of secondary schools or institutes of higher education and lectures and practical sessions for schoolchildren on the topic and students being rare. As a rule, they are usually provided by NGOs and project experts.

In 2005 the Ministry of Education of RT approved a new textbook 'Environment for future generations'. This includes sections on climate change and its consequences and was developed with the involvement of the Central Asia Regional Ecologic Centre (CAREC). Around 300 posters were distributed in 200 schools of the country for extracurricular activities. Focused on the needs of schoolchildren and students, the Youth Ecological Centre has developed books and guidelines on

Photo. Presentations for schoolchildren on climate change

different themes including 'Interesting Environment' (2007), 'Climate change adaptation' (2010), and 'Everything about climate change' (2011).

In 2009, RECCA, the Youth Ecological Centre and NGO 'Malenkaya Zemlya' (Little Earth) developed a new training module on climate change, targeting teachers from secondary schools and lecturers of higher education institutions, and delivered training for these target groups. A 'Green package' of training materials for students developed by RECCA in 2011 for the countries of Central Asia was translated, adapted to the context of Tajikistan and further approved by the Ministry of Education of RT. In 2011 a training module on sustainable development was introduced into curriculum of few leading institutes of higher education. Between 2000 and 2012 a series of lectures on human adaptation to climate change and the medical aspects of climate change were delivered at the Public Health Faculty of the Tajik Medical University.

7.2. Activities on strengthening climate change awareness

The degradation of glaciers and other consequences of global warming are the key reasons for taking immediate and effective measures aimed at reducing GHG emissions including the rational use of water and energy at all levels of the society. Yet, the awareness of the population on the causes and consequences of glacier degradation and climate change is not high. Further efforts to disseminate scientific information and the outcomes of glacier monitoring is required, targeting mass media, decision makers and the general population.

The Committee on Environmental Protection under the Government of RT and Environmental Awareness Department issues information bulletins, journals, newspapers and materials (http://www.hifzitabiat.tj) covering the most pressing environmental topics, including climate. In addition,official documents, educational (scientific-popular) books and materials are posted on the Gidromet website (www.meteo.tj). As part of the development and dissemination of information in the National Communications on climate change, seminars and trainings for specialists and sessions for schoolchildren are carried out.

The programme of environmental summer camps for schoolchildren and students includes training and master classes on assembling solar cookers and solar water heaters, as well as interactive climate change related debates among youth.

TajCN is a network of Tajik NGOs focusing on climate change. The network was formed in 2008 and is a joint initiative of Youth Ecological Centre, NGO 'Malenkaya Zemlya' (Little Earth) and the Environmental NGO's Club. TajCN is an informal union of information exchange and dialogue on environmental issues, including climate change and energy. The network includes around 100 users and is free. The network is involved in advocacy and promotes the interests of civil society on climate change at a policy level and supports the platform for the exchange of information and opinions.

7.3. Initiatives and the projects of non-governmental sector

In Tajikistan, non-profit (non-governmental) public organizations play a very important role in raising public awareness on climate change issues, demonstrating approaches to reduce carbon footprints, improving community access to environmentally clean energy and implementing adaptation measures. A group of NGOs undertakes activities through the Tajik Climate Network which includes debates and discussions on climate change issues and other environment related events. The network carries out round tables, NGO conferences and regularly disseminates 'Climate Dijest' covering local and international developments on climate change, including on community participation. The network has its own website.

There are a variety of NGO activities in Tajikistan on different topics and these are described below.

