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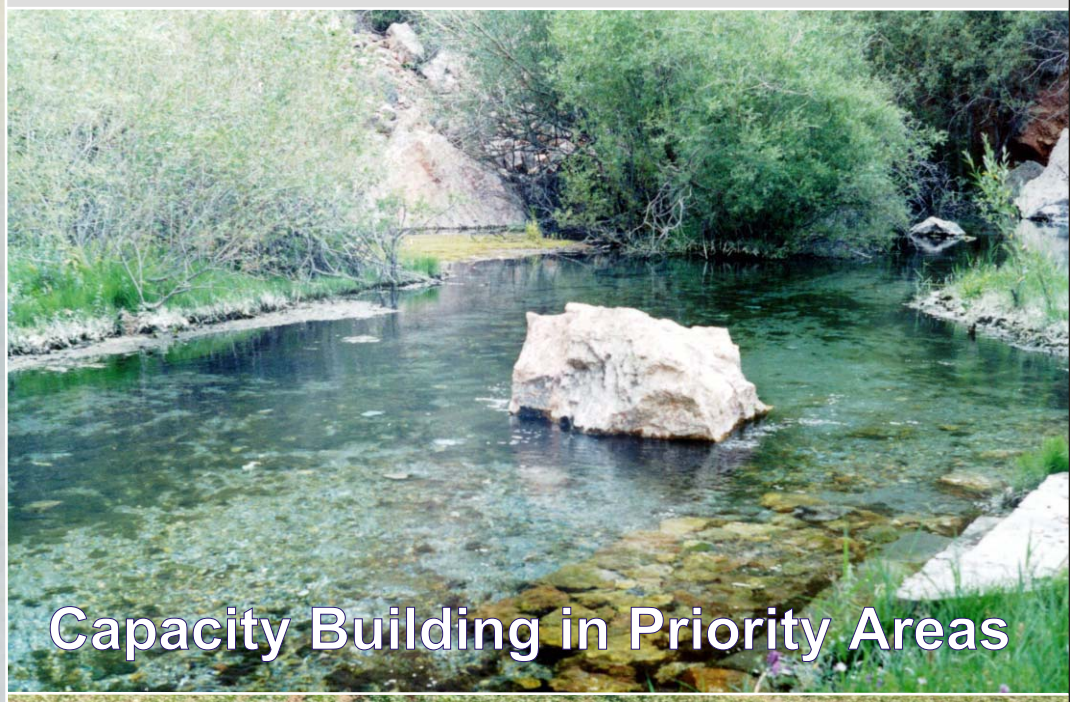
Phase

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



Capacity Building in Priority Areas

Ministry for Nature Protection of the Republic of Tajikistan
The Main Administration on Hydrometeorology and Environmental Monitoring

THE FIRST NATIONAL COMMUNICATION OF THE REPUBLIC OF TAJIKISTAN UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

2

Phase

Capacity Building in Priority Areas

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This document determines the potential for development and the technology needs assessment in the priority areas of Tajikistan's economic sectors on greenhouse gas emission reduction and adaptation. The economic and environmental efficiency, and the legislative and institutional bases are analysed. Barriers and possible ways to overcome these are determined for technology transfer and project realization. Particularly important is to improve the policy and measures aimed at involving international investments to solve the climate change issues in Tajikistan and to mobilize the internal reserves.

The project is implemented by the Main Administration on Hydrometeorology and Environmental Monitoring of the Ministry for Nature Protection of the Republic of Tajikistan, with the financial support from the Global Environment Facility and UNDP.

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Introduction

There are more and more factors pointing to a considerable global climate warming, which may cause serious negative consequences. According to model data, the warming will produce a negative impact on ecological systems, cause glacier retreat and the world ocean level rising, lead to harvest reduction in hot droughty areas, and cause increasingly more droughts. The increase of greenhouse gas (GHG) emissions and concentrations in the air is a casual factor of the global warming. This is to a considerable degree due to human activity, mainly burning fossil fuel, cutting forests, and changing the land management.

The greenhouse gas emissions do not cause a direct damage; thus, they are not considered as critical factors worsening the state of environment. However, their impact on the climatic system has a negative effect on human health, causes a reduction of agricultural productivity, destructive natural disasters, and other negative consequences. In this connection, it would be reasonable to take urgent preventive measures on reducing greenhouse gas emissions and adapting to the climate change for the sake of the present and future generations.

Tajikistan ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1998, meeting the commitments as the non-Annex 1 Convention Party. The initial legislative and institutional base is established in Tajikistan to take actions on climate change issues. The Main Administration of Hydrometeorology and Environmental Monitoring (Ministry for Nature Protection, Republic of Tajikistan) is coordinating measures on climate change issues in Tajikistan.

The First National Communication of the Republic of Tajikistan on climate change was developed in 2001-2002 and submitted to the UN Framework Convention Secretariat and the 8th Session of the Conference of the Parties to UNFCCC (October 22 November 1, 2002, Delhi, India) in October, 2002.

The main purpose of the First National Communication was to provide basic information on climate change issues in Tajikistan to policy-makers and the public. In the process of the communication preparation, the first in the republic investigations were carried out in the following directions:

- Identifying key sources of greenhouse gas emissions and analyzing emission tendencies.
- Climate change scenarios.
- Assessing a vulnerability of natural resources, economy branches, and human health to climate change.
- Developing measures on reducing greenhouse gas emissions and adapting to climate change.

The First National Communication of the republic informed the Framework Convention parties of thevolume and dynamics of greenhouse gas emissions, the vulnerability of natural resources, economy, and human health to climate change, and the measures being realized and planned to mitigate the climate change consequences.

The RT National Action Plan (NAP) on climate change mitigation was approved by the Tajik Government Resolution No.259 of June 6, 2003. The NAP determines priorities and aims of measures taken by the Republic of Tajikistan to solve climate change issues, needs of developing a potential for further research of the climatic system, and the main directions of international cooperation. The NAP measures are the base for planning and decision-making at all state levels. The NAP includes a complex of measures aimed at: i) reducing greenhouse gas emissions and improving the state of their natural absorbents; ii) promoting climate change adaptation; iii) optimizing the systematic observation network; iv) improving the system of education, staff training, and providing access to information; v) compiling a list of sources of greenhouse gas emissions and absorbents.

The present document is developed in the framework of further work on preparing national

reports and provides summarized results of research in the following directions:

- Identification of technology needs for reducing greenhouse gas emissions, improving the state of carbon natural absorbents, increasing energy efficiency, and adapting to negative consequences of climate change.
- Creation and development of a potential for technology transfer, management and realization of projects on climate change mitigation.
- Improvement of systematic meteorological observations and development of projects promoting the development of the national hydrometeorological service.

The second phase focuses on developing the potential, including technology needs assessment and expertise level rise in such areas as: evaluation of the cost of greenhouse gas emission and adaptation; economic and ecological efficiency of projects; evaluation of the legislative and institutional base and determination of barriers in technology transfer and project realization.

An important task of the activity on improving the potential is to assess the needs of improving the policy and measures on involving international investments in solving climate change issues in Tajikistan and to using internal reserves.

The main methods of reducing greenhouse gas emission in Tajikistan are: increasing the efficiency of industrial processes and energy; developing and increasing the use of renewable energy sources; applying effective methods of agricultural activities and forest management in the light of climate change. Of primary importance is integration of all climate change considerations into programs of socio-economic and industrial development.

The priorities of climate change adaptation in Tajikistan are connected with rational management of water resources, conservation of vulnerable ecosystems and biodiversity, transport security, sustainable agriculture and alleviation of drought consequences, and rational nature management. Special attention is paid to public health issues, a reduction of diseases, and adaptation in relation to climate warming. To assess technologies which prevent or minimize the impact of climatic factors and natural disasters on the country economy and the population is also very important.

Thus, capacity building activities make a base for preparing further national reports of the Republic of Tajikistan on climate change and determines priority needs in the development of technological, personnel, and institutional potential, ways of removing barriers in technology transfer and project implementation. The results of the work done are a good base for realizing a project on self-assessment of the national potential for global environment conservation in the climate change thematic area.

The consulting, technical, and financial support in developing the second phase of the First National Communication was provided by the Tajik Government, the Global Environment Facility, the Secretariat of the UN Framework Convention on Climate Change, and the UN Development Program.

The main regulations of the National Communication second phase were discussed at a series of national workshops and expert consultative meetings. All the proposals and remarks were thoroughly analyzed and considered, if possible. The preparation of the National Communication second phase involved over 40 highly skilled experts from the ministries and departments of the Republic of Tajikistan, who had sufficient experience in preparing the First National Communication, in cooperation with scientific institutions and international organizations.

1 Principles and Methods of Technology Needs Assessment

Technology needs assessment (TNA) is a very important stage of work in the process of technology transfer, as determined by the UN Framework Convention on Climate Change (UNFCCC). Decision 4/CP.4, UNFCCC Conference of the Parties, urges non-Annex 1 parties to submit their priority technology needs, particularly those related to technologies of solving the climate change problem. Article 4.5 of the Framework Convention commits Annex 1 parties to take steps on providing support for developing countries in the process of technology transfer. The technology transfer (determined as exchange of experience, knowledge, know-how, and equipment between countries and within a country) is a long-term priority of the UNFCCC. The Global Environment Facility (GEF) provides support for developing countries in determining their technology needs.

Many of scientific-technological and practical methods of reducing greenhouse gas emissions and adaptation are well correlated with the needs of the republic national development. E.g., the adaptation measures, like water resource protection and preservation, agricultural productivity maintenance and improvement, biodiversity conservation, preventive measures on public health protection, and insurance against unfavorable weather conditions are important elements of sustainable development. Many technologies are developed in response to increasing needs of climate change mitigation, particularly in the area of renewable energy sources and energy efficiency.

TNA is aimed at identifying scientific, technological, and practical methods, as well as reforms, which can be implemented in many areas of human activity to reduce greenhouse gas emissions and climate change vulnerability and to solve sustainable development issues. TNA is to promote improved and accelerated application of new technologies. Since Tajikistan is at the initial stage of planning and implementing climate change measures, TNA is a base for preparing and applying priority projects for funding. These are technological, demonstrative, and scientific research projects.

TNA is a tool, by which the identification of technology needs development and selection, and the possibilities in the context of response measures on climate change mitigation, are integrated. Thus, TNA is a purposeful continuation of work carried out within the preparation of the First National Communication on climate change.

To conduct TNA in Tajikistan, three thematic working groups of experts were established, which focused on the following priorities: (i) technology needs in economic sectors, (ii) the potential for improvement; (iii) systematic observations.

The main participants of the TNA process were:

- Independent experts (RT Academy of Science, RT Ministry for Nature Protection, research institutions, high schools).
- Experts from ministries and departments (RT Ministry of Economy and Trade, RT Ministry of Finance, RT Ministry of Transport, RT Ministry of Energy, RT Ministry of Industry, RT Ministry of Agriculture, RT Ministry of Water Management, RT Ministry of Public Health, RT Forestry Committee, RT State Committee on Land Resources, RT State Statistical Committee).
- Interested representatives of industrial sector, business circles, and NGOs.

The informational sources and methodological base for TNA were:

- IPCC thematic publications (Summary and Paper of IPCC Working Group III, methodological and technological issues of technology transfer, etc.).
- International methodologies and publications (GEF-UNDP methodology on technology needs

assessment, experience of countries within the region).

- Data of local research on climate change issues (climate change mitigation, adaptation, and systematic observation).
- Formal informational sources, statistic reports.
- National development plans, industrial strategies, programs, legislation.

National development plans, industrial strategies, programs, legislation:

- Coordination of assessment criteria to analyze technologies and to develop projects for funding.
- Coordination of the preparation process and the role of participants in technology needs assessment and technology transfer (TNA and TT).
- Coordination of the analytical report.

The key factors determining priorities in TNA and project expediency for funding are:

- Development benefits.
- Market potential.
- Contribution to the climate change issues (GHG emission reduction, adaptation).
- TNA activity includes the following steps:
- Identifying priority sectors and problem analysis.
- Identifying the major technology options for each sector.
- Identifying the main barriers and ways to overcome these.

While identifying priority technologies for greenhouse gas emission reduction, the experts considered the importance of new technologies in solving the problems of environmental conservation and sustainable development, and promoting:

- Human health improvement and property security.
- Increase of employment and living standard of the poor.
- Improvement of the potential (personnel, organizational structure, legislative base, project proposal database, research results, partnership).
- Local resource management and new technology application.
- Enhancement of economic efficiency and production base development.

The needs assessment for participation in systematic observation networks includes:

- Overview of hydrometeorological observation network.
- Analysis of possibilities in enhancing the potential.

Three National thematic workshops on TNA were held in 2003, where TNA objectives and methods, as well as the results of TNA experts' work on priority sectors were discussed, and projects were selected and coordinated for funding. The work on TNA resulted in the present publication, containing the relevant information available and summaries of projects to be funded. The project concepts are submitted to potential donors and investors.

2 Key Sectors Identification for Technology Needs Assessment

The selection of key sectors of economy, which need a priority improvement and updating of climate change technologies, is based on the conclusions of the First National Communication on Climate Change, and the RT National Action Plan on climate change mitigation. Evaluation of the main categories of greenhouse gas emission sources is also an important tool in identifying key sectors for technology transfer.

According to the "IPCC Guidelines on uncertainties management" (2001), sectors, in which greenhouse gas emissions are at least 95% of the total emissions in the country, are considered key sectors. It is very difficult to accurately identify key sectors in Tajikistan, because the past decade was marked by a considerable reduction of greenhouse gas emissions and change of a source's contribution to the total emissions.

Most greenhouse gas emissions, resulted from fossil fuel burning, are produced by industrial, residential, and transport sectors. The power industry has minimum CO_2 emissions, since 95% of the electric power system of the republic is based on hydroelectric power stations. However, it should be noted that the specific consumption of fossil fuel is now almost twice as much due to the obsolete and outdated equipment at the thermoelectric power plants (TPP). The major industrial source of harmful substance and greenhouse gas emissions is the Tajik Aluminum Plant, which is responsible for 10% of CO_2 emissions and nearly 100% of perfluorocarbon (PFC) emissions. The contribution of other industrial sources decreased considerably in the last decade due to the production decline. In agriculture, most emissions come from soils and intestinal fermentation. In forestry, the potential air carbon absorption by trees reduced almost by one third due to the considerable cutting of trees.

Thus, the priority sectors of economy, in which most greenhouse gas emissions are indicated, and which consequently need primary actions on emission reduction and increased carbon absorption, are:

- Production and consumption of electric and thermal energy.
- Transport sector.
- Industrial production.
- Agriculture.
- Forestry and Land Management.

Non-traditional renewable energy sources, including solar, wind, biomass, and small river energy, provide great possibilities for emission reduction. Another area, where a considerable reduction of emissions is possible, is an increase of energy efficiency in residential and industrial sectors. The potential of using advanced technologies in power resource saving and emission reduction exists in aluminum, chemical, and construction industries.

The participants of the National Workshop on Climate Change (April 4, 2003) discussed possible areas of activities and outlined priorities in increasing the potential. At the next National Workshop on Climate Change (June 7, 2003), the participants discussed priority proposals on technology transfer and potential increase, including possible funding by GEF and the Clean Development Mechanism (CDM) of the Kyoto Protocol. The TNA document was discussed, with supplements and more precise definitions being made. The participants of the workshop discussed important criteria for project assessment and selection. These are:

- Potential of greenhouse gas emission reduction (or absorption increase) and power efficiency increase.
- Environment benefits.
- Development benefits.
- Economy efficiency.

- Technology importance and validity.
- Market potential, possibilities of technology development and application.
- Socio-economic importance and applicability of technology.

Plans and programs of the socio-economic development consider an increase of production output, mainly in metallurgical, chemical, construction, and light industries, a development of the transport sector, an increase of power output, mining and fossil fuel consumption, and intensification of agriculture.

Projects, which promote a rise of a living standard, particularly of poor people, and an introduction of new environmentally safe technologies, are of highest priority. To reduce greenhouse gas emissions and to enhance energy efficiency, the following projects were considered as high priorities: a) energy efficiency and economy; b) renewable energy sources; c) industrial emission reduction; d) forest planting. A middle priority was identified for projects in the area of: a) transport (using environmentally safer fuels and alternative transport, regulating exhaust gas emissions); b) agriculture (using biomass, improved methods of rice growing, and applying mineral fertilizers); c) land management (preventing humus loss, reducing deforestation, managing forests and lands). A low priority was determined for projects on reducing greenhouse gas emissions in the waste sector, due to their low potential of emission reduction and high implementation costs.

Despite the inconsiderable amount of greenhouse gas emissions (0.5-0.8 tonnes per person a year), the republic needs new technologies to provide sustainable development and long-term results of emission reduction. According to the developed scenarios, greenhouse gas emissions in the national economy sectors, like power, industry, agriculture, will reach, and in some categories exceed, the 1990 level by 2015, if no measures are taken. The highest potential of greenhouse gas emission reduction (from 3 to 15 million tonnes of CO_2) is possible in power production and consumption. Moreover, the increasing of hydropower potential is of greatest regional importance and makes it possible to export over 8-10 billion kWh of environmentally safe electric power to Central Asian countries annually. A 10-20% reduction of emissions is possible in the industrial and agricultural sectors, in particular branches 30-40%.

The previous and present studies show, that adaptation to climate change in Tajikistan is as important in solving the climate change problem as GHG emission reduction. There is a great diversity of natural and climatic zones in the republic: from subtropical to Arctic; the climate change consequences are different inside and between the zones.

The priority sectors, in which adaptation technologies are to be introduced are: (i) water management, (ii) agriculture, (iii) transport, (iv) health protection, (v) decreasing the risk of natural disasters and improving systematic hydrometeorological observations.

- The main tools of involving technologies in priority sectors are:
- Reforming and improving the legislative and institutional base, training personnel, increasing the expertise level in technology transfer.
- Removing the barriers in technology transfer.
- Realizing demonstration projects and full-scale projects.
- Developing research and providing access to recent technological information.
- Raising the awareness of policy makers, specialists, and the public on the climate change problem, including technology assessment and transfer.

3 Technology Needs Overview as per Sectors

3.1. ENERGY PRODUCTION AND CONSUMPTION

3.1.1. Legislative and Institutional Base

One of the factors of sustainable socio-economic development in the republic is an effective management of energy resources. According to the legislation, the energy management should consider the requirements of environmental protection, thus being aimed at solving the climate change problem.

The work on energy management in the Republic of Tajikistan is based on laws and regulations, departmental rules, international agreements, and other sectoral documents.

The main laws regulating the energy management are: RT Law on Energy Industry (2000), RT Law of Energy Saving (2002), RT Law of Nature Protection (1994), RT Law of Natural Resources (1996), RT Water Code (2000). The RT Law of Hydraulic Engineering Design Security is under discussion.

The RT Law of Energy identifies the authorities of the government, the Ministry of Energy, and local authorities in regulating energy problems. According to the law, work on energy management should be licensed. Additional benefits for taxation, etc. can be provided for foreign investments into the country energy by the Tajik legislation. Prices for energy resources are set free. Energy resources and infrastructure may be transferred into concession.

The laws concerning energy in Tajikistan are mostly associated with water management, since the energy industry is based on hydropower, which has a complex energy and irrigation function.

The Resolution of the RT Government approved the General Regulations on Electric and Thermal Power Consumption Standardization in Economy (1997). To improve energy supply for the population, the Resolution on Small Energy Sector Development is approved (1997).

The main goals of the state energy policy are:

- Safe and high-quality supply of energy resources and products to meet the increasing requirements of the republic; providing energy security of the country.
- Providing environmental conservation, as well as protection of the population from harmful effects of energy management.
- Creating conditions to provide a gradual transition to market relations within energy management, to involve in-country and foreign investments, to give economic independence to energy enterprises, and to provide their development based on market competition.
- Enhancing the efficiency of fuel and energy complex, basing on update technologies, energy saving, reduction of specific energy resource consumption by national gross domestic product.

The government approved the Concept of the Fuel and Energy Complex Development in the Republic of Tajikistan for 2003-2015. The concept discusses the situation in the energy sector, characterizes the factors preventing its development, and determines directions for further work on energy management. However, according to expert assessments, the Concept does not fully cover the objectives of reforms and policy improvement in the area of energy management and the environmental problems.