Photo. Celebration of Earth Day

The Youth Ecological Centre implements many awareness raising activities among young people, farmers and communities. The NGO has developed a number of guidelines and issued brochures and posters on climate change and has implemented several community based climate change adaptation projects in rural areas of southern Tajikistan. Based on the outcomes of a vulnerability risk assessment carried out using participatory methodologies, local (community based) action plans on climate change adaptation have been produced in Shaartuz, Kabodiyan, Nosir Khusrav and Gissar districts. As a result of this work, more than 200 homes have been were heat-insulated, 100 energy-efficient stoves installed, the condition of arable lands was improved and reliable access to water to these lands was provided, 15 solar greenhouses, 30 greenhouses, nurseries for 20 thousand saplings were created, and solar photovoltaic panels were installed in health institutions. It is worth mentioning that in many of these activities, the beneficiaries are women as heads of households.

Insulation of houses and construction of stoves might seem a strange activity in the context of climate change (and warming), but the reality is that the unexpected snowstorms and cold weather during winter 2008 led to an energy crises which affected hundreds of farms, and resulted in losses of livestock, potato seeds and vegetable seedling in the southern districts of Tajikistan. The end result was a food crises and a growing risk of famine. These loss of crops , decline of farmers' income, rise in the vulnerability of the poor communities due to natural disasters and severe weather events served as the basis for development of adaptation programmes and projects implemented by NGOs.

To further enhance the awareness of local communities, four Centres on climate change adaptation have been created by the Youth Ecological Centre with the support of Act Central Asia. The Centres disseminate knowledge on coping strategies, on the more effective use of heat, the construction of greenhouses, the installation of solar panels and energy efficient stoves, the application of simple

Photo. Republican Environmental Forum (exhibitions, presentations and awards)

plant protection methods, use of seed reserves, use of drought-resistant crops, more effective use of irrigation water and the introduction of alternative energy sources. Demonstration plots have been created for the development and transfer of adaptation knowledge. The uses of energy-efficient stoves and improvement of the insulation of houses has allowed a reduction in the consumption of wood and coal consumption by 30%. This not only contributes to the improvement of climate system, but also reduces the negative impact on human health of emissions resulting from fuel and biomass combustion within or near houses. More than 300 farmers have been trained on adaptation measures and more than 3 thousand households benefited from adaptation activities.

The NGO 'Malenkaya Zemlya' carries out extensive information campaigns and implements a number

of projects including the community based construction of solar greenhouses and energy-efficient stoves as well as energy saving. The NGO issues a bulletin 'Green Energy and Us' which is devoted to disseminating ideas on the introduction of RES.
With the financial support of the Norwegian Society on Nature Protection, the NGO 'Malenkaya Zemlya' has supplied solar photovoltaic panels and insulated 7 schools based in highland districts of Pamir and central Tajikistan. Ten solar greenhouses have been constructed. This has resulted in the improvement of living standards and partially addressed the food insecurity of the beneficiaries. Seminars on the creation of energy-efficient stoves led to their expansion in southern districts of the country.

The public Organisation 'Zan va Zamin' (Woman and Earth) supports the development of the resilience of women led farms to extreme weather events and climate change in the Hamadoni, Vose and Farkhor districts of southeastern Tajikistan. In particular training on alternative energy sources have been conducted, demonstration plots created to grow resistant plants, and local centres established to implement adaptation measures and to raise awareness of farmers.

With the financial support of GIZ and GEF SGP, the Jamoat Development Centre 'Komsomol' jointly with NGO 'Kullai Donish' and 'Javononi asri 21' and disseminated knowledge on solar dryer technology and income generation from dried fruits and vegetables. The project covered 200 farmers and smallholders which annually produce 10 thousand tons of different fruits and vegetables such as apricots, apples, grapes, egg plants, carrots, onions, etc. The seminars provided covered methods of conservation, drying, cleaning and packaging of products. A small enterprise on production of dryers was established and training was provided to the staff. Twelve solar dryers as well as solar greenhouses and solar water heaters were installed for demonstration.

With financial support of the Christensen Fund, the Public Organisation 'Hamkori bahri Taraqqiyot' (Cooperation for Development) has implemented activities to support climate change adaptation of communities and biodiversity conservation in the Gissar and Rasht valleys of central Tajikistan. Under the project, ten nurseries were created to grow [fruit and fruitless tree] seedlings. Training seminars on the creation of a seed bank and the establishment of fruit tree nurseries were conducted. Brochures and booklets on climate change along with a book 'Agrobiodiversity and traditional knowledge' and a photo atlas 'Agrobiodiversity – our food, resource and wealth' were published for dissemination among farmers, women, students and schoolchildren.

The public Organisation 'Azal' works in the Rasht valley, including the Tavildara districton the rational use of natural resources and community based climate change adaptation. Projects on the, development of nurseries, and management of pastures in extreme weather conditions have been implemented. Trainings and lectures were conducted on the context of climate change.

The Fund to support civil initiatives and the Centre 'Dastgiri' (Support) support soil and water conservation for climate change adaptation on farms through the study and use of traditional knowledge and methods, including on biological drainage such as reducing the level of mineralized underground waters through transpiration of moisture via perennial shrubs and planting tree borders .

With the support of the Micro Loan Fund 'Madina' based in GBAO, 100 houses in the Murghab district (east of Tajikistan) were insulated in 2011. Energy efficient 'Vulkan' stoves 'Vulkan' were also installed and wood was supplied from other districts of the Pamir. This resulted in a significant reduction in the use of teresken [as firewood] by the local population. These activities were implemented with partial funding from GIZ. Microloans of 500 US dollars or more (mainly to cover the cost of equipment and works/services) was disbursed for 1 year or more to carry out the heat insulation of houses, improve energy efficiency in heating and cooking, and for the installation of solar water heaters. Initially households invest their money, but then are able to save due to a reduced level of fuel consumptions and reduction of health risks.

In the north of Tajikistan, the Public Organisation 'Molodyojnaya gruppas po zashite okrujayushey sredi' (Youth group on the support of the environment) broadcast 20 educational radio programmes on enhancing the preparedness of the population to extreme hydro-meteorological events and climate change. The group also issues a quarterly journal 'Best practices on the preparedness and response to natural disasters and climate change'. Solar greenhouses have been constructed in 3 schools of B. Gafurov and Kanibadam districts and seminars were conducted for secondary school teachers on climate change and interactive methods of teaching at school. In 2011, the organization supported an exhibition 'Energy saving technologies and recycling of resources'.

In Soughd oblast, the NGO 'Nau' has carried out extensive work on adaptation practices within the framework of projects supporting local economic development and development of DFs. The organization facilitates access of agricultural producers to the market and creates DF based demonstration plots to test crops and carry out different adaptation measures.

With the support of EU, NCO 'Oftob' (Sun) jointly with the Centre on the Study and use of RES under the Physics and Technical Institute of the Academy of Science of RT supported the introduction of RES in mountain villages of Muminabad, Shurabad and Khovaling districts including 30 photovoltaic and 7 wind-power plants as well as 4 biogas systems using livestock waste. Five solar cookers for the residents of Murgab district were produced. All these activities are of a demonstrative and educational nature and are meant to attracting the attention of the population and local governments to new methods of ensuring energy security and problems of climate change.

The Tajik branch of RECCA in cooperation with the Centre on Climate Change and Disaster Risk Reduction has carried out training courses for civil servants and experts.

The adaptation measures implemented by local NGO/NCOs are low-cost and practical. Further capacity strengthening, including the financing of NGO/NCOs and microloan organizations are required to scale up the initiated efforts on climate change.

7.4. Mass media

Media coverage of climate change issues takes place through published news sources as well as through TV and radio. At the local level, the coverage takes place through linking climate change with the shortage/lack of water and energy. The interest of key media players in environmental problems and climate change is linked to its commercial side where donors often pay for publication of articles or preparing a news reports. The interest of journalists in coverage of climate change issues in press and TV has risen over last 2-3 years. A Journalists' Eco-club was formed covering environmental issues. Mass media, including the press, TV and radio representatives are often invited to seminars, conferences and round tables on climate change. Leading experts of Tajikistan often take part in TV and radio programmes.