The priorities of the state policy in the energy sector are:

- Providing sustainable functioning and development of the fuel and energy complex, and secure energy supply for home

- Maintaining a proper level of technology and environmental security for the fuel and energy complex.
- Enhancing the efficiency of fuel and energy resource management and creating conditions for pursuing an energy-saving policy in the economy, aimed at reducing the public needs of energy and the fuel resource production and consumption.
- Improving the financial and taxation policy
- Developing an investment potential to reconstruct existing and to build new units.
- Reducing the negative impact of the fuel and energy complex on the environment.
- Developing a mechanism for solving the problem of mutual non-payments in the energy sector.
- Developing an update legislative base.

The inter-governmental agreements, characterizing cooperation between the Central Asian countries in the energy sector, are:

- The agreement between the republics of Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan on water and energy management in the Syrdarya River Basin.
- The agreement between the republics of Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan on the parallel work of energy systems.
- The agreement on using the water and energy resources of the Amudarya River (at the stage of preparation).
- The agreement on establishing the water and energy consortium (at the stage of preparation and approval).

At the regional level, the Strategy of cooperation on sustainable and effective management of Central Asia water and energy resources is being realized.

Traditionally, the energy sector had a state monopoly structure. This structure resulted in serious disproportion concerning investments, electric power station operation, and price formation. The traditional organizational structure of the energy sector became low effective due to the transition to the market economy.

Effective market reforms in the sector will considerably increase the quality of production and services provided by energy enterprises and improve the attitude of consumers to energy resources. The primary objectives of the reforming include improvement of the tariff policy and modernization of the production base.

The RT energy sector is managed by the ministries of:

- Energy;
- Land-Reclamation and Water Management;
- Nature Protection;
- Economy and Trade.

The RT Ministry of Energy was established in 2000. Within the framework of the reforms realized, the State Energy Company is transformed into a public corporation named “Barki Tojik”, which is responsible for electric and thermal power production and distribution to consumers within the country. The companies mining fossil fuel (coal, oil, and gas) are subordinate to the Ministry of Energy. The Tajikgas State Unitary Works is responsible for supplying consumers with natural gas, including import deliveries.

The RT Ministry of Energy, in cooperation with the Ministry of Land-Reclamation and Water Management, regulates the reservoir management.

At the regional level, the main institutional structures of energy management are:

- Central Asia Electric Power Council.
- “Energiya” Joint Control Center.
- International Fund for Saving the Aral Sea (IFAS).
- Interstate Water Coordination Commission.
- “Syrdarya” and “Amudarya” river basin water unions.

A well-functioning energy management, providing high-quality services at appropriate costs, is an important factor of economic development. However, the energy sector improvement is retarded by insufficient budgetary and management possibilities. The most serious barrier is insufficient reimbursement of production costs due to the low price, great losses, low level of payments for the electric power consumed, and cross subsidies provided for household consumers at the expense of industries. This deprives the energy sector of means for modernization and restoration.

The energy institutional base of the republic is just being formed. In view of the actions on climate change mitigation, it is important to integrate the issues of environmental protection, and energy production and consumption. A development of the legislative and institutional potential for the energy sector aimed at realizing technology transfer projects is of special importance. It seems advisable to transform the energy enterprises into joint stock companies and private enterprises, to organize non-state energy companies, and to involve international investments through the Clean Development Mechanism of the Kyoto Protocol, as well.

The "Gydroenergoproyekt" State Planning Institute is developing the planning documents for constructing new HPPs, restoring and updating the operating HPPs. The production and scientific activities of the Institute have been conducted for 15 years: projects for small HPP construction have been realized; the hydropower resources have been evaluated; and schemes of using small rivers have been developed.

A research of the non-traditional renewable energy sources is carried out at the Physical-Technical Institute, RT Academy of Science. However, large-scale works cannot be done, because of insufficient funding. The access to new technologies is still quite limited. The Institute carried out experiments on producing photocells basing on gallium arsenide and indium phosphide compounds; gained skills in developing and constructing solar water-heating installations; developed and constructed solar stoves; constructed hydroelectric power mini-plants and portable micro-HPPs, and installed these in mountain villages; developed bio-gas appliances and introduced these in a number of regions of the republic.

Many industrial works have sufficient capacities to produce small renewable energy devices: "ELTO" Plant, Tajikspetsavtomatika Industrial Association (possible production of solar collectors and photocells); Tajik Aluminum Plant (possible production of solar collectors, mini-HPPs, and small wind-energy installations); machine-building and former defense plants (possible production of solar collectors, mini-HPPs, and bio-gas installations). Currently, «Vostokredmet» Industrial Association at the Chkalovsk machinery-building plant develops a production of small HPP equipment.

3.1.2.Energy Resources: Reserves and Management

The situation analysis showed, that the main prospective type of energy resources in Tajikistan is hydropower. The economic use of oil and gas is limited in all but the transport and domestic sectors, mainly because their explored reserves are not great, and the import capacities are insufficient. Coal is used inconsiderably, due to its high costs and delivery difficulties. For the period from 1990 to 2000, the fossil fuel consumption in the country became 8-10 times lower.

Hydropower is the basic energy resource of Tajikistan; its annual reserves are equal to 150 million tonnes of equivalent fuel, which more than 10 times exceeds the country needs of energy resources. Other renewable energy sources, like solar, wind, and biomass energy, could provide nearly 10% of all energy needs of the republic.

Of all fossil fuel reserves available in the republic, coal is considered the most prospective type, its reserves being great. Tajikistan has 35 coal deposits, with 3-4 billion tonnes of potential reserves, including over 670 million tonnes of the explored economically important reserves. However, due to the difficult economic situation and lack of a proper infrastructure, the coal mining is inconsiderable (20-25 thousand tonnes a year). In the last decade, 600-800 thousand tonnes of coal were mined annually, mainly at the Shurab deposit.

The environmental issues in coal mining are still serious, the coal mining impact on the environment being negative. Restoration work at abandoned mines, concerning environmental issues (land re-cultivation) is insufficient, e.g. coal mines at Shurab, where the landscape degradation is observed.

The potential oil reserves are 5.4 million tonnes, natural gas 9.2 billion cubic meters. To develop these, technological complex drilling (over 3-5 km deep) is needed, which requires great expenses for development and exploitation. The republic needs of these fuel types are satisfied mainly by importing from neighboring countries. Another important problem is the state of gas-pipelines, most of which have natural gas leakages, due to the technologically obsolete and outdated equipment.

The present state and the development level of the fuel and energy complex does not satisfy the energy needs of the country. In medium-term prospect, tension in the fuel and energy complex may grow, due to the increase of industrial output and energy consumption by the industrial and consumer sectors on the one hand, and insufficient development of the energy base on the other. To solve the problem, new energy saving technologies should be applied, and the use of secondary energy resources and renewable energy sources should be increased.

The fossil fuels belong to non-renewable energy sources, and their resources are becoming exhausted with time. According to expert assessments, the explored coal reserves of the republic may be exhausted in 100-200 years, those of oil and gas in 20-50 years. That is why, hydropower is the primary and prospective energy source, the annual potential reserves of which are estimated at 527 billion kWh, including the economically efficient hydropower potential 317 billion kWh. No more than 5% of the potential is used currently. The hydropower resources are renewable, do not produce greenhouse gas emissions, except for emissions from flooded lands, and are economically attractive.

Hydropower resources of the republic are accumulated mainly at the Vakhsh and Pyanj rivers and their major tributaries (tab3.1).The specific volume of potential hydropower resources is 3 682 kWh per 1 square km.

10 large HPPs, and 20 medium-sized and small HPPs, which produce 15 billion kWh of electric power annually on the average, are operating in the republic (photo 3.1-3.2). The estimated output of hydroelectric power stations is 4.4 GW.

The energy sector of Tajikistan is to be rehabilitated in future. According to the scenarios, the total volume of electric power will be 29 billion kWh by 2015, which is twice as much as the level of 2000; the

Table 3.1

Potential Hydropower Reserves of Tajikistan

River Basins	Annual average capacity, MW	Annual average energy, TW.h.	Share in total volume, %
Pyanj	14030	122.90	23.20
Gunt	2260	19.80	3.73
Bartang	2969	26.01	4.93
Vanj	1191	10.34	1.96
Yazgulem	845	7.40	1.39
Kysylsu	1087	9.52	1.78
Vakhsh	28670	251.15	48.00
Kafirnigan	4249	37.22	7.00
Karakul-Lake	103	0.90	0.17
Surkhan-Darya	628	5.50	1.03
Zeravshan	3875	33.94	6.38
Syrdarya	260	2.28	0.43
Total	**60167**	**527.06**	**100.00**

Source: Ministry of Energy RT

3.1. Kairakkum Hydropower Plant

3.2. Varzob Hydropower Plant

export volume will be 8-10 billion kWh. It is planned to complete a construction of the Sangtudinskaya HPP (2700 MW) By 2007, to create a greater part of infrastructure, and to put the first line of the Rogun HPP (800 MW) into operation by 2015. This will considerably improve the energy supply.

The strategy of the socio-economic development in Tajikistan considers an increase of coal mining up to 600-800 thousand tonnes by 2015, due to the production restoration and development in the Fan-Yagnob Coal Basin, Ziddy, Nazar-Ailok, Miyonadu, and Shurab deposits. This strategy may not go with the purposes of environmental protection, but it is based on the consideration, that if more coal is used for internal social and economic needs, it will provide the base for the economic development and the solution of the energy supply problem in rural regions. Moreover, using coal is more preferable, than intensive cutting down and using wood fuel.

Oil mining is planned to reach 100-300 thousand tonnes, gas mining 300-500 million cubic meters, by 2015. An increase of oil and gas mining can be provided by restoring the available and developing new oilfields in the south and north of the republic, and implementing geological prospecting work at potential deposits. The development of the oil and gas sector will decrease the dependence of the country on energy import.

3.1.3. Electric Power Production and Consumption

The sustainable work of the Tajik energy system after the USSR collapse is explained mostly by widely used hydropower resources. The energy sector of Tajikistan has a complex power and irrigation function; it is based on hydropower by 95%. In countries, where the energy sector is based on fossil fuels, e.g. Moldova, Kazakhstan, Armenia, the electric power production decreased by 25-50%. In Tajikistan, electric power production decreased to nearly 10%. It is partly due to lack of its own fuel for thermoelectric power plants and insufficient means for its purchasing at foreign markets. Another reason for the decrease of electric power production in Tajikistan is a number of dry years (2000-2001) and the increase of idling water discharge at the major system-forming plant Nurek HPP, resulting in the power production losses (1-2 billion kWh a year) in 1992-2000.

The material and technological base of thermal power management was formed mostly 30-40 years ago, its efficiency being low (photo 3.3). The specific fuel expenditure for electric power production increased from 226 g/kWh in 1990 to 327 g/kWh in 2000. The total power output at thermoelectric power plants decreased in the recent decade to become 0.15-0.22 billion kWh per year.

The industrial sector is the major electric power consumer. With the total power consumption in 2002

3.3. Dushanbe Heat Power Plant

being 16 billion kWh per year, the industry consumes 6.2 billion kWh, i.e. 39%. Second to the industrial sector is the domestic sector. Due to the deficiency in centralized thermal power and natural gas supply of settlements, and the inadequate supply of villagers with energy carriers, the population has to use electric heaters to warm their houses, cook food, and have access to hot water. The demographic growth and the socio-economic development of the regions were other factors promoting an increase of electric power needs in the domestic sector. This resulted in the increase of electric power consumption by the population up to 4.8 billion kWh by 2002, which is 5 times as much, compared to the 1988 level. In this connection, of great importance for energy supply is introducing and applying little power-consuming domestic heaters, which will promote the solution of electric power deficiency problem, particularly in winter. Agriculture, mostly mechanized irrigation, is another major electric power consumer.

3.1.4. Thermal Power Production and Consumption

The heat supply of production consumers and the population of Tajikistan by centralized sources was considerably reduced due to lack of fuel and insufficient thermoelectric power plant capacities. In Dushanbe, the area supplied with thermal power in the cold period of the year was reduced by 2000 to become 10 times smaller, compared to 1990 (fig.3.1). The main thermal power needs are currently satisfied by individual heat sources. The industrial heat power consumers are: chemical plants, cotton fabric factories, food industry, etc.

The heating system delivering heat to consumers is obsolete; the outdated technologies using mineral cotton for pipe isolation result in heat losses by over 5-10% (photo 3.4). Some pipes have no insulation layer at all.

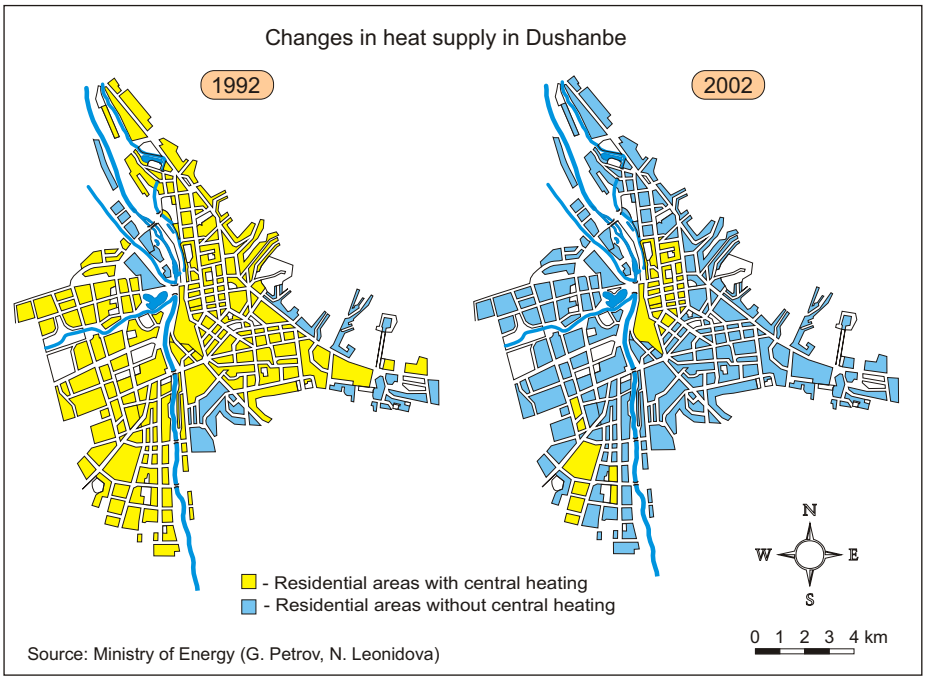


Fig. 3.1.

3.4. Heat distribution network in Dushanbe

The main problems of supplying the housing and communal sector with heat are:

- Outdated technology of heat system insulation.
- Intensive inner and outer corrosion of pipelines, partly destroyed pipeline network.
- Lack of thermal power counters.
- Heat losses in buildings due to the imperfect constructions and building materials.
- Low tariffs and non-payments for the power consumed.

The currently operating thermoelectric power plants use gas and black oil fuel, which, while burning, emits less greenhouse gases, than coal. However, the energy industry has a serious crisis because of the deficiency of the above energy resources, which are imported from the neighboring countries, and the outdated industrial funds. Boiler-houses use coal and black oil as fuel. In the coal-based heat power industry, heat production is associated with the highest CO_2 emissions, compared to other energy sources.

The available coal reserves will make it possible to introduce technologies for using coal fuel with low indications of environment pollution. Water-coal fuel is a thin-dispersed water-and-coal-based mixture; it is intended to use instead of traditional fuel at thermoelectric power plants, in steam and water boilers, and heat generators of water supply systems, without boilers and heaters reconstruction. The water-coal fuel is advisable to use for industrial and municipal boiler-houses. The Tajik energy system can use the water-coal fuel fuel at two major heating plants: Dushanbe HP and Yavan HP. The water-coal fuel production and use technology was tested at the Isfara "Khimzavod" Public Corporation showing economic efficiency.

Heat production, based on thermoelectric power, has good prospects in the republic. One of the examples of efficient technologies are electric heaters, based on carbide and graphite elements, using the municipal network voltage and the temperature of 250°C. To produce the carbide and graphite elements, the local raw material the waste of metallurgical and chemical production of the republic is used. Devices based on these elements are available for wide sections of the population. The scientists of the republic created models of these heating elements. In individual hot water production, energy efficient water heaters, with a thermostat and highly efficient heat-keeping surface, are becoming widely applied. These devices are mainly imported from far foreign countries. A production of these at local plants would be advisable.

3.1.5. Energy Efficiency and Energy Saving

Traditionally, the power-consuming level in Tajikistan was considerably higher, than in industrially developed countries, because power was abundant, while prices were low, which did not stimulate planning and constructing industrial works and houses basing on new energy-efficient technologies. Moreover, the economic decline resulted in a ten-year lack of material and technological services and industrial reconstruction, which led to a considerable increase of the production energy-consuming level.

In the 1990-s, an almost tenfold decrease of electric power consumption was observed, resulting from a number of consequences.

The obsolete technological equipment is one of the main reasons for this situation. E.g., the specific power expenditure for smelting one tonne of aluminum at the Tajik Aluminum Plant reached 22 thousand kWh, which is almost twice as much as the standard observed in industrially developed

countries. Other industrial works have similar showings.

The high power-consuming level of Tajikistan economy is also associated with the sharp increase of power losses resulting from overload, high accident risk, lack of appropriate repair, and poor exploitation of networks from high-voltage to distributive ones. The technological losses in the power system exceed 15%. The low efficiency of energy consumption results from using energy-consuming heating, ventilating, and lighting systems, and poor thermal insulation of buildings.

In addition to the difficult situation in the socio-economic sector, there are serious problems, decreasing the possibilities of effective energy use, within the energy sector itself. The power consumption accounting system of the republic is rather ineffective. Many counters are out of order or removed.

The lack of proper accounting and control of power management, and the lack of production fund modernization, limit the possibilities to increase energy efficiency. The insufficient use of energy saving technologies in the industrial and housing sectors promotes an increase of energy consumption.

According to the assessment of the UN SPECA program experts, the decrease of power use efficiency in Tajikistan in the 1990s is 44% (from 1.9 kWh/US$ in 1992 to 2.8 kWh/US$ in 1999). However, taking into consideration the complex factors and unaccounted losses, the energy efficiency decrease is still more pronounced both in the industrial and non-industrial sectors.

In the mid-term prospect, it is extremely important to improve the energy efficiency, take measures on energy saving and wide use of small energy sources in order to reduce the existing power deficiency and to improve power supply.

One of the reasons for the low efficiency of energy consumption is lower tariff for the residential sector, compared to the industrial and commercial sectors. This situation is due to the high poverty level (<80%) in Tajikistan. In the developed countries, the power costs in the residential sector are much higher, than in industry and other economic branches.

Non-payments for power are an important problem; the low income of poor families in rural areas makes this problem almost insolvable. Using renewable energy sources instead of wood, coal, or black oil, and providing a stable delivery of environmentally safer energy resources could solve a number of social and environmental problems of rural areas.

The current power consumption structure is economically ineffective. For the recent 10-15 years, a twofold decrease of power consumption in industry, with more than fivefold increase of power consumption by the residential sector, is observed. This results (considering the current tariffs) in serious financial losses in the power system. The average tariff is within the power cost price, which is 0.4 cents/kWh for the Tajikistan power system, the tariffs for the residential and agricultural sectors being actually subsidized by the industrial sector.

The financial improvement of the energy system is the main mover of reforms in the sector. This includes: improving the legislative base, primarily the taxation code; improving the payment discipline; developing and realizing measures on power consumption improvement, providing a reduction of power use by ineffective productions and in the residential sector. Reforming the tariff system and increasing the average tariff for power up to 2.5 cent/kWh will allow the energy sector to reach the standard profitability level, with the total annual profit at least 200 million US$. Some financial resources should be used to advance the sector and to increase efficiency. It seems quite probable, that reducing fossil fuel mining in the Central Asian region and increasing its prices in the mid-term prospect may attract the interest of the neighboring republics to realizing joint projects on hydropower development.

The economic efficiency of the Tajik energy sector depends on a power tariff and the share of hydropower. With the power tariff being 2.5 cents/kWh by 2015 and the investments needed for effective development being available, the maximum share of the coal fuel in the Tajik energy sector will not exceed 30%.