Following the earlier tradition in formulation of the First and Second Communication (since 2000), regular TV and radio programmes on climate change have been organized whilst developing the TNC. During the hot summer of 2013 when the temperature reached 47^{0}C, Professor Kayumov organized series of TV shows to help prevent negative impacts on health and reduce the effectof the heat wave among vulnerable population groups and economic sub-sectors.

As a result of work with the mass media, a short film on the outcomes of the expedition on the state of

Photo. Celebration of Navruz

glaciers and hydrological regime of Vakhsh and Pyanj rivers was prepared. Jointly with the NGO 'Khoma' training courses on climate change have been carried out for journalists. Based on the outcomes of a competition, two journalists were sent to the UNFCCC Conference in Cancun (Mexico) both to participate and provide media coverage of the event.

Mass media representatives are regularly invited to seminars, conferences, and round tables organized by NGOs, however their efforts are not adequate for the effective dissemination of knowledge and information. Mass media is given an important role in public campaigns on climate change such as 'Earth Hour', 'Earth Day', 'Energy-efficiency Day' and so on. At the same time, NGOs create their own sources of information such as the website of NGOs Network (www.tajcn.tj), Youth Eco-Centre (www.ecocentre.tj), NGO 'Malenkaya Zemlya' (Little Earth, www.little-earth.info.ms), Climate Network of NGOs in Eastern Europe and Central Asia (http://infoclimate.org). The e-digests and 'Green Energy and Us', 'Nature' and other journals are published regularly.

7.5. Capacity development needs

In 2008, with the purpose of enhancing the capacity and raise awareness of civil society, a Climate Network of Tajik NGOs was established, the first of its kind in Central Asian region. Currently the network has united s70 members representing public organization, scientific institutions and experts. One of the key objectives of the network is to ensure greater public participation [which is very limited at present] in decision making process, including in climate related programmes and projects. The main problems preventing participation at the moment are:

- A lack of understanding of the current environmental and climate policy by NGOs;
- A lack of understanding of the benefits and importance of joint efforts in promoting public interests;

- A Lack of effective strategies for public participation and poor strategic planning by NGOs;
- Digital inequality' among NGOs, different levels of access to ICT preventing effective electronic dissemination of information and participation in discussions;

To ensure more active participation in decision making processes, NGOs of the Climate Network should go beyond the provision of current recommendations of raising awareness and conducting seminars. There is a need to develop more active forms of public participation including:

- The organisation of public monitoring and use of local expertise;
- Ensuring financial transparency and effectiveness of climate change financing;

To further enhance the capacity of members of the NGO network as well as other public organizations, there is a need to focus more on improving understanding of national policy and the activities of international finance institutions which invest into climate related programmes. It is also important to develop a strategy on improving public participation, and enhance the coordination of activities. This will contribute to a greater awareness of people on climate change issues, best adaptation practices and management of climate change risks.

Annexes

GHG emissions and absorption tables (2003 - 2010)

Tajikistan: Greenhouse Gas Inventory in 2003, Gg

GHG sources and sink categories	CO_2 emissions	CO_2 absorption	CH_4	N_2O	NOx	CO	NMVOCs	SOx
Total emissions and removals by key gases	2 767	-1 929	122	8	11	189	7	9
1. Energy	**2 140**	**0**	**7**	**0**	**11**	**12**	**2**	**4**
A. Fuel combustion	2 140		0	0	11	12	2	4
1. Electricity	25		0	0	0	0	0	0
2. Industry and construction	655		0	0	2	0	0	1
3. Transport	304		0	0	3	6	1	1
4. Other	1 156		0	0	7	6	1	2
5. CO_2 emissions from biomass burning	0		0	0	0	0	0	0
B. Fugitive emissions from fuel	0		7		0	0	0	0
1. Solid fuels			1		0	0	0	0
2. Oil and natural gas			6		0	0	0	0
2. Industrial processes	**628**	**0**	**0**	**0**	**0**	**171**	**4**	**5**
A. Mineral products	95					0	0	0
B. Chemical industry	39		0	0	0	0	0	0
C. Metal production	494		0	0	0	171	0	5
D. Other types of production	0				0	0	4	0
3. Solvents				**0**			**0**	
4. Agriculture			**93**	**7**	**0**	**5**		
A. Enteric fermentation			77					
B. Manure management			11	0				
C. Rice cultivation			4					
D. Agricultural soils				7				
E. Savanna burning			0	0	0	0		
F. Burning of agricultural residues			0	0	0	5		
5. Land use change and forestry		**-1 929**	**0**	**0**	**0**	**0**		
A. Changes of forest and other woody biomass stock		-496						
B. Conversion of forests and pastures			0	0	0	0		
C. Wastelands								
D. CO_2 emissions and removals in soils		-38						
E. Other		-1 396	0	0	0	0		
6. Waste			**22**	**0**	**0**	**0**	**0**	**0**
A. Solid waste disposal on land			22					
B. Wastewater handling			1	0				

Tajikistan: Greenhouse Gas Inventory in 2004, Gg

GHG sources and sink categories	CO_2 emissions	CO_2 absorption	CH_4	N_2O	NOx	CO	NMVOCs	SOx
Total emissions and removals by key gases	3 297	-2 038	125	8	12	218	9	10
1. Energy	**2 567**	**0**	**3**	**0**	**11**	**21**	**4**	**5**
A. Fuel combustion	2 567		0	0	11	21	4	5
1. Electricity	280		0	0	0	0	0	0
2. Industry and construction	466		0	0	1	0	0	1
3. Transport	511		0	0	5	16	3	1
4. Other	1 310		0	0	5	5	1	3
5. CO_2 emissions from biomass burning	0		0	0	0	0	0	0
B. Fugitive emissions from fuel	0		3		0	0	0	0
1. Solid fuels			0		0	0	0	0
2. Oil and natural gas			3		0	0	0	0
2. Industrial processes	**731**	**0**	**0**	**0**	**1**	**192**	**5**	**5**
A. Mineral products	112					0	0	0
B. Chemical industry	82		0	0	0	0	0	0
C. Metal production	537		0	0	1	192	0	5
D. Other types of production	0				0	0	4	0
3. Solvents				**0**			**0**	
4. Agriculture			**98**	**8**	**0**	**5**		
A. Enteric fermentation			81					
B. Manure management			12	0				
C. Rice cultivation			4					
D. Agricultural soils				8				
E. Savanna burning			0	0	0	0		
F. Burning of agricultural residues			0	0	0	5		
5. Land use change and forestry		**-2 038**	**0**	**0**	**0**	**0**		
A. Changes of forest and other woody biomass stock		-596						
B. Conversion of forests and pastures			0	0	0	0		
C. Wastelands								
D. CO_2 emissions and removals in soils		-50						
E. Other		-1 392	0	0	0	0		
6. Waste			**24**	**0**	**0**	**0**	**0**	**0**
A. Solid waste disposal on land			23					
B. Wastewater handling			1	0				