It should be considered, that the participants' views of energy saving are somewhat different. The

energy companies are interested in increasing power production and sale, and profits, the energy saving being not their priority. The state monopoly considerably hampers the small initiative development. The industrial cost price decrease and profitability increase could be reached by reducing specific power expenditure per production unit. This is an important stimulus for improving energy saving and energy use efficiency. The population will be interested in saving power and reducing power consumption, if there is an adequate legislation and tariff policy. Otherwise, there will be a problem of non-payments and unaccounted energy consumption. Applying new energy saving technologies both in the industrial and residential sectors is the main mechanism of this problem solution.

It is less expensive to save energy, than to develop new energy sources. With the expenses for measures on energy saving and energy efficiency being equal to those for developing new energy sources, energy saving is the best strategy, because it does not lead to a negative impact on the environment. Moreover, a reduction of greenhouse gas emissions, reached due to the measures on energy saving, will be associated with a reduction of toxic substance and harmful gases emitted by energy sources and industrial works, which is of additional interest. Introducing energy saving methods and energy efficient technologies can cause reduction of emissions in industries (building, metallurgy, chemical industry) - up to 20-30%, in the residential sector - over 30%, as well as in the transport and agricultural sectors.

The investments in new energy saving technologies will be considerably increased, if the government stops subsidizing the energy sector and allow power price increasing up to the cost price level. A significant factor preventing this is the population poverty.

The standard regulating mechanism (cutting off defaulters and non-effective consumers) cannot be applied in the energy sector of Tajikistan, because the republic energy system is based on hydropower. The HPPs can only provide a seasonal regulation of the river discharge, not a long-term water accumulation. E.g., if the Nurek HPP stops its operation and water escape, the Nurek Reservoir will be filled to the available capacity in one month and a half, with the annual average water discharge of the Vakhsh River. In this case, to conserve this energy resource is not advisable. In countries, where the energy sector is based on thermal power plants using fossil fuel, energy conservation is economically reasonable, allowing using it for other purposes, while saving hydropower and reducing electricity generation at HPPs will not give positive results.

To successfully realize the RT Law on Energy Saving, a development of legislative documents, standards, and instructions is needed. It is very important to do scientific research concerning energy production and consumption, and new technologies development and application. Promoting new methods and technologies in energy saving, and organizing thematic exhibitions and workshops are also of great significance. Realizing demonstration projects on energy saving and energy efficiency will make it possible to determine economic efficiency and technology market, and to provide a good model for further wide application of technologies.

The key regulating mechanism of the energy sector is the tariff policy. The energy prices are set free in the republic; however, considering the state monopoly of the energy sector, the price policy is largely regulated by state companies, which are not always guided by economic efficiency, due to the great importance of social, territorial, and other aspects.

The problem of energy efficiency and energy saving has become quite acute in the republic in the recent decade. It is urgent to improve energy efficiency in all areas of energy production and consumption: industrial production, agriculture, and residential sector. To solve the problem, the reforming policy should be pursued, and the following major technologies need to be applied:

- Replacement of energy-consuming domestic devices with updated ones (lighting, heating, and conditioning appliances), and application of technologies in the local production of new electric equipment.

- Using advanced technology equipment in the industrial sector (aluminum, cement, ammonia, and textile production).
- Introduction of progressive thermo-insulation of households, commercial buildings, and heating network.
- Modernization of gas pipelines and reduction of non-production losses of natural gas.
- Installation of gas and heat consumption monitoring systems.

3.1.6. Problems of Energy Supply in Residential Sector

Despite the considerable amount of hydroelectric power produced in the republic per capita (2.5 thousand kWh per year), this energy is mostly consumed by the industrial enterprises, urban (photo 3.5) and rural settlements (photo3.6) with developed infrastructures. Its use is low-efficient, resulting in a considerable electric power deficiency, particularly in winter. Small and remote settlements, mostly in the mountainous areas, have no access to electric power and efficient technologies of the available energy utilization. The local use of small renewable energy sources could solve the problem of supplying remote settlements with energy and improve the social conditions of the population. However, the current level of their application and distribution is quite low.

3.5. Urban housing estate in Dushanbe

3.6. Suburban housing estate

The lowest level of normal energy supply per person is 1 kW. The energy supply level, based on using electricity, is currently 0.2-0.4 kWh/person. The energy supply, based on using fossil fuels and biomass, is 0.3-0.5 kWh/person. Thus, a deficiency of the minimum energy supply level is observed.

The rural population widely uses biofuels (firewood, kizyak (pressed manure), brushwood, cotton residues, and other biomass) to meet their energy demands. However, the contribution of these energy sources to greenhouse gas emissions in the republic cannot be appropriately evaluated, with any data being available. It should also be considered, that the contribution of burning biofuel to the global warming is inconsiderable, because it just accelerates the natural carbon circulation in nature, while burning of fossil fuels promotes increasing carbon accumulation in the air. According to the international methodology, emissions resulted from burning biofuels are not included in the total emissions by the inventory of greenhouse gas emissions.

The way of utilizing energy sources and, consequently, greenhouse gas emissions, are different in different regions of the republic. Some regions possess sufficient reserves either of coal surface deposits, used by the local population, or biological fuel, mainly cattle (kizyak) and plant residues. Others have a deficiency both of electric power and local fuels. There are limits of using biofuels, which prevent a negative impact on the environment. Nonetheless, when energy needs exceed the limits, it may lead to using green plants to

produce energy. It is likely, that in 1994-2002, over 0.2-0.5 million tonnes of woody biomass, part of which came from forest cutting, were used annually.

Cutting forests and shrubs to use these as fuel, leads to decreasing forest areas and volumes, mountain slope deforestation, increasing mudflow and soil erosion risks. This leads to a development of the desertification process and decreases the soil and biomass ability to absorb carbon dioxide from the air. Also, this is a stress factor for biological diversity.

There are many sad examples of cutting valuable forest areas. E.g., almost all saxaul natural brushwood and plantations, as well as forest shelterbelts, are cut down in the Shaartuz and Kabadiyon districts (Southern Tajikistan). Considerable resources of teresken the basic high-mountain shrub species - are depleted in the Murgab District (Eastern Pamir). In Western Pamir, the deforestation rate reached a catastrophic scale because of the serious electric power deficiency. Valuable juniper forest areas are cut down in the upper reaches of the Zeravshan Valley (Northern Tajikistan).

That is why, to solve the problem of environmental protection and to mitigate climate change, it is important to solve the problem of energy supply for the population. It is quite urgent to analyze the situation and to take effective measures on improving the energy supply of the residential sector on the sustainable basis.

3.1.7. Reduction of Greenhouse Gas Emissions in Energy Sector and the Hydropower Potential Development

The basic energy needs of the world community are satisfied by burning fossil fuels (oil, gas, coal), associated with billions of tonnes of greenhouse gas emissions, an increase of which in the air leads to the global climate change.

The energy consumption in Tajikistan considerably differs from the average world indices, since the hydropower share here is over 60-75% of the total energy consumption, biomass not included (for comparison: the hydropower share in the world energy consumption is only 2%).

There are great possibilities of reducing emissions in the air by reforming the energy policy and funding the traditional energy sector.

The hydropower sector is based on using renewable energy resources, not being associated with greenhouse gas emissions. Its current consumption level substitutes a consumption of 5 million tonnes of conventional fossil fuel. This causes low emissions of greenhouse gases in Tajikistan. By the specific indices of greenhouse gas (mainly CO_2) emissions, Tajikistan occupies the most advantageous position among the countries of Central and Eastern Europe, the Caucasus, and Central Asia.

The energy scenarios of Tajikistan, providing sustainable development, are determined by environmental and economic factors. In view of environmental protection and decreasing impact on climate, the hydropower share should be at least 60-70%. With higher consumption of fossil fuel (over 30-40%), particularly coal, greenhouse gas emissions will reach the 1990 level in the mid-term prospect. Considering the increasing energy needs, with the coal share being over 50% of the total energy consumption, CO_2 emissions can reach 30 million tonnes by 2015.

The technological measures, in addition to energy reforms and policy improvement, can considerably promote the country's priorities in solving the climate change problem.

The environmental situation in the energy sector has been considerably improved in the recent decade. The sharp reduction of fossil fuel use resulted in the 8-10-fold reduction of greenhouse gas emissions in the production sector. At the same time, the volumes of unaccounted fuel consumption in the residential sector, as well as the human impact on forest resources (tree cutting, timber resource decrease), which are biological fuel sources, increased.

The highest priority is the development of hydropower potential and infrastructure to supply

consumers, particularly in rural and remote regions, with hydropower. The basic technology needs are:

- Rehabilitation of the operating HPPs and modernization of heat and power plants.
- Construction of new HPPs of the Vakhsh Cascade, primarily Rogun and Sangtuda HPPs.
- Construction of new HPPs in the Pamirs.
- Construction of small HPPs and increase of non-traditional renewable energy utilization.
- Rehabilitation of the energy infrastructure in rural areas.

Involving international investments in the construction of new large HPPs and rehabilitation of the current energy infrastructure will provide a considerable reduction of potential greenhouse gas emissions. This will be associated with the twofold increase of the hydropower potential use, which is equivalent to the annual consumption of 12-15 million tonnes of fossil fuel. The period of expenditure cover is 5-10 years. The time of HPPs operation is 50 years. The realization of planned investment projects will be of great importance in the social sector, industry development, and allow an increase of environmentally safe energy export to neighboring countries.

In the 1990s, the share of hydropower in the energy consumption structure of Tajikistan increased from 45% to 75%. However, this increase is not associated with the increase of hydroelectricity production. It is due mainly to the decreased fossil fuel consumption in the recent decade. In addition, the problem of unaccounted energy consumption (both fossil fuel and wood, and other biomass) should be taken into consideration, since no energy accounting was implemented in the republic in recent 12 years.

In Tajikistan, a significant role in greenhouse gas emissions is played by the residential sector, which is responsible for one third of carbon dioxide emissions from burning fossil fuels and for 30% of electric power. That is why, the main possibilities of emission reduction and energy efficiency improvement should be considered as high priority in this sector.

Of great potential importance is realization of projects on greenhouse gas emission reduction in the context of reaching the Millennium Development Goals, concerning the atmosphere protection and the energy sector. One of the purposes is to reach the environmental sustainability; the important indices, determining progress in this respect, are: (i) increasing the energy consumption efficiency per GDP unit; and (ii) reducing carbon dioxide emissions per capita.

A great advantage of the greenhouse gas emission reduction in the energy sector is undoubtedly the positive effect on human health, due to the air pollution decrease. The most important for human health environmental problem, following the access to clean water, is air pollution, particularly caused by soot, sulfur dioxide (SO_2), ozone (O_3), nitric oxides (NO and NO_2), and carbon oxide (CO) emissions.

According to the WHO data, the indoor air pollution has much higher risk for health, than the outdoor air pollution, and is a reason for premature death. Usually, this problem is more serious in rural areas, where people use traditional fuels (firewood, charcoal, manure, and other residues) to cook food and heat their houses. The problem will be still more serious, if the price reform in the energy sector is inadequate in relation to families with low income, making them return to using traditional fuel, a part of which is produced by cutting green plants. Thus, it is very important for the strategies and reforms of the energy policy to take these problems into consideration.

To reduce greenhouse gas emissions is possible by modernizing gas pipelines and gas-distributing equipment for reducing fugitive emissions. Improved technologies of underground coal mining, and oil product mining, transportation and storage, will also make it possible to reduce greenhouse gas emissions.

There are considerable unused renewable energy sources (solar, biomass, wind, and small river energy). Financial difficulties are the main obstacle in their development. Moreover, since the projects on small renewable energy sources are, as a rule, small, compared to large projects, their costs are high, not providing small investors with possibilities to work on these technologies.

3.1.8. Policy Improvement in Energy Sector

To create a competitive and stable energy sector, which will ultimately provide funds for the update technology development and high-quality services for consumers, the following reforms should be realized:

- Setting a price level, which will provide a reimbursement of production expenses and productivity increase.
- Setting taxes encouraging long-term commitments for developing energy resources, and compensating negative aspects of production and energy consumption.
- Improving the payment collection discipline.

In addition to these measures, special efforts should be made on environment protection in order to:

1. Make sure, that, when energy prices are increased, reasonable prices should be considered, so that people with low income will not have to use cheaper, but less safe fuels, or to burn firewood and increase the risk of deforestation.
2. Set feasible emission standards for enterprises, which will be appropriate to the country specific features and local priorities.
3. Support the development of environmental assessments, including maximum permissible emissions.
4. Systematically analyse the investment impact on the environment to make sure that: (i) the environment is not considerably destroyed, and (ii) investment decisions consider external expenses for environmental protection.
5. Promote the establishment of an effective, transparent, well-regulated environmental management system, fostering the public involvement and aimed at the best experience and internationally accepted standards.

Thus, the energy policy and reforms will most likely decrease the energy consuming capacity and reduce carbon dioxide emissions in the air. Also, they will be important in environmental protection by (i) promoting safer fuels; (ii) improving the environment management; (iii) removing market barriers against renewable energy sources and investments in energy saving.

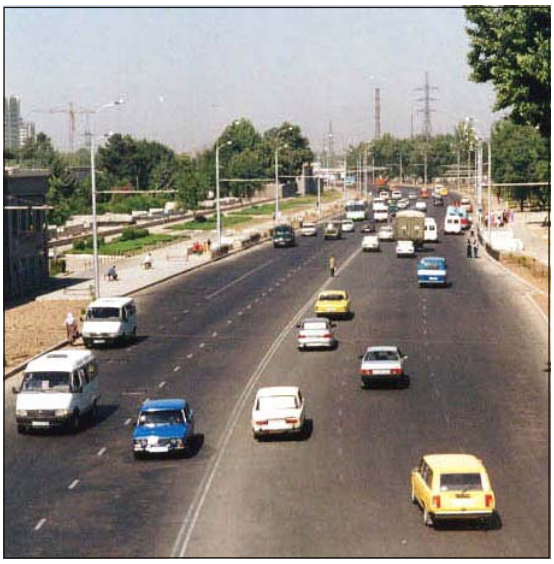
An extremely important objective is poverty alleviation, since it is a key factor for setting adequate tariff rates and decreasing the negative impact on the natural resources, mainly forests, which are currently intensively used as a biofuel (photo 3.7).

3.7. Firewood stock preparation

3.1.9. Using Environmentally Sound Technologies in Transport Sector

The specific fuel consumption by the motor transport sector in mountainous regions is higher than in plain areas. The great part of the total number of cars in Tajikistan has been exploited for over 10-15 years, which creates premises for a potentially large volume of harmful matter and greenhouse gas emissions (photo 3.8). The low-quality fuel makes the problem more critical.

Using a liquefied gas fuel provides a great potential for emission reduction in the transport



3.8. Intensive road traffic in Dushanbe

sector. The share of the Dushanbe public route transport (minivans), working on a liquid gas fuel, increased up to 70% by 2003, resulting from the considerable reduction of CO_2 and harmful matter emissions. Some trucks also have gas equipment.

The economic limitations became the major moving factor of transition to gas fuel, because using gasoline fuel appeared too expensive. This example shows, that introduction of new technologies in the transport sector could provide economic and environmental benefits.

Extremely important for the transport sector is an introduction of highly safe technologies in using liquefied gas fuel. This will provide considerable environment benefits and allow keeping the tariffs of local passenger and cargo traffic at an appropriate level.

The electric power transport functions in Dushanbe and Khujand and is not associated with greenhouse gas emissions. The number of passengers transported by trolleybuses annually is 30-40 million persons. Technologically, it would be important to improve the state of trolleybus transport and to reconstruct the electric power infrastructure, which is currently unsatisfactory. There is a need and there are possibilities to use electric power transport in other cities of the republic.

The regulation and optimization of the motor transport and transport communication is an important technological measure on reducing greenhouse gas emissions. When the Anzob tunnel at the Dushanbe-Khujand motor road is constructed and put into operation, the northern areas will be connected with the center, southern areas of the republic, and the GBAR all year round. Using the tunnel will allow considerable reducing of transport fuel and greenhouse gas emissions, and negative impact on the environment, and improving of transport safety, thus increasing the adaptation potential.

3.1.10. Non-Traditional Renewable (Alternative) Energy Sources

There are areas, where the economic and environmental situation is favorable for a priority small energy development, including:

- Zones of decentralized energy supply, with low density of population.
- Zones of centralized energy supply, with great capacity deficiency and considerable energy losses in the agricultural production.
- Zones of mass recreation, with energy needs.
- Zones with problems of supplying private houses, farms, etc. with energy.

Using small non-traditional renewable energy sources (sun, wind, small rivers, and biomass), the potential of which is high in the republic, seems prospective. The landscape-geographic and climatic characteristics of the republic territory cause the diversity of possible ways and areas of small renewable energy source use (fig. 3.2.).

The main directions of further work will include:

- Assessing needs and economic efficiency of small renewable energy sources; identifying consumers and local market of appliances.
- Providing access to technologies and developing equipment for solar energy transformation into heat and electric power; developing new materials.

Fig. 3.2.

- Supplying the local industrial base with equipment to produce solar radiation devices, small and mini-HPPs, biogas installations; developing the infrastructure on equipment installation and maintenance.

Small Hydropower Energy

The developed hydrology network of Tajikistan, including large and small rivers, creates a good base for using hydropower, particularly in the mountainous areas of the country. Small and mini-HPPs, with capacity from 1 kWh to 10 MW, can be constructed, using local labor resources. The potential of small hydropower in Tajikistan is over 18 billion kWh a year, which equals to a prevention of annual 5-6 million of carbon dioxide emission, resulting from the equivalent amount of fossil fuel.

A construction of 20 small HPPs is possible in the Kalai-Humb, Vanch, and Rushan districts (Western Pamir), considering local needs in electric power. Proceeding from the experience, Eastern Pamir area is on the whole unfavorable for constructing small and mini-HPPs, due to the severe climatic conditions and ice-formation on rivers.

There are perfect potentialities of small hydropower development in Central Tajikistan, where over 100 small and mini-HPPs can be constructed. The technological and economic calculations made for 14 prospective small HPPs show 348 million kWh of the potential annual average power generation, with total investments being 44 million US$.

According to the expert assessments, the small river energy (photo 3.9-3.10) can meet 50-70%, in some areas 100%, of the energy needs in remote regions. This will give direct benefits to over 250 thousand people.

The Government paid special attention to small energy development, planning to annually provide funds for it. However, the republic is currently unable to fund the small hydropower development; the most probable way of solving the problem is to involve local and foreign investments.

3.9. Waterfall in Varzob district

3.10. Mountain river

The following small hydroelectric power plants (SHPP) were constructed in 1994-1999, the construction being funded by the centralized investments and the Barki Tojik Company:

1. "Tekhrav" SHPP, 360 kW capacity, GBAR (1994)
2. "Khistevars" SHPP, 630 kW capacity, Sogd Region (1996)
3. "Khazara-1" SHPP, 250 kW capacity, Varzob District (1998)
4. "Kyzyl-Mazar" SHPP, 70 kW capacity, Sovetsky District, Khatlon Region (1998)
5. "Anderbag" SHPP, 300 kW capacity, GBAR (1999)
6. "Khazara-2" SHPP, 250 kW capacity, Varzob District (1999)
7. "Cheptura" SHPP, 500 kW capacity, Shakhrinav District

The Aga-Khan Foundation funded the SHPP construction in the GBAR in the same years:

1. "Shipak" SHPP, 30 kW capacity, (1997)
2. "Vand" SHPP, 60 kW capacity, (1998)
3. "Dekh" SHPP, 30 kW capacity, (1998)
4. "Bardara" SHPP, 50 kW capacity, (1998)
5. "Raumed" SHPP, 30 kW capacity, (1998)
6. "Yanshor" SHPP, 30 kW capacity, (1998)
7. "Bosid" SHPP, 75 kW capacity, (1999)
8. "Pagor" SHPP, 100 kW capacity, (1999)
9. "Barchadiv" SHPP, 45 kW capacity, (1999)
10. "Adeshikh" SHPP, 30 kW capacity, (1999)
11. "Bodom" SHPP, 30 kW capacity, (1999)
12. "Vezdora" SHPP, 30 kW capacity, (1999)

The program of building small HPP is given in table 3.2.