Tajikistan: Greenhouse Gas Inventory in 2005, Gg

GHG sources and sink categories	CO_2 emissions	CO_2 absorption	CH_4	N_2O	NOx	CO	NMVOCs	SOx
Total emissions and removals by key gases	2 645	-2 063	131	9	10	219	9	10
1. Energy	**1 856**	**0**	**3**	**0**	**9**	**11**	**2**	**4**
A. Fuel combustion	1 856		0	0	9	11	2	4
1. Electricity	59		0	0	0	0	0	0
2. Industry and construction	210		0	0	1	0	0	0
3. Transport	497		0	0	5	7	1	1
4. Other	1 091		0	0	4	4	1	3
5. CO_2 emissions from biomass burning	0		0	0	0	0	0	0
B. Fugitive emissions from fuel	0		3		0	0	0	0
1. Solid fuels			1		0	0	0	0
2. Oil and natural gas			3		0	0	0	0
2. Industrial processes	**789**	**0**	**0**	**0**	**1**	**204**	**7**	**6**
A. Mineral products	139					0	1	0
B. Chemical industry	80		0	0	0	0	0	0
C. Metal production	569		0	0	1	203	0	6
D. Other types of production	0				0	0	6	0
3. Solvents				**0**			**0**	
4. Agriculture			**103**	**9**	**0**	**5**		
A. Enteric fermentation			86					
B. Manure management			13	0				
C. Rice cultivation			4					
D. Agricultural soils				8				
E. Savanna burning			0	0	0	0		
F. Burning of agricultural residues			0	0	0	5		
5. Land use change and forestry		**-2 063**	**0**	**0**	**0**	**0**		
A. Changes of forest and other woody biomass stock		-613						
B. Conversion of forests and pastures			0	0	0	0		
C. Wastelands								
D. CO_2 emissions and removals in soils		-51						
E. Other		-1 400	0	0	0	0		
6. Waste			**24**	**0**	**0**	**0**	**0**	**0**
A. Solid waste disposal on land			23					
B. Wastewater handling			1	0				

Tajikistan: Greenhouse Gas Inventory in 2006, Gg

GHG sources and sink categories	CO_2 emissions	CO_2 absorption	CH_4	N_2O	NOx	CO	NMVOCs	SOx
Total emissions and removals by key gases	3 474	-2 086	134	7	12	237	10	10
1. Energy	**2 663**	**0**	**4**	**0**	**11**	**10**	**2**	**4**
A. Fuel combustion	2 663		0	0	11	10	2	4
1. Electricity	335		0	0	0	0	0	0
2. Industry and construction	630		0	0	2	0	0	1
3. Transport	598		0	0	5	7	1	0
4. Other	1 100		0	0	3	3	1	3
5. CO_2 emissions from biomass burning	0		0	0	0	0	0	0
B. Fugitive emissions from fuel	0		4		0	0	0	0
1. Solid fuels			1		0	0	0	0
2. Oil and natural gas			3		0	0	0	0
2. Industrial processes	**811**	**0**	**0**	**0**	**1**	**222**	**8**	**6**
A. Mineral products	124					0	2	0
B. Chemical industry	66		0	0	0	0	0	0
C. Metal production	621		0	0	1	221	0	6
D. Other types of production	0				0	0	6	0
3. Solvents				**0**			**0**	
4. Agriculture			**106**	**7**	**0**	**5**		
A. Enteric fermentation			88					
B. Manure management			14	0				
C. Rice cultivation			4					
D. Agricultural soils				7				
E. Savanna burning			0	0	0	0		
F. Burning of agricultural residues			0	0	0	5		
5. Land use change and forestry		**-2 086**	**0**	**0**	**0**			
A. Changes of forest and other woody biomass stock		-613				**0**		
B. Conversion of forests and pastures			0	0	0	0		
C. Wastelands								
D. CO_2 emissions and removals in soils		-51						
E. Other		-1 422	0	0	0			
6. Waste			**24**	**0**	**0**	0		
A. Solid waste disposal on land			23			**0**	**0**	**0**
B. Wastewater handling			1	0				