In planning the small river hydro-energy management, a diversity of factors should be considered:

- Hydrology (river basin water balance; average long-term, maximum, and minimum water expenditure, suspended alluvium, etc.).
- Socio-economic situation (expenses for construction and exploitation, time of expenditure cover, proximity to potential energy sources, infrastructure availability, etc.).
- Technological characteristics of equipment (technology conformity with hydrometeorological conditions, reliable operation, and maintenance capacity, etc.).

To apply technologies of constructing small and mini-HPPs, the necessary production (TadAZ, machine-building plants) and scientific (Gidroenergo-

Table 3.2.

The Program of Construction in Tajikistan for the nearest period

No	SHPP	N, KW
	Construction of New SHPPs	
1	"Kukhiston"SHPP Mastchokh District	1200
2	"Artuch"SHPP,Penjikent District	600
3	"Tutek"SHPP,Garm District	750
4	"Shash Boloi" SHPP,Darband District	300
5	"Runoi" SHPP,Garm District	1000
6	"Khait" SHPP,Garm District	250
7	"Surkhav"SHPP,Tavildara District	500
8	"Pitavkul,SHPP,Dirgital District	500
9	"Degilmon" SHPP, Tajikabad District	1200
10	"Vorukh" SHPP, Isfara District	600
	SHPP Reconstraction	
1	"Fatkhobod" SHPP Tajikabad District	500
2	"Garm" SHPP, Garm District	500
3	"Buvak" SHPP, Varzob District	500
	SHPP Projekt Development	
1	"Katta-Sai" SHPP, Ura-Tube District	500
2	"Sangikar" SHPP, Garm District	500
3	"Gurumbak" SHPP, Tavildara District	500
4	"Artuch" SHPP, Penjikent District	600

Source: Ministry of Energy RT

proekt Research Institute; Physical-Technical Institute, RT Academy of Science) base is available in Tajikistan. Also, there is an experience of constructing and mounting these installations. However, new effective technologies, the production base development, specialists training, and service infrastructure are still needed.

The impact of small and mini-HPPs on the environment is inconsiderable, as compared to medium-sized and large HPPs, in the vicinity of which such negative effects, as riverside erosion, ground water level rise, tectonic activity change, biodiversity losses resulting from area flooding, etc. are recorded.

The environmental effect of small HPPs has many benefits. These are: first, a reduction of potential carbon dioxide emissions, which would have taken place if the HPPs have not operated. E.g., a small HPP, with 500 kW capacity, located within the mid-mountain zone of Central Tajikistan, can produce 3 m kW of electric power annually. This is equivalent to a substitution of coal and biofuel (mainly wood biomass) consumption and a reduction of CO_2 emissions - 5-8 thousand tonnes annually, or 100-300 thousand tonnes for the period of the project operation. Another important environmental and social effect is a reduction of forest cutting and an increase of the available energy resource efficiency.

The specific cost of small HPPs is from 300 to 600 US$ per 1 kW of capacity; expenses for transportation and mounting works increase the total cost up to 600-1200 US$ per 1 kW. The expenses are mostly determined by locality, technologies used, transportation characteristics, and other factors. The cost of power generation by small and mini-HPPs can

vary greatly. Most probable are costs varying from 0.02 to 0.04 US$ per 1 kWh.

The recently developed models are based on technologies and equipment provided by neighboring and far foreign countries. When the local small HPP production is developed, the specific expenditure for their installation and exploitation will be reduced by 20-30%, and, consequently, they will be more available for private consumers and farms. In addition, this will promote a development and expansion of the local market, service sector, and infrastructure. Demonstrating the experience and providing the population with information on small HPPs is of great importance for small hydropower development.

The most urgent objective is a construction of small HPPs, 500-2500 kW, and mini-HPPs, up to 100 kW. The sphere of small HPP application is variable. Small HPPs with 5-50 kW capacity can be used for lighting remote settlements consisting of 10-100 houses. More powerful HPPs can provide power for domestic electric devices, small produce processing farms (mini-plants), and heating supply. Thereby, using highly efficient electric devices (fluorescent lamps; heaters, consuming little energy, etc.) will provide additional benefits and potentialities of energy storage and consumption. The time of small and mini-HPP expenditure cover is 3-8 years, period of operation until major reconstruction is 20-25 years.

Solar Energy

Solar energy development has great prospects in Tajikistan. There are 280-330 sunny days a year. Total solar radiation reaches 7500-8000 mJ/sq.m. on sunny days.

The length of solar radiation in a particular area is very important for efficiency assessment of solar energy installations.

The total length of solar radiation fluctuates from 2100 to 3170 hours a year. The minimum total length of solar radiation is recorded in mountainous regions, characterized by considerable cloudiness throughout the year and a locked relief (Dekhavz 2097 hours, Fedchenko Glacier 2116 hours). The maximum solar radiation (over 3000 hours a year) is recorded in the southern part of the republic (Pyanj 3029 hours) and in Eastern Pamir (Karakul Lake 3166 hours), where the cloud cover is quite inconsiderable, and the open space prevails. These areas are most favorable for solar energy use (fig. 3.2).

The minimum solar radiation, from 61 (Dekhavz) to 172 (Karakul) hours, is in December. In summer (July), the solar radiation increases tomaximum 270 hours in the upper reaches of the Zeravshan River and 390 hours at Khujand.

The above solar energy potential can be used both to produce solar energy by photocells and to produce heat energy with the help of solar radiation collectors; in addition, it can be effectively used in architectural composition of buildings (passive solar planning) for heating purposes, etc.

The technology of solar energy transformation into electric power is fairly well developed and successfully applied in industrially advanced countries. Currently, research on increasing the transformation efficiency, which is now 15-20%, and reducing the cost of photocells, is being conducted. The necessary raw material, production facility ("ELTO" Plant), and scientific base (Physical-Technical Institute, RT Academy of Science) is available to introduce this technology in Tajikistan. Also, there is a domestic experience of constructing similar installations. However, training of specialists, access to new technologies, infrastructure development, and scientific research are still needed.

The technology of solar energy transformation into heat energy (water or air heating) is more available (photo 3.11). These installations can be

3.11. Solar water heating installation

constructed, using local materials (aluminum) and involving the local industrial works (TadAZ, machine-building plants), and infrastructure (building companies). Solar water-heating installations producing hot water and heat (hot water supply for houses, hotels, holiday homes, showers at summer cottages, rural areas, and greenhouses) can be widely used. Constructing solar stoves and drying-rooms for dried fruit, tobacco, medicine herb production seems very prospective.

According to the calculations, 1 square meter of solar collector saves 0.15-0.2 tonnes of conventional fuel (i.e. 150-200 kg of coal or nearly 100 kg of oil products) in Tajikistan. Thus, a solar installation, 10 square meters in area, can provide energy equal to that resulted from burning of 2 tonnes of coal. Passive solar houses are heat-insulated specially planned and sun-oriented architectural constructions, allowing a 25% reduction of energy consumption.

In view of prevailing use of hydropower, photo-electricity is not supposed to be widely applied, due to its high cost and complicated maintenance; nevertheless, using solar lamps, autonomous power systems for radio-retransmission installations, meteorological stations, etc. seems prospective. Tourist and international organizations are also interested in using photoelectric devices independent (autonomous) power supply.

Wind Energy

The wind energy potential of Tajikistan still remains almost unstudied. This is connected with the insufficient hydrometeorological observations and lack of specialized research. No wind speed measurements were conducted at 30 meters above ground, whereas in this zone the wind energy potential can be 10-20% higher, than at the 10-meter level.

Wind speed and direction greatly depend on a locality, environment, and the yearly atmospheric circulation. Locked lowlands and mountain foots are characterized by the most frequent calms (45-55%); in the foothill and mountain areas, the calm frequency decreases to 20-30%. The least calm frequency is observed at glaciers (6-10%) and open-mountain passes (15%).

Mean annual wind speed varies from 0.8 to 6.0 m/sec. The strongest winds blow in highland areas, in open relief forms (glaciers, mountain passes) and where the orographic factors promote an increase of the atmospheric pressure gradients and leads to an increase of wind speed (Khujand, Fayzabad). The mean annual wind speed in these regions reaches 4-5 m/sec; in open lowlands and wide valleys it is 2-4 m/sec; in locked lowlands (Dushanbe) and southern plains (Kurgan-Tube), it does not exceed 1-2 m/sec.

According to expert assessments, wind energy installations could be competitive with other energy sources only in some regions of the republic. The Fayzabad mountainous region, Fergana Valley, Murgab Depression, as well as Khaburobad, Shakhristan, and Anzob (photo 3.12) mountain passes are supposed to be the most favorable areas in Tajikistan for using wind energy, based on wind electric power station.

It is advisable to involve technologies and equipment from developed countries, since there is

3.12. Wind power station on the Anzob pass

neither a local production base nor any experience of planning and constructing wind energy installations. In future, the local conditions for production and maintenance of these installations can be created.

Although hydropower prevails, application of wind power as a supplementary source of energy with small capacity (1-50 kW) is justifiable in certain regions of Tajikistan.

The technological and economic assessment of wind energy installation costs is 1000-1500 US$ per 1 kW of the rated capacity. Wind turbine operation and economic efficiency are mainly determined by the mean annual wind speed, which should be at least 3-4 m/sec, the best value being 5-7 m/sec.

Biomass Energy

In agricultural areas of the republic, biofuel (wood, kizyak, manure, brushwood, etc.) can be used to produce thermal and electric power. According to the expert assessments, biofuel is of primary importance in households of s of the country population. Using bio-energy installations is important at large cattle-breeding and poultry farms, which need waste utilization, in addition to energy production.

Energy production is possible by burning biogas, generated by means of anaerobic fermentation of manure. In a damp, warm medium, lacking in oxygen, anaerobic bacteria generate biogas (CH_4 and CO_2 mixture). The process is conducted in special installations biogas generators. The gas yield is 0.2-0.4 cubic meters a day per 1 kg of dry matter. To provide households with energy, the biogas installation capacity can be 3-5 cubic meters, for larger farms, or more severe climatic conditions up to 10 cubic meters. The cost of the installation varies from 300 to 500 US$, depending on the material used. By technological parameters, brick is the best material. The time of the installation operation is 20 years.

Now, small capacity biogas generators operate in Tajikistan (photo 3.13). Their production is technologically possible; it is advisable to organize this under local conditions, since there is a necessary production base, developed models, and specialists.

There are 35 complexes and farms with over 400 of dairy animals. To reduce methane emissions from manure, and to produce energy for domestic needs, the technology of methane recuperation from cattle-

3.13. Biogas generator in rural area

breeding waste products should be applied at the farms. In rural areas, with no access to natural gas, this technology is prospective. Large cattle-breeding complexes have possibilities for constructing electric power stations based on biofuel. According to expert assessments, wide application of the technology of using manure, mud of water purifying systems, agricultural wastes, and solid communal waste for biogas generation, can provide an annual reduction of methane emissions up to 5-8 thousand tonnes.

Thus, to improve the energy supply of the population, based on environmental sustainability, it is necessary: to improve the energy resource efficiency, focusing on small renewable energy sources; to qualitatively improve the energy consumption structure; to minimize the use of fossil fuels and wood biomass; to popularize using of new energy technologies among wide sections of the population.

The geographic situation and climatic conditions of Tajikistan promote using renewable energy installations: small and mini-hydroelectric power stations, wind energy installations, solar stoves and water heaters, devices generating biogas out of waste products (manure, plant biomass, solid communal waste).

3.2. INDUSTRY

3.2.1.Legislative and Institutional Base

The Republic of Tajikistan adopted programs on developing particular industries, including The State Program of Processing and Sale of Precious and Semi-Precious Stones for 2001-2005 (2001) and the Program of Gold and Silver Mining for 2002-2010 (2002). The Concept of Industrial Development and the Program of Light Industry Development are being developed. The programs are aimed at increasing mining, processing, and production; developing new deposits, and realizing investment projects.

The RT Ministry of Industry was established in 2002, basing on the RT State Committee for Industry, and is the main state body coordinating the industrial policy. The Ministry realizes programs of the industrial complex development, works out and implements measures on regulating technological, environmental, and other standards and requirements for the industrial sector activities.

The industrial production of the republic focuses on the following areas: non-ferrous metallurgy (aluminum production), light and food industries.

There are 80 main branches of industry within Tajikistan comprising of 1.257 different enterprises in 2001, including 860 non-state and 397 state ones. 148 joint-stock and 34 joint industrial companies are registered in the republic.

The available industrial capacities of the republic are extremely exhausted and require considerable modernization and reconstruction. Projects on reconstructing ammonia and carbamide production to increase the capacity up to 200 thousand tonnes of carbamide a year (”Tajikazot” JV) and restoring the capacities of Tajikhimprom Joint Stock Company (”Kimiyo” JV) are being implemented. Talks are being conducted on reconstructing the capacities of Tajikcement State Unitary Enterprise and building capacities for scrap-iron and ferrous metal processing at the Tajik Aluminum Plant.

The Republic of Tajikistan possesses great reserves of natural and hydropower resources. There are sufficient reserves of raw materials for the metallurgy, chemistry, building, and other industries.

Stability and increase of the industrial production have been recorded since 1998. Non-ferrous metallurgy prevails in the industrial sector, its share being 54.2% in 2001.

For the period till 2015, the non-ferrous metallurgy output is supposed to increase to the level of 1990; a development of metallic antimony, lead-and-zinc, and wolfram concentrate production, and raw mineral and various ore deposits are planned. By 2015, the chemical production (ammonia) output will

exceed the level of 1990 by 1.8 times. A considerable increase is expected in the light industry, particularly cotton and raw silk processing. A re-orientation of some works to processing utility waste (ferrous and non-ferrous metals) is planned.

The non-ferrous metallurgy sector produces over 50% of industrial production; 90% of the sector is occupied by aluminum production. The primary aluminum production is supposed to reach 396 thousand tonnes by 2015. A further increase of gold mining is planned due to the joint exploitation of the Chore, Taror, Jilau, and other deposits. The total gold output is expected to reach 11 tonnes by 2015.

The total chemical production output will supposedly increase by 4.3 times by 2015. An increase of carbamide production up to 190 thousand tonnes a year is supposed. The machine-building production is supposed to increase: domestic refrigerators 30 times; electric stoves 5; buses 5. The production of building materials, including cement, is expected to increase up to 700 thousand tonnes annually.

The building material industry will realize measures on quality improvement, increasing of building materials variety, reconstruction, and introduction of new kinds of production. By 2015, a sevenfold increase of the light industry output is supposed. The textile industry, namely cotton fiber processing, will be of primary importance.

3.2.2. Greenhouse Gas Emissions in Industry

The major sources of greenhouse gas emissions in the republic are aluminum, cement, and ammonium production (photo 3.14-3.16).

In 1990, the highest levels of CO_2 emissions were recorded in aluminum (675 thousand tonnes), as well as cement (532 thousand tonnes) and ammonia (164 thousand tonnes) production. In 1998, the technological processes in metallurgy, mainly aluminum production, determined the greatest contribution (86%) in CO_2 emissions in non-energy industrial processes, followed by ammonia 9% (29-32 thousand tonnes) and cement 3% (10-20 thousand tonnes) production. The contribution of other sources, including cast iron smelting, lime production, and soda ash consumption, is 1-2%.

The projected increase of industrial output will lead to annual increase of CO_2 emissions up to 1.6 million tonnes by 2015. The greatest volumes of CO_2 will be emitted by primary aluminum (44%), cement (23%), and ammonia (18%) production. With no measures being taken, the CO_2 emissions will exceed the level of 1990 by 2015.By 2015, the annual aluminum output is planned to increase by 2-4%. If no measures are taken, greenhouse gas emissions in the aluminum production will increase by 35-40%, compared to 2000.

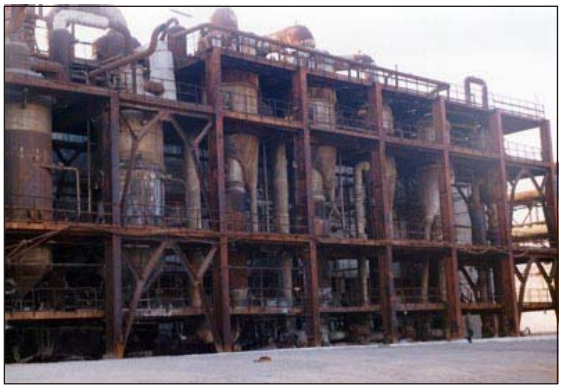
The main directions in improving available and applying new technologies in the industrial sector, aimed at reducing the impact on climatic system, are:

- Developing and applying new technologies and processes.
- Improving processes: combining processes, heat losses reduction.
- Applying new materials.
- Utilizing and processing emitted gases and waste products of industries.

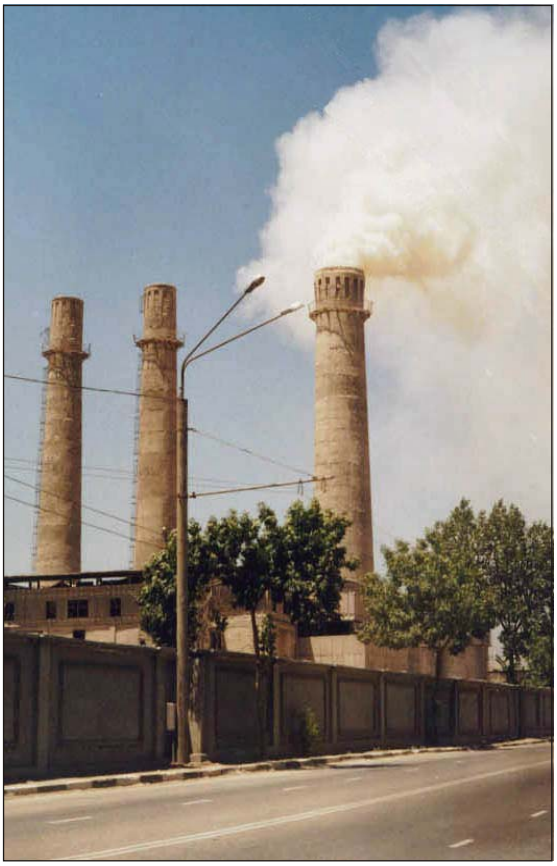
With new and improved available technologies being applied in industries, a reduction of CO_2 emissions by 420 thousand tonnes, or 26%, is possible by 2015. A considerable emission reduction in cement (1.3 times), ammonia (1.7 times), and lime (2 times) production is expected. The CO_2 emissions in the aluminum production can be reduced by 12-15%, those of perfluorocarbon by 30-40%.

To reduce greenhouse gas emissions in the industrial sector is also possible by saving fuel and energy resources and applying energy-saving technologies. The industry contribution in CO_2 emissions, resulted from burning fossil fuel, was 10-25% in different years. When energy-saving technologies are applied, a reduction of emissions from burning fuel in the industrial sector by 15-20% is possible.

3.14. Tajik Aluminium Plant



3.15. Tajikazot Industrial Enterprise



3.16. Tajik Cement Plant

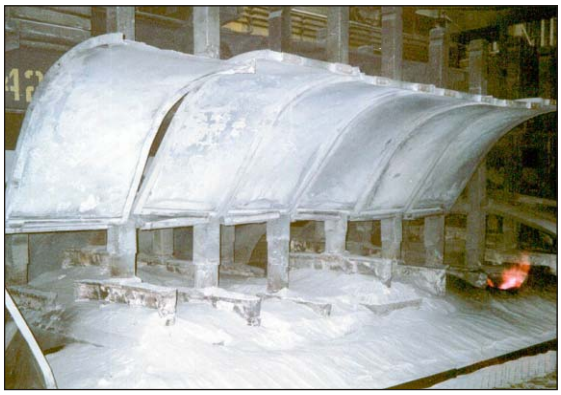
3.2.3. Greenhouse Gas Emission Reduction in Aluminum Production

The highest level of CO_2 emissions in the industry of Tajikistan is observed at the Tajik Aluminum Plant (TadAZ). TadAZ includes 10 electrolysis workshops, which use electrolyzers with current load being 160 and 175 kA. The electrolyzers work on the base of technologies using prebaked anodes. The raw material for the aluminum production (alumina and cryolite) and baked anodes production (coke and pitch) is imported from foreign countries. The aluminum production is energy-consuming; it became possible in the republic mostly due to inexpensive hydroelectric power.

The main sources of greenhouse gas and harmful substance emissions at TadAZ are aluminum electrolysis workshop (photo 3.17) and baked anode production. One of the basic environmental requirements to the plant is following the environment (including atmospheric air) state standards. Powerful gas purification and dust-catching facilities provide a 95% purification of harmful gas and dust emissions. The gas-purification waste products are re-utilized in the production process.

In the aluminum electrolysis workshop, greenhouse gases occur from the interaction of oxygen and fluorine resulting from electrolysis with the anode material (carbon). The oxygen, discharged on anode, is not isolated free; it oxidizes anode carbon to produce gaseous oxides, mainly CO_2. At the same time, CO_2 occurs due to air oxygen interacting with the upper anode under electrolyte surface. The total amount of CO_2, produced in the electrolysis workshop in the process of 1 tonne of aluminum production, is 1.14 tonnes.

The anode effect appears periodically in the process of aluminum electrolytic production. It is associated with decreasing alumina contents in



3.17. Eletrolyzer at the Tajik Aluminium Plant

electrolyte. The anode effect is removed by adding a new portion of alumina and mixing the electrolyte, thus the normal electrolysis process is restored. The anode effect causes a quick overheating of electrolyte, increasing aluminum solubility and losses in electrolyte. Therefore, the anode effect should be quickly removed. The average number of anode effects is currently 1 a day, 2-3 minutes long.

The anode effect causes a sharp increase in voltage, from 4.1-4.3 v in the normal process to more than 50-60 v, and an appearance of CF_4 among anode gases, the concentration of which increases with voltage increase. Anode gases (when the anode effect occurs) include: CO_2 25%, CO 50%, and CF_4 25%. The impact tetrafluorcarbon (CF_4) produces on the climatic system is 6500 times greater than that of CO_2. Thus, even small volumes of perfluorocarbon emissions play an important role in the global warming.

Another source of greenhouse gas emissions at the Tajik Aluminum Plant is baked anode production, including raw coke hardening, hardened coke drying, and "green" anode baking (photo 3.18-3.19). In baked anode production, with natural gas burning considered, up to 600 kg of CO_2 occur per 1 tonne of aluminum produced.

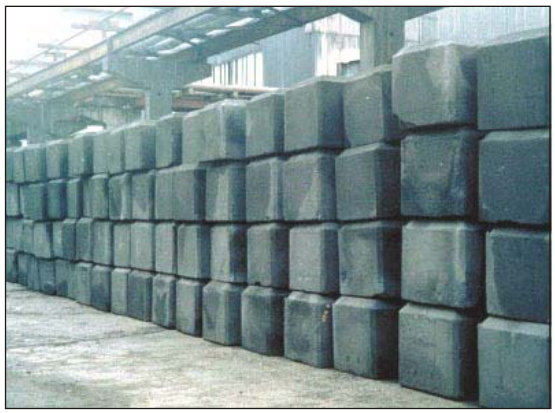
Thus, during processing aluminum at TadAZ, carbon dioxide (in coke drying 0.9%, coke hardening 3.8%, anode baking 12%, electrolysis 83.3%) and perfluorocarbons (in electrolysis 100%) occur.

The basic technological measures on greenhouse gas emission reduction in aluminum production are:

1. Reducing coke carbon monoxide due to improved temperature control.
2. Rational use of natural gas in coke hardening and anode baking.
3. Increasing anode inertness due to saturating their surface with inhibitors (boric acid, silicon dioxide, etc.)
4. Using advanced automatic systems of electrolysis process regulation.
5. Decreasing the number and duration of anode effects due to qualitative and quantitative conducting of process.

A reduction of coke and "green" anode carbon monoxide can be reached by improving control of the process, rational and economic using of natural gas. Coke losses resulting from carbon monoxide are 8-13%; they are due mainly to oxygen surplus in the hardening zone, when the furnace and condenser

3.18. Rotating furnace at the Tajik Aluminium Plant



3.19. "Green" anodes at the Tajik Aluminium Plant

joint is depressurized. At 1000°C, the coke carbon monoxide is 2 times less than at 1200°C, and 3 times less than at 1350°C. Introducing an automatic system of technological process regulation will allow an automatic control of the coke hardening and anode baking technological process, which will allow to reduce coke carbon monoxide and natural gas consumption.

One of the main methods of increasing anode inertness (non-oxidizing) is using inhibitors (boric acid, silicon dioxide, etc). Using these in anode production is aimed at hampering the anode oxidizing by anode gases and air oxygen. A prospective method is processing of lateral and upper faces of baked anodes with boron-containing solutions or special compound spraying. A small amount of silicon dioxide added to the process considerably increases the inhibiting properties of boric acid. With inhibitors being used, the amount of CO_2 emissions in the electrolysis process can be decreased by 30-40 kg per 1 tonne of aluminum produced.

The anodes within electrolyzers can be covered with an alumina layer, decreasing the upper unplunging anode oxidation, thus reducing CO_2 emissions.

The modern ACSEPs allow maintaining of optimal process parameters, including interpolar space, alumina concentration, etc. Thus, stable magnetogasdynamic processes, minimum electrolyte circulation, and permanent electrolyte level are provided. This allows saving of electric power, raw material, and improving the efficiency of production technology. With increasing the number of anode effects up to 0.4-0.5 times a day due to ACSEP, the amount of CF_4 emissions can be reduced by 30-40%.

3.2.4. Greenhouse Gas Emission Reduction in Chemical Industry

According to the expert assessments (Uzbekistan's Phase 2 Communication, 2001), the Central Asian chemistry branches are characterized by high-energy efficiency of production, exceeding that of the developed countries by 1.5-2 times. This is explained by the traditional technologies application and the basic funds obsolescence.

To decrease greenhouse gas emissions in the chemical industry is possible through applying energy-efficient technologies and using CO_2 as a raw material.

Carbon dioxide emitted from the lime and ammonia production, can be utilized to produce industrial (caustic) soda, which is widely used in many branches of economy. The Yavan Electrochemical Plant ("Kimiyo" JV) is currently using an inconsiderable part of CO_2 emissions to produce Na_2CO_3.

With the industrial method of soda production (100 thousand tonnes annually) being applied, 60 thousand tonnes of CO_2 can be utilized. The rate of utilization can be still increased, if the non-reacted CO_2 is returned to the technological process.

The ammonia production modernization, with the cuprammonium purification system being replaced with a more efficient system of purifying the converted gas to remove CO_2 and CO, will allow a reduction of CO_2 emissions at the "Tojikazot" JV by 50 thousand tonnes a year. Here, 165 kWh of electric power can be saved annually.

3.2.5. Greenhouse Gas Emission Reduction in Building Material Production

The development of the economy in Tajikistan is impossible without developing the building material industry, particularly in view of constructing large hydropower plants, road infrastructure, and new residential buildings. The building material industry currently includes over 50 enterprises producing cement, lime, pipes, material for walls, roofing slate, etc. (photo 3.20).

3.20. Dushanbe Asbestos-Cement Factory

The building material industry should be based on resource-saving, little-energy-consuming, and highly efficient technologies.

The only cement plant is currently operating in the republic is the Dushanbe Cement Plant, with the rated capacity of 1100 thousand tonnes of cement a year. The actual capacity of the plant is currently 10%.

The CO_2 emissions and energy-consuming capacity of cement production can be reduced by various methods. The most effective method is a transition from the current technology to the “dry” method of production, which will save energy resources and reduce greenhouse gas emissions by 200 thousand tonnes a year, when the plant reaches the full rated capacity. The main difference between the “dry” method of cement production and the “wet” technology is a method of supplying raw charge to the furnace. The “wet” method is as follows: the raw charge is supplied, being moistened by 30-50%, the ballast water evaporation consumes more than one third of the energy used for clinker production; the total heat consumption is 1700-2000 kcal/kg, compared to 1200 kcal/kg in the “dry” method. To reduce dust emissions in the air, dust-catching facilities, which promote the local environment improvement and heat energy secondary use (3.5 TJ for 10 years), should be used.

Another method of reducing emissions and energy consumption is applying a technology of natural (Roman) cement production; the local raw material is available. The technology includes baking at 600-700^{o}C. For comparison, Portland cement, produced by the Dushanbe Cement Plant, is highly energy-consuming, the baking temperature reaches 1500^{o}C, and fuel expenditure is 2000 calories per 1 kg of clinker. In the natural (Roman) cement production, the specific fuel consumption and CO_2 emissions is twice as low. Natural (Roman) cement can be used in brickwork and plastering, in low-grade concrete, etc. The rated annual natural (Roman) cement need is 100 thousand tonnes.

A reduction of cement consumption can be reached by applying secondary materials to cement binding. The tests carried out confirm the efficiency of applying the fluorine production waste products (Takob Concentration Mine) to cement binding (15-20% of cement mass), which promotes an improvement of physical and mechanical characteristics of materials, with parallel reduction of cement expenditure; in addition, waste products are utilized, and the environment is improved.

In the brick production of Tajikistan, baking and drying furnaces are used, operating on natural gas and coal. The available technologies of baked brick, chamotte brick, and fire-brick production can be updated to reduce energy expenditure. The baking process lasts 24 and more hours, the baking temperature reaches 1000-1300^{o}C. The drying process lasts 5 days at 100-120^{o}C. The energy consumption can be reduced by 10-15% due to combining the drying and baking processes, as well as increasing the baking process efficiency.

Replacing the baked brick with unfired brick makes it possible to save a considerable amount of energy. An increasingly wide application in the building industry has white silicate brick, produced by non-baking method from moistened mixture of sand and a small amount of lime. The high strength of brick is reached by its processing with steam in autoclaves under the pressure of 10 atm. High-efficiency heat-insulation materials play a considerable role in energy saving.

3.2.6. Using Stone Casting to Reduce Greenhouse Gas Emissions

Stone casts are produced by rock smelting, followed by heat processing, in special moulds. The area of the cast application is great: the chemical and cement industry; lacquer and dye production; road, hydropower, and irrigation construction; municipal services, etc. The stone casts are used in the production of pipes, drain-pipes, vessels and dippers for keeping corrosive liquids, tubing for tunnel construction, insulators, pavement tiles, etc.

A basalt-based production of mineral fiber with good exploitation characteristics (the temperature interval of application, aggressive media resistance, strength), which can be used as a heat-insulating material, is possible. Applying a new and increasing the efficiency of the existing heat insulation of buildings, using this fiber, will provide a reduction of up to 30% of heat loss and the energy saving. A restoration of the insulation layer on heating mains is also urgent.

According to the calculations, the conventional fuel consumption in the stone cast production is 40 times less, than in the metal production. 1 tonne of iron and steel cast needs 1780 kg of equivalent fuel, while 1 tonne of large-sized slagstone casts only 45 kg. The stone casting technological process results in minimum CO_2 emissions. Organizing the stone casting with the output of 10 thousand tonnes will cause an annual reduction of CO_2 emissions estimated at 16 thousand tonnes, compared to steel and cast iron processing and smelting of the same volume.

The stone cast production uses available raw materials and industrial dump slag, utilizing industrial waste products (e.g. Takob Concentration Mines), thus improving the environment.

The metal casting capacities available in the republic allow a transition to a new production with minimum expenses. The annual stone cast needs in many industries of the republic is 5-10 thousand tonnes, mainly sewer and irrigation pipes.

3.2.7. Reduction of Power Inputs for Water Use in Industrial Sector

The industrial enterprises of the republic use water from municipal water pipes and their own wells. The main index of perfect water supply in the industry is a water use frequency, i.e. a ratio of the total volume of water consumed by an enterprise to that of fresh water for the same period of time. At chemical enterprises, the water use frequency should be over 5-7, in the food industry is 3. In Tajikistan, it is actually 1. The greatest volumes of water for technological needs are consumed by the chemical and mining industries.

Closed water supply systems have great economic and power advantages, e.g. the “Kimiyo” JV (Yavan Electrochemical Plant) alone is able to save up to 50% of electric power or nearly 14 million kWh, using circulating water. With the “dry” method of cement production being applied, the water consumption for production use is 2.5 times less, as compared to the available technology.

3.3. AGRICULTURE

3.3.1.Legislative and Institutional Base

The main legislative documents, regulating the relations within the agricultural sector of the republic, are: RT Law of Land Reform (1992), RT Law of Farms (1992), the Land Code (1996), etc.

The RT President Decrees (no. 342, October 9, 1995; and no. 874, December 1,1997) on allotting 75 thousand hectares of irrigated and non-irrigated lands for private and subsidiary households of the population.

The RT Government approved the Mid-Term Program on Combating the Crisis in the Tajik Agro-Industrial Complex for the period up to 2005.

Over s of the population in Tajikistan live in rural areas, more than a half (59%) of the economically active population (1 million people) is involved in agriculture. The agriculture specific weight in the GDP structure is 26%.

The plant-growing share in the agricultural gross product is 78%, that of cattle breeding 22%. Nearly 42% of plant-growing output is produced by agricultural companies, 23% - by farms, and 35% - by the population. Over 90% of cattle-breeding output is produced by the population. The share of the non-governmental sector (farms and private persons) in the total output of cereals, raw cotton, potatoes, vegetables, and fruit exceeds 60-70%. The plant-growing output, particularly cereals, raw cotton, potatoes, vegetables, and water-melons, has been tending to increase by 20-80% for the past 5 years.

Intensifying the agricultural production will allow a twofold increase of agricultural output by 2015. One of the priorities for the long-term perspective is increasing cereals, mainly wheat, production. The cereals production is planned to exceed 1 million tonnes by 2015. The raw cotton output will increase up to 800 thousand tonnes by 2015. The head of livestock will increase up to 1.2 million, and the number of sheep and goats will reach 2.6 million by 2015.

With the reforms going on in future, the share of the non-state sector in the total agricultural output will be over 90%. The outlined tendencies of agriculture development will make it possible to approach the rational standards.

3.3.2. Greenhouse Gas Emission Reduction in Cattle Breeding

Despite the decline of production, particular branches of agriculture still remain major sources of greenhouse gas (mainly methane and nitrous oxide) emissions in the air. The total methane emissions in agriculture were 6.4 thousand tonnes in 1998, over 90% of emissions being produced by the cattle-breeding sector.

Methane is formed as a result of intestinal fermentation in herbivorous animals; it is a digestion by-product. Ruminants (cattle, sheep) emit 97-98% of the total methane resulted from intestinal fermentation. The amount of emitted methane depends on the physiology of animals, and the quality and quantity of plant forage eaten. A forage allowance can provide better indigestion and smaller amount of methane emissions. Specialized research should be carried out in this direction.

Methane emissions also result from cattle-breeding waste decomposition in anaerobic medium. Methane emissions depend to a large extent on the number of cattle, particularly milking animals, and ways of manure storage and use. When liquid manure is kept or processed (e.g. in reservoirs or pits), it decomposes in anaerobic medium and produces a considerable amount of methane. When solid manure is kept or removed to the fields as a fertilizer, its decomposition is different, and the amount of methane emissions is inconsiderable.

Methane emitted from manure has almost reached the level of 1990 and is nearly 10 thousand tonnes a year. With measures being taken in agricultural sector, the annual reduction of methane emissions will be 5-8 thousand tonnes by 2015, which is equivalent to over 100 thousand tonnes of carbon dioxide. The main technological measures include recuperating methane from cattle-breeding waste products and improving the methods of manure storage and use. Applying industrial installations producing heat and electric power seems reasonable for methane recuperation at large cattle-breeding farms.

3.3.3. Greenhouse Gas Emission Reduction in Rice Cultivation on Irrigated Fields

Rice cultivation is a highly profitable branch of agriculture. The rice areas were twice increased for the recent decade in the republic to occupy nearly 20 thousand hectares.

Rice is sown by broadcast method in April. The sowing rate is 180-200 kg of seeds per hectare. Rice fields are covered with water layer, 8-10 cm thick, which increases as plants grow. Mainly late-ripe (125-145 days) rice varieties are grown. The main rice-growing areas are located in the Sogd Region (photo 3.21), the Vakhsh River flood-lands, and the central part of the Districts of Republican Subordination (DRS).

Organic matter decomposes in anaerobic medium on irrigated rice fields, causing methane emission. The amount of emitted methane depends on rice varieties, the number of harvests, vegetation period, soil type, temperature, and methods of irrigation and fertilizer use. Methane emissions from rice fields increased from 4 thousand tonnes in 1990 to 7.5 thousand tonnes in 2002.

The seedling-planting method of rice cultivation is more progressive; it creates conditions for reducing methane emissions, as compared to the traditional rice cultivation. Its main advantage is a shorter vegetation period, and a possibility to receive two grain harvests a year, which is of great importance under existing deficiency of food and land resources. Moreover, the rice-sowing rate will increase by 3 times. The seed expenditure is 50 kg/hectare instead of 150-200 kg/hectare, which makes it possible to save 150 kg of seeds per hectare, the economic effect being 150 somoni. The vegetation period reduces by 30-40 days, the amount of methane emissions by 20%.

The main requirements for introducing this method of rice growing are training farmers and applying new technologies.

3.21. Rice sowing in Sogd region

3.3.4. Reduction of Greenhouse Gas Emissions From Agricultural Soils

Nitrous oxide emissions from agricultural soils are due to the natural nitrogen circulation in soils, and organic and mineral fertilization. Gaseous nitrogen emissions depend on the types of soil, contents of humus, activities of microorganisms, soil processing and liming, pasturing, and fertilizing.

In Tajikistan, fertilizers are applied in cotton, cereal, vegetable, potato, and watermelon crops. Fertilizers are applied before plowing, during crop sowing, and as additional fertilizing.

The annual agricultural needs in mineral fertilizers are: 100 thousand tonnes of nitrogen, 80 thousand tonnes of phosphorus, and 60 thousand tonnes of potash fertilizers. Actually, nearly 50 thousand tonnes of mineral fertilizers are applied in the republic. However, the agricultural fertilizing machinery is obsolete, and a mechanized fertilization is used only in cotton-growing.

Agricultural soils are the main source of nitrous oxide emissions. Nitrogen emissions are associated mainly with the microbiological processes, soil nitrification and de-nitrification, as well as methods of organic and mineral fertilizer application (photo 3.22). As compared to 1990, nitrous oxide emissions from agricultural soils reduced now by 50%. Since 1996, an increase of nitrous oxide emissions due to the increased mineral fertilization is observed.

A direct and indirect nitrous oxide emission comes from agricultural soils. When nitrogen-bearing fertilizers are applied, the amount of direct emissions from soils increases by 15-30%.

To reduce nitrogen losses and to increase nitrogen fertilizer efficiency, technologies on the best use of fertilizers (rational rate, time and methods of application, regulation of nitrification processes), combined with the rational system of soil processing and proper irrigation regime, should be introduced. When fertilizers are applied by band method at 15-cm depth, with 10-15 cm interspaces between rows, nitrification microorganisms show low activity, and nitrogen losses are reduced. The band method of fertilizer application considerably increases the effectiveness of their use by plants and reduces nitrous oxide emissions by 5-10%.

To reduce nitrification processes, inhibitors can be applied. These preparations prevent nitrogen nitrification and reduce gaseous nitrogen emissions by 1.5-2 times. Applying capsule fertilizers with regulated time of capsule decomposition and nutrient release is another option for nitrogen emission reduction.

The latter two methods are, however, too expensive. The calculation of emission reduction costs shows, that the specific cost of measures is 5-30 US$ per 1 tonne of CO_2 equivalent. Projects aimed at reducing greenhouse gas emissions are economically efficient.

3.22. Cotton sowing in Ismoili Somoni District

3.4. FORESTRY AND LAND MANAGEMENT

3.4.1. Legislative and Institutional Base

The main legislative and program documents in land management are: Statute on State Regulation of Land Management and Protection (1997), RT Land Code (1996), RT Law of Land Reform (1992), RT Law of Land Evaluation (2001), and RT Law of Land Management (2001).

The RT Government approved the State Ecological Program for 1998-2008 in 1997. The Program on Irrigated Land-Reclamation Measures for 1998-2003 was developed. In 2001, the RT National Program of Actions to Combat Desertification was accepted.