Tajikistan: Greenhouse Gas Inventory in 2007, Gg

GHG sources and sink categories	CO_2 emissions	CO_2 absorption	CH_4	N_2O	NOx	CO	NMVOCs	SOx
Total emissions and removals by key gases	2 540	-2 091	139	7	7	239	12	10
1. Energy	**1 725**	**0**	**2**	**0**	**6**	**9**	**2**	**3**
A. Fuel combustion	1 725		0	0	6	9	2	3
1. Electricity	178		0	0	0	0	0	0
2. Industry and construction	373		0	0	1	0	0	0
3. Transport	385		0	0	3	7	1	0
4. Other	790		0	0	2	2	0	2
5. CO_2 emissions from biomass burning	0		0	0	0	0	0	0
B. Fugitive emissions from fuel	0		2		0	0	0	0
1. Solid fuels			1		0	0	0	0
2. Oil and natural gas			2		0	0	0	0
2. Industrial processes	**814**	**0**	**0**	**0**	**1**	**224**	**10**	**6**
A. Mineral products	138					0	2	0
B. Chemical industry	48		0	0	0	0	0	0
C. Metal production	629		0	0	1	224	0	6
D. Other types of production	0				0	0	8	0
3. Solvents				**0**			**0**	
4. Agriculture			**112**	**7**	**0**	**5**		
A. Enteric fermentation			92					
B. Manure management			15	0				
C. Rice cultivation			4					
D. Agricultural soils				7				
E. Savanna burning			0	0	0	0		
F. Burning of agricultural residues			0	0	0	5		
5. Land use change and forestry		**-2 091**	**0**	**0**	**0**	**0**		
A. Changes of forest and other woody biomass stock		-613						
B. Conversion of forests and pastures			0	0	0	0		
C. Wastelands								
D. CO_2 emissions and removals in soils		-52						
E. Other		-1 425	0	0	0	0		
6. Waste			**25**	**0**	**0**	**0**	**0**	**0**
A. Solid waste disposal on land			24					
B. Wastewater handling			1	0				

Tajikistan: Greenhouse Gas Inventory in 2008, Gg

GHG sources and sink categories	CO_2 emissions	CO_2 absorption	CH_4	N_2O	NOx	CO	NMVOCs	SOx
Total emissions and removals by key gases	2 518	-2 087	156	7	8	230	21	10
1. Energy	**1 782**	**0**	**2**	**0**	**7**	**11**	**2**	**4**
A. Fuel combustion	1 782		0	0	7	11	2	4
1. Electricity	141		0	0	0	0	0	0
2. Industry and construction	471		0	0	1	0	0	1
3. Transport	314		0	0	3	8	2	0
4. Other	857		0	0	3	3	0	3
5. CO_2 emissions from biomass burning	0		0	0	0	0	0	0
B. Fugitive emissions from fuel	0		2		0	0	0	0
1. Solid fuels			1		0	0	0	0
2. Oil and natural gas			2		0	0	0	0
2. Industrial processes	**735**	**0**	**0**	**0**	**1**	**214**	**19**	**6**
A. Mineral products	92					0	10	0
B. Chemical industry	44		0	0	0	0	0	0
C. Metal production	599		0	0	1	214	0	6
D. Other types of production	0				0	0	9	0
3. Solvents				**0**			**0**	
4. Agriculture			**128**	**7**	**0**	**5**		
A. Enteric fermentation			108					
B. Manure management			17	0				
C. Rice cultivation			4					
D. Agricultural soils				6				
E. Savanna burning			0	0	0	0		
F. Burning of agricultural residues			0	0	0	5		
5. Land use change and forestry		**-2 087**	**0**	**0**	**0**	**0**		
A. Changes of forest and other woody biomass stock		-612						
B. Conversion of forests and pastures			0	0	0	0		
C. Wastelands								
D. CO_2 emissions and removals in soils		-53						
E. Other		-1 422	0	0	0	0		
6. Waste			**25**	**0**	**0**	**0**	**0**	**0**
A. Solid waste disposal on land			24					
B. Wastewater handling			1	0				