The laws of land management address the issues of effective land use, environmental technology application, and prevention of the negative impact on the environment produced by economic activities. The land reform objectives are: creating conditions allowing an equal development of different management forms; providing all ways of economic development; providing sustainable land use and protection to increase agricultural output. The Land Legislation regulates the relations within the land management sector between state bodies, local authorities, and state land management representatives, juridical and physical persons.

The state regulation of land management and protection is realized by the RT State Committee on Land Resources and RT Ministry for Nature Protection.

The RT State Committee on Land Resources develops a common policy of implementing the decisions on land use and land relations and realizes the state control of effective use and protection of land resources, registration of all land-users; also, it develops and realizes state programs in this sector. The State Committee includes: regional, district, and municipal committees on land resources, the "Tajikzaminsoz" and "Fazo" planning research institutes, working on: land-user mapping, registering various land categories, carrying out soil and geobotanical investigations, specifying the areas and boundaries of degraded lands.

The main laws, program and normative documents in forestry are:

- RT Law on Nature Protection (1994).
- RT Forest Code (1993).
- RT Concept of Forestry Development till 2005 (2000).
- Provision on Forest Protection (1999).
- Provision on State Control of Forest Status, Use, Reproduction, Conservation, and Protection (2000).
- Provision on Accessory Use of Forest (1999).

The State control of forest management and protection is realized by the RT Forestry Committee and the RT Ministry for Nature Protection.

The RT Forestry Committee includes 4 regional forestry committees, 34 state-operated forestry enterprises, 5 forest nurseries, 4 nature reserves, and a forestry research institute. In addition, the RT Forestry Committee manages the protected area network and exercises control of forest resources and forest management.

3.4.2. Problem Analysis

Wood biomass reduction and worsening land status resulted in a reduction of air carbon accumulation by trees, shrubs, and soils, and an increase of soil carbon emissions due to land erosion and degradation.

Forests are major carbon dioxide storage facilities. The forest area is 410 thousand hectares, which is 3% of the total area of the republic. The Tajik forests are heterogeneous, being represented by 268 tree and shrub species, many of which are of great

environmental and economic value (photo 3.23-3.24). The forests are characterized by low productivity, the average wood reserves per 1 hectare is 13.3 cubic meters. Forest plants with plenitude of 0.3-0.4 prevail. The forests are located mainly in the mountain zone; they have the most important erosion-preventing, soil-protecting, and water-regulating functions and are a source of industrial raw materials and food products.

The amount of illegal forest cuttings sharply increased in recent years, due to the insufficient supply of the population with energy resources. This results in reducing forest timber reserves, because forest cuttings exceed the forest growth. Moreover, the unregulated over-grazing in the state forest areas in the recent decades led to soil degradation, grass impoverishment, and reduced the forest plants productivity.

As compared to the past period, the volumes of forest-restoration work reduced, particularly works on forest sowing and planting (from 4.4 to 2.2 thousand hectares). The share of work on promoting the natural forest reproduction is increased, though this is a less effective environmental measure. The areas of forest shelterbelts reduced to a considerable degree; work on planting these stopped completely (for comparison: until 1990, forest shelterbelts were planted on 300 hectares annually). Due to the poor equipment of forest protection workers, a proper protection of forests from illegal cutting and fires is impossible. No work on forest planting or full-scale monitoring of forests has been done since 1992.

3.23. Broad leaved forest in Varzob

3.24. Juniper forest in the Shahristan Mountains

4601 thousand hectares (32.3%) of the total area (14255.4 thousand hectares) of Tajikistan are agricultural lands. The rest area (8.9 million hectares) is unsuitable for agriculture: watercourses, glaciers, rocks, mountain slopes, pebbles, mountain river-beds, and low-productive high-mountain pastures.

70 thousand hectares of pastures, of which 16 thousand hectares are irrigated, were not in use in 2001, because of salinization and swamping, irrigation water deficiency, and non-operation of the collector-drainage system and pump stations.

At the same time, virgin and fallow lands, including former hayfields and pastures, are developed for cereal crops; near-slope lands, where erosion processes result in soils impoverishment in 1-2 years, are often used. This leads to economic losses considerably exceeding harvest profits.

With soil cultivation being correct, the agrocoenoses are observed to accumulate organic mass. In contrast to undeveloped soils, here the biological productivity becomes considerably higher, and the content of carbon increases. Intensive land reclamation, however, with no soil-improving measures being taken, leads to a decrease of its biological productivity.

The strongly dissected relief of Tajikistan, intense precipitation, and low density of green plantations cause soil erosion; the total area of eroded lands is 9 million hectares (over 60% of the country area). Over 50 million tonnes of soil is annually washed away from arable lands, resulting in the loss of 1 million tonnes of humus. In recent years, in soils of many agrocoenoses, particularly in irrigated areas, dehumification is observed, resulting from insufficient application of fertilizers, incomplete crop rotation, and unsustainable agriculture.

The soil degradation leads to a reduction of food products, decline in living standards, and even in migration of the population. The unreasonable land plowing at the expense of forest cutting and nonobservance of aeromechanics in dissected relief areas promotes a development of erosion processes and natural disasters.

3.4.3. Technology Zoning in Forestry and Land Management Sectors

In the lowlands of Northern Tajikistan, gray soils, replaced by juniper forest soils higher above the sea level, prevail. Desert gray-brown soils rich in stones are widespread in plains of the republic. The agricultural development of these soils promotes carbon accumulation.

This region is suitable for planting quick-growing poplars, erosion-preventing and near-ravine forests. Developing fruit varieties and planting forest shelterbelts on agricultural lands seem prospective. Establishing protected zones within juniper forest areas, as well as promoting the natural processes of forest-reproduction in juniper forests and limiting cattle-grazing and illegal cutting have good prospects.

Favorable climatic conditions for forest plants and gardening development are observed in Central Tajikistan; the region is characterized by brown mountain soils, rich in humus, the variable specific composition of forest plants, and the largest woodland areas. The region is favorable for planting broad-leaved walnut and maple forests, poplar and other quick-growing plantations.

In non-irrigated areas of the zone, cereal cultivation and gardening are possible. The steep slopes, more than 13^0, are recommended for terraced agriculture. In plains, gray soils containing 2-3% of humus are common, where cotton, alfalfa, and cereals are cultivated. Applying rational methods of agriculture increases carbon accumulation in these soils.

Southern Tajikistan is characterized by hot and dry climate. Here, light gray and loess soils, combined with alkali, saline, and gypsum soils, prevail. Fragments of xerophytic light forests are observed. This region is most favorable for pistachio-almond plantations; in irrigated areas, poplar planting is recommended. To improve the soil cover and to combat soil erosion, planting forest shelterbelts, preventing forest cutting and over-grazing, and restoring saxaul plantations on sand massifs are advisable. To reduce salinization processes, the collector-and-drainage system efficiency should be improved, and water-saving irrigation technologies should be applied.

The Western Pamir area is represented mainly by rocks and talus. The soil cover is weakly developed, with light-brown soils prevailing. Tree plants are accumulated in river basins at 1700-3000 meters and include the following species: willow, sea-buckthorn, walnut, Sievers's apple-tree, and currants.

Sea-buckthorn, willow, and local poplar species plantations are recommended for forest-restoration. The local growing of walnut and apricot varieties is prospective. To stop illegal cuttings in this region, explanatory work among the population should be done, and local people should be involved in tree planting in the mountains and settlements. Of great importance is a sufficient supply of the local population with energy resources, including those produced by renewable energy sources.

In the Eastern Pamir area, a severe cold and dry climate prevails, soils, mainly rich in stones, are weakly developed, being frozen for 6-9 months a year. High-mountain desert and meadow soils are dominating over riversides. Trees are represented by some low species of willow, birch, and sea-buckthorn. No frostless periods can be observed above 4200 m, the only precipitation is snow. The natural and climatic conditions are not favorable for forest growing.

3.4.4. Technology Benefit Assessment in Land Management and Forestry

To solve environmental and climate change problems, work on applying methods of sustainable land management and effective forestry should be done.

According to the calculations, to increase the amount of air carbon, accumulated by trees and shrubs, to the level of 1990, new forest plantations should be laid on the area of 40 thousand hectares, and completed systems of forest shelterbelts should be created on agricultural lands (3 thousand hectares), by 2015. This can be done, if the current volumes of work on forest sowing and planting are at least twice increased, from 2 to 4 thousand hectares annually. In planting forests, preference should be given to quick-growing tree varieties, which quickly assimilate air carbon: Lombardy poplar, pine, tree of heaven. Where soils are fertile and fairly moist, walnut, Turkestan maple, and fruit trees are to be planted. Under arid climatic conditions, pistachio and Bukhara almond plantations are advisable. Saxaul should be planted in sandy areas.

To carry out work on forest restoration and new technologies application, the potential of the existing 5 forest nurseries should be used, which grow over 2 million seedlings annually. Of primary importance is to regularly practice sapling growing at forestry enterprises.

Depending on the intensity and effectiveness of measures to be taken, the amount of carbon assimilated by forest plants will increase by 15-20%, compared to the level of 1990, which will make 70-100 thousand tonnes of CO_2 annually (1.1 tonnes per 1 hectare). If no measures are implemented, the current tendency to reducing carbon assimilation by wood biomass will be further developing. The specific cost of works on forest-reproduction and afforestation will be determined by local conditions, and estimated at 1 to 3 US$ per 1 tonne of CO_2 absorption, assuming the effective period of forest functioning to be over 30-50 years. The total amount of funds necessary to realize the measures is 30-40 million US$ of basic investments and 2-3 million US$ annually to expand the activity.

It should be noted, however, that the work will lead to expected effects only if parallel measures on improving forest protection and monitoring, increasing the volumes of work on forest protection (from pests and diseases), regulating cattle-grazing in forest areas, and reducing illegal cuttings, are implemented. The latter is directly related to supplying the population with energy resources. Also important is to raise the status of protected natural areas (nature reserves and strict nature reserves).

Saline and gypsum soils occupy 22% of the total irrigated area of Tajikistan. Implementing land-reclamation measures will desalinize soils and increase their fertility.

Improving the water collector-and drainage network is an important measure to prevent greenhouse gas emissions in the irrigated agriculture. In prospect, the irrigated agriculture should be re-oriented to applying methods of overhead and intrasoil drip irrigation.

On slope lands, with over 13^0 steepness, a soil processing for sowing annual agricultural crops should not be allowed. These lands are advisable to use for planting fruit trees and vineyards in terrace agriculture. On flatter slopes, lands should be plowed across the slope, with soil-protection systems being applied (photo 3.25).

3.25. Erosion protection forest belt in Varzob district

Cultivating soil-improving crops (alfalfa), and proper crop rotations using the agricultural landscape systems will make it possible to prevent humus losses and carbon emissions. The greatest carbon reserves are observed in soils with the largest accumulations of underground biomass.

Correct agricultural cultivation and irrigation of gypsum soils makes their biological activity higher and increases humus and carbon reserves. To increase the fertility of the soils being currently developed in the southern republic, short-term cotton-and-alfalfa rotations and organic manure supply are recommended.

Within the land reform and farm development, it seems advisable to improve the pasture rotation system and to regulate its management through introducing a land tax.

The sustainable and effective use of arable lands and pastures, land-reclamation improvement, and application of new agricultural technologies will promote an increase of carbon absorption by soils up to 300-400 thousand tonnes a year.

4 Climate Change Adaptation

The Inter-Governmental Panel on Climate Change (IPCC) is aware that taking measures on reducing greenhouse gas emissions only is not enough to prevent the dangerous human impact on the climatic system. Work on adaptation is of great importance for sustainable development, rational natural resource management, and human health protection.

The assessments of natural resources, national economy and human health vulnerability to the climate change show a significant impact of climatic factors, so appropriate adaptation measures could reduce or prevent unfavorable consequences of climate change, providing a general preparedness for climate change and a contribution to sustainable development.

The criteria determining the adaptation priorities are:

- The negative impact of climatic factors and expected changes.
- Threat to human life and health, cultural heritage, economic development, food product security, infrastructure, water resources, land resources, and biological diversity.
- Economic efficiency and other parameters.

The adaptation technology assessment concerns scientific-technological and practical methods, as well as reforms, which can be introduced in nature management and social development to decrease vulnerability to climate change. The climate change adaptation is an adaptation of natural and human systems to the current or expected climate change and its consequences, aimed at both solving the relevant problems and using benefits of the measures realized.

The major factors of adaptation technology needs assessments are:

- Adaptation can considerably reduce the climate change unfavorable effects in the mid-term prospect.
- Increasing the adaptation potential is urgent to decrease vulnerability of the poor in rural regions, too sensitive natural resources, and national economy sectors dependent on weather conditions.
- Planned measures can considerably reduce damages and expenses.
- The variability of extreme hydrometeorological conditions and phenomena is of critical importance for vulnerability and adaptation (not average values change of a climatic system) assessments.
- The adaptation potential is different in different regions and socio-economic groups; unfortunately, it is poor regions and groups that are most vulnerable, having great difficulties in the process of adaptation to climate change.

4.1. WATER MANAGEMENT

4.1.1. Problem Analysis

The assessment of vulnerability to climate change shows, that the Tajik water resources within the Vakhsh, Kafirnigan, Kyzylsu, Zeravshan, and some other river basins will probably reduce in medium-term prospect. This tendency can lead to catastrophic consequences in some regions. A considerable summer reduction of river discharge, compared to a standard level, is possible. The current

glacier degradation will make the water crisis still more aggravated in future.

The water management system of the republic includes 1730 km of irrigation network with concrete facing, 7775 km of hydraulic engineering designs, over 2 thousand boreholes, over 500 pump stations, and over 2.9 thousand km of pressure pipelines.

The annual average water consumption by economic branches of the republic is 10-12 cubic meters. The irrigated land management consumes over s of water resources; 3% of the total water intake is used for economic and drinking needs. In view of the economic development, an increase in water consumption is expected.

The climate change in the recent decade has caused a negative impact on water supply for the economy and the population of Tajikistan. Reservoirs are being silted; canals and collector-drainage networks are being destroyed; the irrigating water deficiency, groundwater regime change, and water quality worsening are observed. The poor state of irrigation and drainage systems influences salinization and flooding of agricultural lands and leads to a harvest reduction.

One of the important tasks of the water sector is to provide the population with drinking water of high quality. Nearly 50% of the population has no access to clean (good quality) drinking water; with the climate change adaptation measures being not realized, this problem can cause catastrophic consequences.

Thus, introducing new technologies in water branches and improving water management are the major directions of climate change adaptation measures.

4.1.2. Basic Technology Needs

Technologies directed to rational water management, increased water use efficiency (increasing the irrigation system efficiency, applying advanced methods of irrigation, and subsoil drainage network) and integrated water resource management are of top priority.

To reduce damages caused by natural hydrometeorological phenomena, the network of riverside fortifying and anti-mudflow constructions should be increased, their efficiency being improved.

Improving the water management can provide water saving and socio-economic benefits. Introducing payments for irrigation water resources promoted a reduction of water consumption by 30%, which shows a more effective approach to water resource management.

The basic technology needs, related to the water sector adaptation to climate change, include:

- Automating the water distribution and consumption system, based on the Geoinformation System (GIS)
- Increasing the irrigation system efficiency and introducing new methods of irrigation and water saving.
- Rehabilitating and reconstructing the irrigation systems to reduce water losses related to evaporation and filtration.
- Encouraging water-saving technologies in industry, agriculture, and water management.
- Transition to a wide use of closed drainage system and reutilization of purified drainage water.
- Creating a reservoir network in appropriate agricultural areas to provide necessary water reserves in “dry” years and to decrease the risk of destructive floods.
- Stabilizing and fortifying streambeds, affected by floods, erosion, etc.
- Improving the mudflow-preventing and bank-fortifying construction systems.
- Updating the systems providing drinking water of proper quality and purifying sewage in cities.
- Creating transit reservoir-biofilters to purify water from toxic admixtures.
- Expanding the bank protecting forest plantations.
- Adjusting watering regimes (including watering time and rate revision) to climate change.

4.2. AGRICULTURE

4.2.1. Problem Analysis

The vulnerability assessment showed a considerable dependence of the agricultural production on climatic conditions and their variability. The plant-growing in Tajikistan is based on irrigable and non-irrigable agriculture (photo 4.1), in case of water deficiency caused by climate change, the irrigable land area will reduce, and the status of non-irrigable lands will worsen.

The widespread processes of desertification require a fundamental change of the whole agricultural system in terms of climate change.

Every year, the unfavorable weather conditions and phenomena (drought, hail, intensive precipitation, high and low temperatures) cause considerable damage to the agricultural sector of the republic. In particular years, large areas under crops are flooded, leading to harvest destruction.

To reduce the agriculture vulnerability to climate change and to improve the adaptation potential is possible by applying new technologies and developing effective methods of agriculture management.

4.1. Rain-fed arable lands

4.2.2. Basic Technology Needs

New technologies related to agriculture adaptation are advisable to apply in the following areas:

- Updating the agricultural material and technological base.
- Providing scientific and technological facilities for agriculture, including a long-term prognostication.
- Implementing combined agrotechnical and land-reclamation measures on improving the structure of areas under crops.
- Rationalizing the crop rotation, combined with all-round mechanization, chemicalization, and application of biological methods to combat agricultural pests.
- Realizing measures on preventing soil salinization and swamping.
- Providing financial stability and insurance of farms.
- Improving selection work on growing drought-resisting and high-yielding agricultural crop varieties, requiring little water.

To increase the level of cotton-growing adaptation to climate change, it is urgent to:

- create and introduce fast-ripening, disease- and heat-resisting cotton varieties.
- forecast and take timely measures on prevention of cotton pests and diseases distribution.
- increase the efficiency of cotton irrigation by applying water-saving technologies.

To increase the level of grain farming adaptation to climate change, it is urgent to:

- create and introduce local crop varieties, resistant to unfavorable climatic conditions.
- select disease- and heat-resisting grain crop varieties.
- increase the efficiency of grain crop protection from pests and diseases and forecast pests distribution in terms of climatic conditions.

To increase the level of cattle-raising adaptation to climate change, it is necessary to:

- improve the forage reserve.
- Increase areas for private cattle-grazing, toughening control of their management.

4.3. TRANSPORT INFRASTRUCTURE

4.3.1. Problem Analysis

In Tajikistan, the climate impact on roads is considerable; it results in destroying road surfaces, bridges, and washing out roads by mudflows and avalanches. More than 300 km of mountain roads are prone to unfavorable climatic factors every year (photo 4.2-4.3).

New standards and technologies, applied in the road construction and reconstruction in view of climate change, will decrease the transport infrastructure vulnerability and increase the transportation security (photo 4.4). Designing and installing protective constructions will make it possible to reduce damages in the transport sector.

4.3.2. Basic Technology Needs

The priority directions of technology transfer in the transport sector to mitigate the climate change negative consequences are:

- Monitoring of dangerous geological and hydrometeorological phenomena at dangerous roadcuts.
- Constructing new highly effective protective installations (anti-avalanche, anti-mudflow, slope-fortifying).
- Constructing and reconstructing roads, with regional requirements on road-surfaces and a climate zone being considered.

4.2. Destruction of road Dushanbe-khorog by natural disasters

4.3. Destruction of road by natural disasters in Anzob pass

4.4. The road of Anzob pass

4.4. PUBLIC HEALTH

4.4.1. Problem Analysis

Human health is to a considerable degree determined by the impact of climatic factors. The vulnerability assessment showed, that higher temperatures, precipitation alteration, and climate change vulnerability would cause changes of geographical boundaries and seasonal prevalence of transmissible infectious diseases, and an expansion of areas and seasonal periods of some infectious-parasitic diseases.

The changes of climate conditions would increase the prevalence of many water- and food-transmissible infections. The climate change would cause a negative impact on the environment, resulting in the increasing risk of food biotoxication.

Changes, related to surface water quantity and quality, cause effects on the prevalence of alimentary diseases, particularly abdominal typhoid. Weakening the control and sanitary inspection of water quality would increase the risk of these infections prevalence, particularly in rural areas, where the population has insufficient access to clean drinking water.