Tajikistan: Greenhouse Gas Inventory in 2009, Gg

GHG sources and sink categories	CO_2 emissions	CO_2 absorption	CH_4	N_2O	NOx	CO	NMVOCs	SOx
Total emissions and removals by key gases	2 011	-2 090	165	9	7	208	26	8
1. Energy	**1 377**	**0**	**1**	**0**	**6**	**8**	**1**	**3**
A. Fuel combustion	1 377		0	0	6	8	1	3
1. Electricity	180		0	0	0	0	0	0
2. Industry and construction	370		0	0	1	0	0	0
3. Transport	372		0	0	3	6	1	1
4. Other	456		0	0	2	2	0	2
5. CO_2 emissions from biomass burning	0		0	0	0	0	0	0
B. Fugitive emissions from fuel	0		1		0	0	0	0
1. Solid fuels			1		0	0	0	0
2. Oil and natural gas			1		0	0	0	0
2. Industrial processes	**633**	**0**	**0**	**0**	**1**	**193**	**25**	**5**
A. Mineral products	94					0	6	0
B. Chemical industry	0		0	0	0	0	0	0
C. Metal production	539		0	0	1	192	0	5
D. Other types of production	0				0	0	18	0
3. Solvents				**0**			**0**	
4. Agriculture			**138**	**9**	**0**	**7**		
A. Enteric fermentation			114					
B. Manure management			17	0				
C. Rice cultivation			6					
D. Agricultural soils				9				
E. Savanna burning			0	0	0	0		
F. Burning of agricultural residues			0	0	0	7		
5. Land use change and forestry		**-2 090**	**0**	**0**	**0**	**0**		
A. Changes of forest and other woody biomass stock		-614						
B. Conversion of forests and pastures			0	0	0	0		
C. Wastelands								
D. CO_2 emissions and removals in soils		-55						
E. Other		-1 421	0	0	0	0		
6. Waste			**26**	**0**	**0**	**0**	**0**	**0**
A. Solid waste disposal on land			25					
B. Wastewater handling			1	0				

Tajikistan: Greenhouse Gas Inventory in 2010, Gg

GHG sources and sink categories	CO_2 emissions	CO_2 absorption	CH_4	N_2O	NOx	CO	NMVOCs	SOx
Total emissions and removals by key gases	1 907	-2 091	167	9	6	208	25	9
1. Energy	**1 251**	**0**	**1**	**0**	**5**	**8**	**2**	**3**
A. Fuel combustion	1 251		0	0	5	8	2	3
1. Electricity	98		0	0	0	0	0	0
2. Industry and construction	328		0	0	1	0	0	1
3. Transport	406		0	0	3	7	1	1
4. Other	420		0	0	1	1	0	2
5. CO_2 emissions from biomass burning	0		0	0	0	0	0	0
B. Fugitive emissions from fuel	0		1		0	0	0	0
1. Solid fuels			1		0	0	0	0
2. Oil and natural gas			0		0	0	0	0
2. Industrial processes	**656**	**0**	**0**	**0**	**1**	**192**	**24**	**5**
A. Mineral products	132					0	3	0
B. Chemical industry	0		0	0	0	0	0	0
C. Metal production	524		0	0	1	192	0	5
D. Other types of production	0				0	0	21	0
3. Solvents				**0**			**0**	
4. Agriculture			**139**	**9**	**0**	**7**		
A. Enteric fermentation			116					
B. Manure management			17	0				
C. Rice cultivation			6					
D. Agricultural soils				9				
E. Savanna burning			0	0	0	0		
F. Burning of agricultural residues			0	0	0	7		
5. Land use change and forestry		**-2 091**	**0**	**0**	**0**	**0**		
A. Changes of forest and other woody biomass stock		-614						
B. Conversion of forests and pastures			0	0	0	0		
C. Wastelands								
D. CO_2 emissions and removals in soils		-60						
E. Other		-1 418	0	0	0	0		
6. Waste			**26**	**0**	**0**	**0**	**0**	**0**
A. Solid waste disposal on land			25					
B. Wastewater handling			1	0				

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