The climate (particularly temperature) change causes an increase of human being's vulnerability. The analysis of the total mortality showed its increasing in summer periods, particularly among old (able to work) people and children. The mortality index in rural areas is much higher than in urban areas, due to the unregulated microclimate, inadequate work conditions, and the low socio-economic level.

Applying new technologies, which result in a reduction of climate change negative effects and consequences, could improve human health and increase the population adaptation potential.

4.4.2. Basic Technology Needs

An effective public health system can promote climate change mitigation in terms of human health. Technology transfer is an important element in this sector. In view of technology transfer, providing access to technologies at the national and local levels is necessary to study any changes causing diseases, which may probably relate to climate change. Important measures on increasing the technology efficiency are: raising the awareness of people of possible climate change impact on human health, monitoring of climate change consequences, and training skills of specialists in the public health sector.

Development of electronic database on climate change and human health issues is a base for applying a new technology of epidemiological inspection of diseases and control of the epidemic process (fig. 4.1).

Measures on combating malaria vectors should include:

1. Breeding gambusia fish in malaria water reservoirs and on rice fields.
2. Insecticide treatment.
3. Purifying irrigation canals and drainage systems.
4. Draining swamped areas.
5. Using individual protection means against mosquitoes.

A number of measures preventing intestinal infections should include:

- Providing people with clean drinking water; sewage decontamination; sanitary treatment of public transport, residence areas of urban and rural population, industrial and agricultural enterprises.

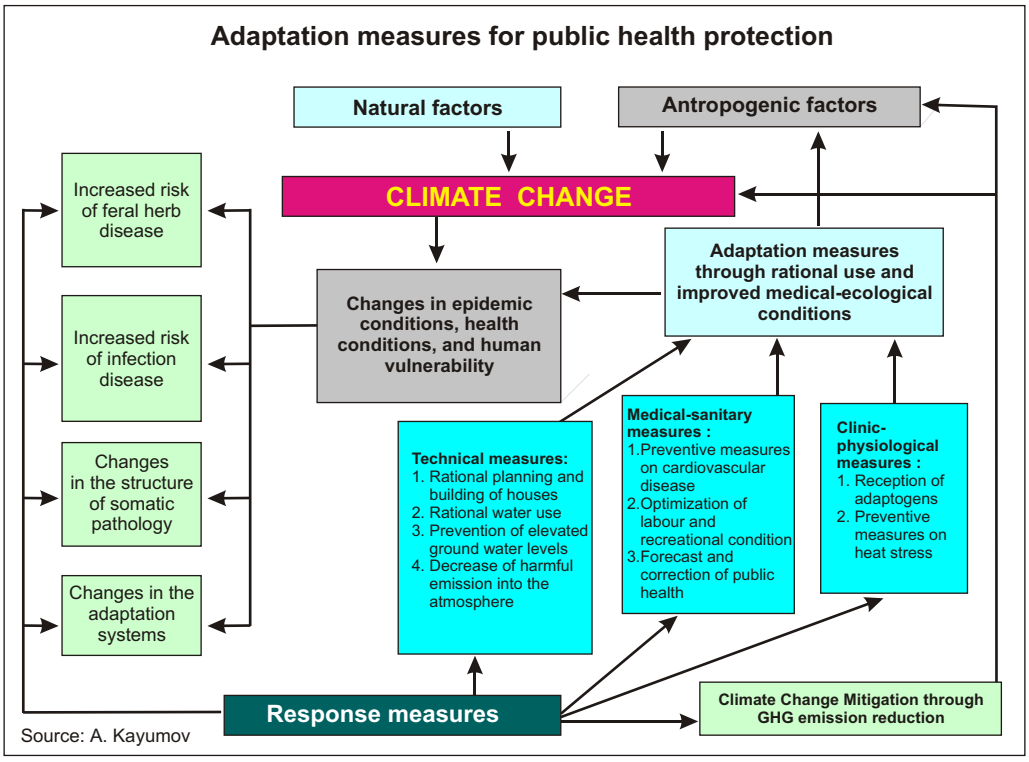


Fig. 4.1.

- Improving the microbiological, chemical, and physical control of surface and ground waters.

The available architectural and construction technologies used in residential and public housing do not sufficiently promote the rational use of locality landscape and microclimate in town-planning, which decreases the comfort level. The urbanization process is becoming more acute due to exhaust gases, noise, vibration, and over-heating. The climate change adaptation measures in town-planning, aimed at reducing heat stress, are one of the important directions in health improvement.

The main technological solutions of the problem are:

- Building dwelling houses, considering landscape characteristics and height above sea level.
- Orienting dwelling houses to cardinal points to fully use solar energy.
- Applying new construction materials and high-technology design.

Thus, technological measures are: improving the public health infrastructure, providing control and management of infectious-parasitic diseases and water quality. On the whole, climate change still increases the importance of this priority, which is one of the highest priorities in the sustainable development of the republic.

4.5. NATURAL DISASTERS

4.5.1.Legislative and Institutional Base

The vulnerability assessment showed, that natural disasters, like catastrophic floods, mudflows, landslides, and droughts, are due mainly to climatic factors, causing considerable material damages and loss of life. Other dangerous meteorological phenomena, like hailstones, intensive precipitation, strong wind, and mist, are important factors.

Observing and forecasting dangerous hydrometeorological and other processes, as well as developing and realizing measures on preventing and eliminating natural disaster consequences, are of great importance for climate change issues.

The RT Law of Civil Defense (1996) and RT Law of Legal Regime of Emergency State (1999) are currently in force in the republic. The Tajik government approved the provisions: On the RT Evacuation Committee (2002), and On the RT State Committee for Emergency (2002). The RT President decrees and Government instructions on preventing and eliminating natural disaster consequences are in force. The draft RT Law on Protection of the Population has been developed. This will be a basic document for realizing measures on people protection, assessing damages, and eliminating natural disaster consequences.

All measures on getting ready for natural disasters are realized under the leadership of the Tajikistan Government, through governmental committees on emergency, evacuation, and stable operation of the republic economy. The chairmen of the committees are deputy prime ministers, members heads of the ministries, governmental departments and institutions. The Head of the RT Civil Defense is the RT Prime Minister, the deputy head is the RT Minister of Emergency.

The major works on monitoring dangerous natural phenomena are realized by the Central Department of Geology (landslide, karst development, rockfall) and the Main Administration on Hydrometeorology and Environmental Monitoring (intensive precipitation, hailstones, strong wind, drought, dust storm, ice-covered ground, avalanche, mudflow, flood). The Institute of Geology and Institute of Seismology of the RT Academy of Science carry out research on the conditions and reasons for particular natural disasters (landslides, earthquakes).

The Main Administration on Hydrometeorology and Environmental Monitoring issues forecasts of possible unfavorable and dangerous hydrometeorological phenomena and water level changes in major rivers. Forecasting and actual information is submitted to the relevant organizations (local authorities, the Ministry of Emergency, etc.), which realize measures on preventing and eliminating the natural disaster consequences. There are uncertainties in the risk assessments of mudflows and floods because of insufficient information from remote areas due to non-operation of some hydrometeorological points and stations, lack of data processing methods and means, and means of communication.

At present, full-scale monitoring and forecasting of natural disasters in Tajikistan seems difficult, due to insufficient funds provided for the Survey of Dangerous Geological Processes (the Central Department of Geology) and the Tajik Met Service (the Main Administration on Hydrometeorology and Environmental Monitoring).

The RT Ministry of Emergency and Civil Defense (ME) exercises the leadership in pursuing the state policy in protecting people and economy of the republic from and getting them ready for emergency situations.

The ME exercises direct leadership of measures on preventing and eliminating natural disaster consequences. The ME includes 5 zonal headquarters: in the GBAR, Sogd, and Khatlon regions, and in the Gissar and Rasht Valleys. The emergency headquarters, local authorities, enterprises and institutions have plans of emergency actions.

The main ME structures, responsible for emergency response measures, are: the Department of People and Area Protection, the Republican Chemical and Radiometric Laboratory, the Troops Department, the Military Medical Department, the Rear and Equipment Department, "Centrospas" Department, "Usoi" Department, etc.

There is a daily exchange of information on the situation in settlements, risk zones, and infrastructure units, based on the data of the hydrometeorological and seismological services, the survey of dangerous geological processes, etc. The regional emergence headquarters receive information on possible unfavorable hydrometeorological phenomena, promoting mudflows and floods. However, the communication within the republic is bad, because many telephone and radio lines are out of action. The difficulties in communication are also connected with the power deficiency in the autumn and winter period, particularly in the GBAR and the Rasht Valley.

In case of considerable emergency situations, representatives of the governmental emergency committees, civil defense services, local authorities, and other organizations come to the place to assess the damage caused. Also, rescue groups from the "Centrospas" Department and other RT ME units (if necessary, military units of the RT Ministry of Defense) come to take part in measures on rescuing victims and eliminating natural disaster consequences.

The measures on eliminating emergency consequences are funded by the republican, local, and departmental budgets. Damages can also be paid by public foundations, private donations, etc. When the expenses, needed for natural disaster elimination, are considerable, funds are provided by the Government reserve foundation. Foreign countries and international organizations can also be involved.

In the early 1990s, the republic developed a program of measure on preventing and eliminating emergency consequences. However, it was impossible to realize the program due to lack of funds. The main barriers in effective realization of measures on preventing and eliminating natural disaster consequences are: poorly equipped rescue services, ineffective leadership, and, sometimes, insufficient preparedness. Preventive measures are realized mainly due to the support of international financial organizations (World Bank, Asian Bank).

It is important to increase the potential of republican and local emergency bodies, to improve the interaction of the local committees and their contacts with civil defense headquarters and services.

4.5.2. Natural Disasters and Their Consequences

Many natural disasters, associated with unfavorable weather phenomena, relate to the global climate change consequences. Being unexpected and unpredictable, they are difficult to adapt to. For the ten-year period - 1991-2000, over 90% of people, who became victims of dangerous natural disasters, died from severe meteorological and hydrological phenomena. In this period, the quantity of meteorological and hydrological natural disasters, including droughts, mudflows, and floods, increased. According to the WMO forecasts, natural disasters, such as floods and droughts, will be more frequent in the nearest 10-20 years.

Natural disasters occur in Tajikistan every year, causing victims and considerable economic damages. Over 50% of imminent processes and phenomena are reported from the Districts of Republican Subordination (DRS), the least number is observed in the Gorny Badakhshan Autonomous Region (GBAR). The formation and development of imminent processes is closely related to hydrometeorological phenomena, e.g. quick temperature change, snow melting, etc. Some 38% of the imminent processes in the republic are landslides, 31% - mudflows and floods, 21% erosion processes. Rockfalls, avalanches, river bank washout, and suffosion make 10% of the processes.

Over 50 thousand landslide threatening areas, grouped in seismogenous and non-seismogenous landslides, are observed in the republic. The main reason for seismogenous landslides are earthquakes. The volumes of seismogenous landslides are 10-15 times larger, than those of simple landslides; in some cases, they shift for over 1 km from the detachment wall. The landslide, caused by the Khait earthquake force 9 (1949) and carried away at least 30 thousand lives, serves an example. Non-seismogenous landslides and falls are often caused by hydrometeorological factors. In 2002, a landslide, caused by heavy precipitation, occurred at the Baipaza HPS (Vakhsh River), where the HPP main building was threatened with flooding.

The most avalanche-dangerous areas are on the slopes of the Zeravshan and Gissar ranges, parts of the Turkestan Range, in the Obihingou, Obihumbou, Vanch, and Yazgulem river basins. The major republican highways, Dushanbe-Khorog and Dushanbe-Khujand, are closed for 4-6 months a year, because of the avalanche danger (photo 4.5).

The formation of mudflows in Tajikistan is associated with loose-detrital material accumulations on mountain slopes and in streambeds, intensive precipitation, river flooding, and glacier shifting. In 1998, huge mudflows were reported from the Garm, Penjikent, and Tavildara districts.

Floods can be caused by intensive rainfalls or snowfalls and glacier melting in the spring and summer period, e.g. mudflows and floods in the Yakhsu, Varzob, Pyanj (1992 and 1998), and other river basins (photo 4.6). The Magian-darya, Shing, Kshtut, Fandarya, Yagnob, Pongaz, Oshoba, Shaidon (Central and Northern Tajikistan), Vanch, Yazgulem, Bartang, Gunt, Shakhdara (Western Pamir), Yakhsu, Tairsu, and Kyzylsu (Southern Tajikistan) river basins are the high-risk zones of mudflow and flood formation. In all, 466 settlements are prone to floods and mudflows. Nearly 50% of all mudflows are reported from the DRS.

Another reason for catastrophic mudflows and floods are glacier or blocked-up lakes, which are numerous in mountainous Tajikistan.

The analysis showed a close relation of hydrometeorological factors to mudflow and flood formation. An increase of precipitation quantity and water reserves in snow, combined with a quick increase of temperature, causes an increase of mudflow and flood quantities, and their destructive consequences.

To inform people in the villages, located in the Bartang, Pyanj, and Amudarya river basins, of the possible outburst of the Sarez Lake, a system of early warning is being installed. A portable radio-warning system is installed in the nearest to the lake villages (Barchadiv, Nisur, Basid, Yapshorv, Adjirkh, Razuch, and Rushan), being connected with the cities of Dushanbe and Khorog. In prospect, the villages, located in the lower reaches of the Pyanj River, are to be provided with means of warning. In case of the Sarez Lake outburst, 116 villages will be threatened with flooding.

Another dangerous area in the Pamirs is the Vanch River Basin, in the upper reaches of which a lake, with up to 2-4 million cubic meters of water, is

4.5. Avalanche in the Pamir Mountains

4.6. Mudflow in the Varzob Gorge

formed once in 10-15 years. The glacier lake formation and outburst was observed in 1963, 1973, and 1989. The flood wave was up to 3-4 m high. Only the timely preventive measures helped to avoid dramatic consequences; otherwise, 18 villages numbering 5 thousand people would have been threatened with flooding. In 2001, a regular glacier shifting began, but the river was not blocked, and no lake was formed, because the glacier stopped at 200-300 meters from the riverbed. Earlier, wireless radio stations were installed in the Vanch River Basin, in order to inform people of the lake outburst or possible outburst. These stations do not exist any more.

In 1996-2002, the economic damage caused by the drought of 2000-2001 made almost 50% of the total damages resulted from all natural disasters (photo 4.7). In the same period, the economic damages, caused by mudflows and floods, made 33%, earthquakes 9%. The economic losses, resulted from the earthquake of March 3, 2002, made 89% of those caused by all earthquakes. In 2002, the greatest part of damages, over 50%, was caused by mudflows and avalanches. Considerable damage, caused by these natural disasters, was observed also in 1993, 1997, and 1998. In 2002 and 2003, floods, which destroyed parts of villages and agricultural areas under crops, occurred in the south (Pyanj and Kyzylsu rivers).

The greatest number of victims are caused by catastrophic mudflows, resulted from outburst of temporary lakes or due to heavy rains, e.g. at the villages of Navdi (Rasht District, 1998), Dashtak (Roshtkala District, 2002), Vashan and Revad (Aini District, 2002), in the Asht and Djirgatal districtss (1999). The total number of victims, resulted from mudflows in 1996-2002, was 261 people.

4.7. Bridge destructed by a mudflow in the vicinity of Dushanbe

The number of imminent processes in the Sogd Region is 350. Most of the processes (77%) are landslides, mudflows, and floods, 5% of which occur in the Aini and Penjikent districts (fig. 4.2-4.3).

Nearly 342 imminent processes, 87% of which are landslides, mudflows, floods, and erosion processes, are reported from the Khatlon Region. Most (57%) of dangerous and very dangerous processes occur in the Farkhor, Khovaling, and Vose districts. In case of floods, the flooding zone covers villages and areas under crops in the Shaartuz and Kabadian districts. Since no bank-protecting and bank-fortifying work was implemented in full volume, there is an annual threat of flooding the villages in the Kulyab, Vose, and Moskovsky districts, which were flooded in 1992, 1993, 1998, and 2003 (fig. 4.2-4.3).

Over 277 imminent processes, 90% of which are landslides, mudflows, and floods, are reported from the GBAR. The main processes are observed in the Darvaz, Vanch, Rushan, and Ishkashim districts. Most villages of the Khumbou, Vanch, Gunt, Bartang, and Shakhdara river basins are located in potentially dangerous zones.

Some 803 imminent processes are reported from the plains of the DRS. Landslides, mudflows, and erosion processes make 90% of the total number of the imminent processes. Most of them occur in the dangerous areas of the Shakhrinav, Varzob, Kafirnigan, and Fayzabad districts. Dushanbe, the capital of the country, is located in this zone. Annually, mudflows caused by heavy rains flood the streets and roads in the northern and northeastern parts of the city and destroy buildings.

In the mountainous part of the DRS, the number of imminent processes is 415. Most of the processes (90%) are landslides, mudflows, floods, and erosion processes. Nearly 75% of the imminent processes occur in the Garm, Darband, and Tajikabad districts.

According to the approved plan, 8 thousand households (of these, 28% are in the Sogd Region, 20% - in the Khatlon Region, 40% - in the Districts of Republican Subordination, and 2% - in the GBAR) should be resettled from the very dangerous zones.

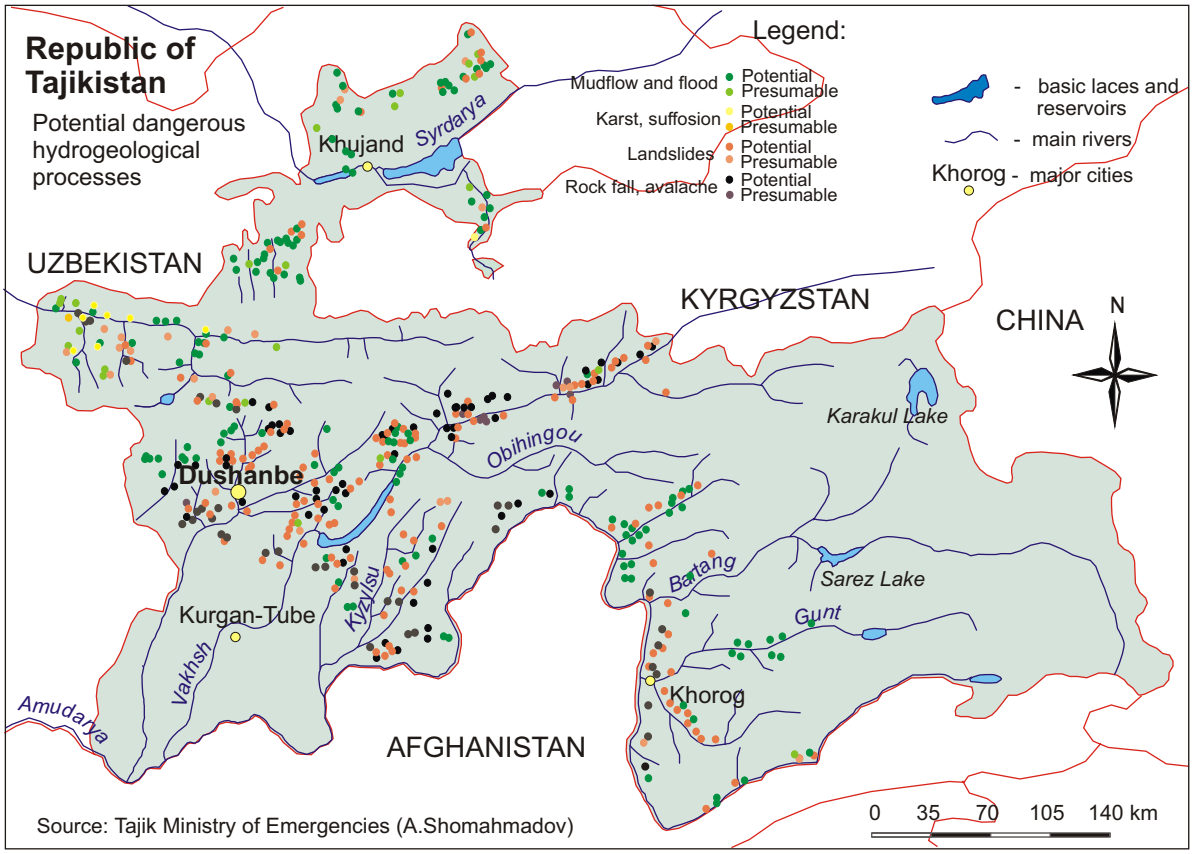
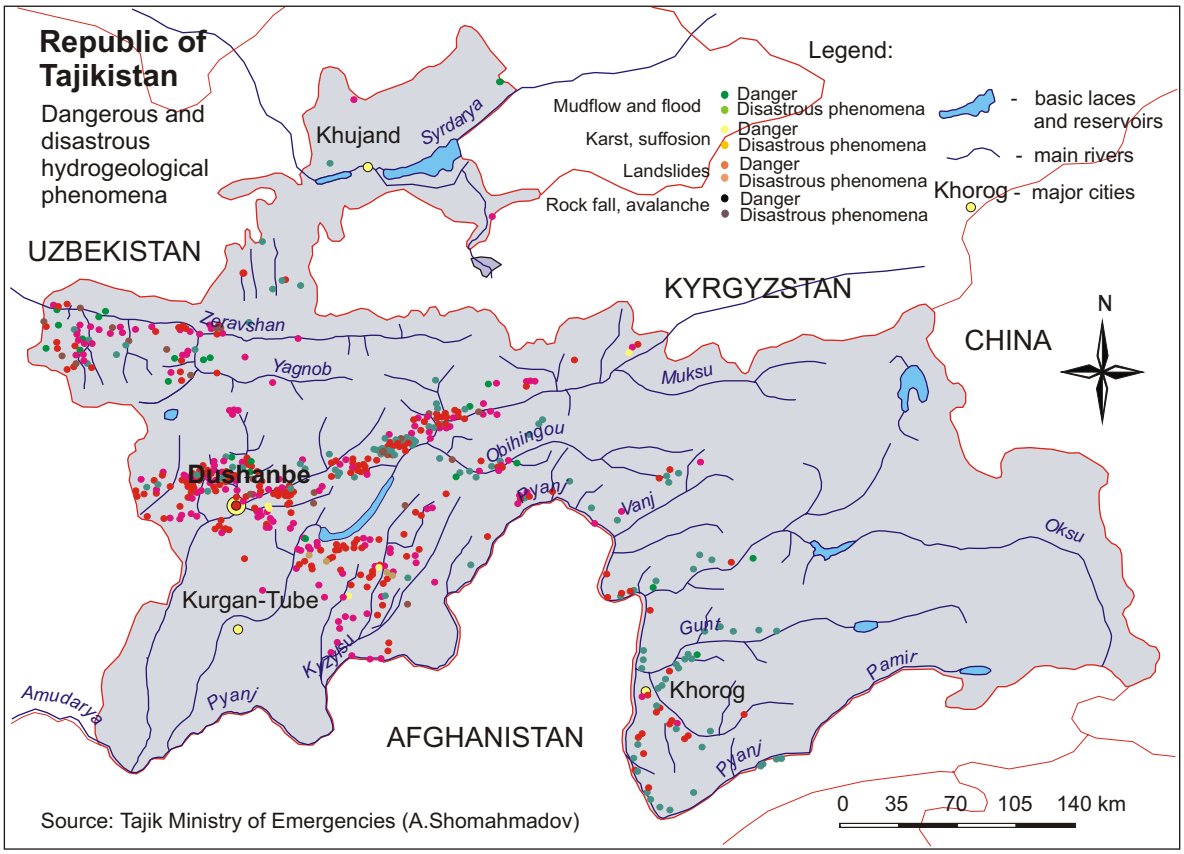

Republic of Tajikistan
Potential dangerous hydrogeological processes
Legend:
Mudflow and flood
Karst, suffosion
Landslides
Rock fall, avalanche
Potential
Presumable
- basic laces and reservoirs
- main rivers
Khorog - major cities
UZBEKISTAN
KYRGYZSTAN
CHINA
AFGHANISTAN
Khujand
Syrdarya
Dushanbe
Kurgan-Tube
Khorog
Karakul Lake
Sarez Lake
Obihingou
Kyzylsu
Vakhsh
Bartang
Gunt
Amudarya
N
0 35 70 105 140 km
Source: Tajik Ministry of Emergencies (A.Shomahmadov)

Fig. 4.2.


Republic of Tajikistan
Dangerous and disastrous hydrogeological phenomena
Legend:
Mudflow and flood
Karst, suffosion
Landslides
Rock fall, avalanche
Danger
Disastrous phenomena
- basic laces and reservoirs
- main rivers
Khorog - major cities
UZBEKISTAN
KYRGYZSTAN
CHINA
AFGHANISTAN
Khujand
Syrdarya
Dushanbe
Kurgan-Tube
Khorog
Zeravshan
Yagnob
Muksu
Obihingou
Pyanj
Vanj
Oksu
Kyzylsu
Gunt
Pamir
Amudarya
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0 35 70 105 140 km
Source: Tajik Ministry of Emergencies (A.Shomahmadov)

Fig. 4.3.

4.5.3. Basic Technology Needs to Reduce the Risk of Natural Disasters

Natural disasters are dangerous because they are unexpected. However, their consequences can be prevented or considerably mitigated, if proper preventive measures are taken, including adequate forecasting and quick information transfer, warning and evacuation of the population, and technical protective measures. To improve the preparedness of the population and minimization of possible negative consequences of climatic catastrophes, regular training, including that within the framework of the ME, and developing efficient mechanisms of interaction between local and republican authorities, special services, and the population.

The main task of the development of climate change adaptation measures is reducing the risk and impact of natural disasters on the population and state economy. The RT National Action Plan on climate change mitigation (2003) determines the following general directions of measure realization:

- Restoring and improving the existing hydro-meteorological observation network in order to improve forecasting, warning, and regulation of floods and other natural hydrometeorological phenomena (NHP), with the most appropriate density of hydrological stations and points reaching 1 per 1000 square km.
- Updating the systems of information collection, processing, analysis, interpretation, and quick dissemination, including databases, GIS, and electronic models of NHP formation and impact.
- Developing and realizing a number of measures on natural disaster management.
- Planning, developing and implementing demonstration projects, aimed at creating, improving and developing resources and structures for planning technical and non-technical measures of protection from floods.
- Improving preparedness of the population and appropriate government bodies for natural disasters, providing necessary equipment.
- Reducing the risk and impact of floods and other NHPs, particularly in areas with undeveloped infrastructure, where the population is poor. Placing houses and public buildings in safe areas is very important.

The main technology needs of the republic to improve protection from natural disasters and to mitigate their negative consequences are:

- Applying and expanding the network of automatic data units to determine snow accumulation, air temperature, heavy precipitation, and floods (sharp change of water level in rivers).
- Improving the natural disaster forecasting, based on personnel training and application of high-efficiency forecasting methods, computerized data processing, and satellite monitoring systems.
- Applying regional climatic models to assess the risk of droughts and floods;
- Applying meteorological radar installations to determine centers of hailstones and heavy rainfalls and snowfalls and to minimize their impact.
- Providing anti-hailstone installations to protect the area of 200-300 thousand hectares.
- Developing and quickly updating databases (with GIS technologies being applied) of mudflow, flood, landslide, avalanche, drought, and other dangerous phenomena issues.
- Applying new means of radio communication and warning systems to inform people of natural disasters in the most vulnerable areas.
- Instructing people in case of natural disasters, providing them with teaching and visual aids, audio- and video-materials.
- Planning and building protective constructions in high-risk zones.
- Providing special equipment for rescue groups in vulnerable areas and the RT ME "Tsentrospas" Department.

Since catastrophic mudflows and floods cause the greatest economic damage in Tajikistan, and considerably threaten human life and health, the following areas should be focused on:

Floods:

1. Preventive measures on protection from floods:

- Regulating river discharge through reservoirs.
- Constructing protective dams.
- Improving heavy rainfall sewerage systems in settlements.
- Draining swamps.
- Re-settling people to safer areas.
- Works on forest rehabilitation and planting over riversides and mountain slopes.
- Hydro-insulation of buildings and infrastructure units.
- Storing up food and equipment reserves in case of floods.

2. Improving flood forecasting and increasing the hydrometeorological observation (including automatic flood data units) efficiency.

Mudflows:

1. Forecasting mudflow floods and regularly examining mudflow-dangerous areas.
2. Fortifying terrace slopes.
3. Prohibiting forest cutting on mountain slopes and regulating cattle-grazing.
4. Constructing hydropower engineering protection installations (dams, and mudflow derivation canals).
5. Slope afforestation.

5 Developing and Improving the Potential

5.1. Institutional Base

The development and improvement of the institutional base for realizing measures on greenhouse gas emission reduction and climate change adaptation are important elements in the technology transfer process and project realization, with international financing sources (CDM, GEF, etc.) being involved.

After Tajikistan ratified the UN Framework Convention on Climate Change in 1998, a Governmental Working Group was established and National Coordinator on developing the National Action Plan was appointed in 1999. That was the base for realizing measures on climate change mitigation. The Working Group played a key role in identifying and appointing experts on implementing thematic researches and determined priorities in climate change measures in view of economic and regional needs, and further development objectives.

The support provided for the Republic of Tajikistan in preparing the First National Communication on Climate Change made it possible to form working groups of experts from the ministries and departments, to use an international consultant's service in knowledge improvement, and to create an organizational base.

In 2003, the RT Government entrusted the realization of the Framework Convention and coordination of the RT National Action Plan on Climate Change Mitigation to the Main Administration on Hydrometeorology and Environmental Monitoring of the RT Ministry for Nature Protection (Tajik Met Service). A specialized coordination center on climate change, with a permanent staff and national experts and consultants being involved, is established within the Main Administration structure.

The RT Ministry for Nature Protection is the authorized state body for sustainable nature management and environment protection in the Republic of Tajikistan.

The Ministry includes a specialized state control inspection of air protection, working on registering permanent sources of harmful substance emissions, developing standards of maximum permissible emissions, and controlling the implementation of air protection measures. The Ministry develops methods, instructions on calculating impact on the environment, environment quality (including air) standards, collects, analyzes, publishes and disseminates environmental data, including harmful emission volumes in the air and air quality.

The State Environmental Expertise of the RT Ministry for Nature Protection works on inspecting the economic activity in terms of the environmental legislation and environmental requirements.

The regional committees on environment protection of the republic follow the orders of the RT Ministry for Nature Protection concerning the control of air pollution and other sources causing impact on the environment.

Tajik Met Service carries out systematic hydrometeorological observations and monitoring of the environment, climate change research and dangerous weather phenomena assessments. Tajik Met Service plays the leading role in providing international cooperation and interdepartmental coordination on such issues as: developing policy and measures on climate change mitigation, compiling a list of greenhouse gas emissions, raising the public awareness, and providing access to climate change information.

The climate change cooperation with competent regional and international organizations and initiatives, e.g. International Fund for Saving the

Aral Sea, World Meteorological Organization, the Intergovernmental Panel on Climate Change, the UN Environmental Program, etc., is being realized.

Thus, the initial institutional base for implementing the UN Framework Convention commitments, has been created. However, the available potential of state environmental bodies managing the measures and projects on climate change technology transfer is insufficient. An interaction of international organizations on capacity building and raising the level of knowledge and information is required.

The basic needs in the institutional potential development of the state climate change coordinating body are:

- Creating conditions for the permanent staff working on climate change issues.
- Providing a regular access to Internet and other global informational resources.
- Raising the status of institutional units, responsible for climate change issue solution, including technology transfer coordination.
- Raising the expertise level.
- Increasing the efficiency of interdepartmental cooperation and informational exchange.

In prospect, the coordinating body potential should be sufficient to:

- Formulate a policy and general leadership of technology transfer activity.
- Assess and approve projects.
- Integrate climate change issues into investment projects and programs.
- Develop contacts with investors, donors, and the private sector.
- Develop a database of technology information and development needs.
- Raise the public awareness of technology transfer issues.

A republican office for managing issues of greenhouse gas emissions, technology transfer, and database of measures and projects (planned and being realized) should be organized with the support of international organizations.

The Governmental Working Group should include skilled experts, business and NGO representatives. The republican ministries and departments should promote a high expertise level, specialists' training and involvement in interdepartmental cooperation, including work on technology transfer.

5.2. Legislative Base

The legislative base regulating human impact on the climatic system, includes:

- UN Framework Convention on Climate Change (ratified in 1998).
- RT Law on Nature Protection (1994, amended in 1996).
- RT Law of Air Protection (1996).

In particular, article 53 of the RT Law on Nature Protection points to urgent climate protection from human impact. This should be based on: i) systematic climate change observations; ii) developing standards for permissible anthropogenous emissions causing impact on climate; iii) developing energy programs aimed at reducing carbon dioxide and other greenhouse gas emissions, and iv) applying sanctions for law violation. Article 26 of the RT Law of Air Protection includes requirements for economic units to follow standard of anthropogenous emissions causing impact on the climatic system.

The RT Law on Nature Protection and the RT Law of Air Protection should be improved to bring them into accord with the Framework Convention general principles. This will include raising the requirements of environmental security for economic units and applying incentives and an economic mechanism to reduce greenhouse gas emissions. It is important to reorganize the structure and increase the efficiency of environmental funds.

The RT Law on Environmental Expertise considers the list of all economic activities subject to a

compulsory environmental expertise. A decision on the environmental security of a particular unit is based on an expert resolution.

The RT Law of Energy determines the main objectives of the Tajik energy policy, the powers of the government and the Ministry of Energy, energy services provided, licensing, efficient energy management, a reduction of the energy sector impact on the environment. However, this document does not consider incentives and privileges in applying environmentally safe technologies in the energy sector.

Other relevant laws are weakly reflecting environmental issues.

In 2003, the RT Government approved the National Action Plan of the Republic of Tajikistan on climate change mitigation (No.259 of June 6, 2003). The NAP determines the priorities and directions of measures on climate change to be taken in Tajikistan, the needs in the potential development of further research and expansion of scientific knowledge of the climatic system and its change, and the general directions of international cooperation. Measures included in the NAP are the base for planning and decision-making at all state levels.

The current legislation and the NAP envisage greenhouse gas emission rates. According to the commitments of the Framework Convention, which is the basic legal document on climate change issues, the economic units must take measures on cutting their levels of greenhouse gas emissions and provide reports on these. Currently, no setting of rates or systematic registration of greenhouse gas emissions is carried out due to lack of standards, reporting forms, and the undeveloped institutional structure. In prospect, economic and individual rates must be developed, and a uniform reporting system on greenhouse gas emissions must be applied.

Setting greenhouse gas emission rates will require great work on providing control of emissions and standard observance. Applying standard mechanisms of emission rates may probably be low effective, because once the rates are reached, enterprises will have no incentives to realize measures on emission reduction.

Applying economic mechanisms will add to and improve the legislative regulation. An effective, though new mechanism, used worldwide, is applying tax for carbon content in fuel, depending on the buildup of greenhouse gases, and energy tax. As the experience shows, these taxes allow a 5-10% emission reduction and an increase of environment protection funding.

Another significant economic tool is providing incentives and privileges for applying new technologies, and small grants for demonstration projects.

It is essential to increase the role of environmental expertise and the principle of compulsory realization of technology measures on greenhouse gas emission reduction and energy efficiency increase.

5.3. Knowledge, Access to Information, and Expertise Level

The current system of collecting and disseminating information of environmentally sound technologies in Tajikistan is at the stage of formation. Projects are prepared for funding within the programs on environment rehabilitation and protection, e.g. on the Aral Sea problem.

A series of climate change projects consists of 46 proposals, including those aimed at transferring technologies of greenhouse gas emission reduction, increasing the energy efficiency, saving energy, and adapting to climate change. The project proposals include a short description, technology cost, time of implementation, environmental and other benefits. The projects are submitted by industrial circles, state ministries and departments, research institutions, and non-governmental organizations. The initial project base will promote a dialogue with investors and technology transfer process. The project realization will give a considerable impetus to the development of the legislative and institutional base, necessary for effective actions.

Obviously, not all of the proposed projects have a sufficiently well substantiated basic development scenario (e.g. greenhouse gas emissions) or show the effectiveness of new technologies. Increasing the expertise level in this respect is required. Special attention should be paid to analyzing environmental and other benefits, and determining project costs and technology level. Projects should be as diverse as possible.

5.4.Training and Improving Professional Skills

Technology transfer needs high-skilled leaders and technical workers. Specialists working on technology transfer process, must be well aware of environment issues, be able to assess technology needs, and determine the economic efficiency and environmental benefits.

While preparing the First National Communication on climate change, training seminars and consultative meetings were held covering, among others, the issues of project development and implementation. Experts acquired proper knowledge and initial experience. To provide the human potential development, however, it is essential to establish and support permanent working groups of experts. A realization of demonstration and full-scale projects plays an exclusively important role in getting practical experience. Cooperation on greenhouse gas emission issues, including that within the regional project on improving greenhouse gas inventories, coordinated by REC, is a good base for exchange of experience.

The methodological issues, related to technology transfer, greenhouse gas emission inventory, and climate change vulnerability assessment are still the cores of the problems. The methodology limits and procedures being complicated and inaccessible in local languages make experts' work extremely difficult.

Lack of environmentalists working with international agreements and organizations, and insufficient access to information resources erect barriers in developing cooperation and getting information of new technologies and political decisions.

In view of this, it is necessary to raise the knowledge level of experts in relevant subject areas , to organize training of specialists from responsible environmental structures so that they could study the international negotiation process in practice.

Of great importance is to disseminate international information among interested ministries and departments in due time and to promote providing access to Internet.

6 Project Development and Management

6.1. Investment Conditions

In the 1990s, the economic development level of the republic was considerably decreased due to the political instability, destructive natural disasters, and the breaking of traditional economic relations existing in the Former Soviet Union. By 1997, the GDP was reduced by over 60%, compared to 1991; the living standards sharply declined, 80% of the country population became poor. Unemployment covered up to 30% of labor resources.

Due to the efforts of the government, the country managed to secure peace and national concord, opening prospects for the socio-economic growth and macroeconomic stabilization. The inflation was reduced, the poverty growth was stopped, and the possibilities of budgetary funding were increased due to the income increase.

The main barrier in the economic development of Tajikistan is lack of the capital.

With the small inflow of foreign investments, the economic development is impossible. The available productive capacities are considerably obsolete and require updating and restructuring. From the environmental point of view, the greater part of the production base of the republic (over 75%) is considered inefficient, being over 20 years old. On the whole, the republic is rich in manpower resources, however there is a deficiency of skilled specialists.

The republic possesses rich hydropower resources, on which the energy and industrial sectors development is based. The warm climate, combined with abundant water resources, creates favorable conditions for cotton-growing. These factors will determine the current and future economic base of the country.

The present situation in Tajikistan is favorable enough to involve foreign investments, support market structures and develop the business, financial and bank system.

The RT Law of Foreign Investment was accepted in 1992; it provides investors with broad possibilities and considers a number of legal guarantees and privileges (participation in privatization, investment reimbursement, income transfer abroad, bank account opening, insurance security, taxation and customs privileges).

The foreign business activity, related to establishing enterprises, is regulated by the RT Law of Foreign Investment (1992), RT Law of Businesses (1991), RT Law of Joint Stock Companies (1993), RT Law of Foreign Economic Activity (1993), RT Law of Concessions (2000), RT President Decree of Measures on Further Development and Improvement of Economy Reforming Efficiency (1999), and other legal documents. Agreements with foreign countries on: avoiding double taxation, investment security, etc., are signed.

Nearly 323 million US$ of foreign investments, including 224 million US$ of direct investments, were accumulated in the past 10 year period. The funds were used mainly in deposit exploitation and precious metal mining, non-ferrous metallurgy, cotton fiber processing, and drink production.

The main objectives of the state investment policy are:

- Improving and further developing the legislative base to promote the foreign investors' activity, considering the country interests.
- Considering the priorities of the socio-economic development of the republic in realizing large investment projects.
- Creating a favorable investment climate, establishing a stimulating taxation and customs

regime for foreign investors, applying practical mechanisms to protect interests and rights of investors in realizing investment and joint projects.

- Focusing on the social orientation of the investment activity, increasing investments in fundamental and applied sciences.
- Establishing a foreign investment insurance system.

In the long-term prospect, the investment policy will be realized in the following directions:

- Involving direct foreign investments in the real economic sector, thus providing a sustainable economic development.
- Using local sources budgetary funds, accumulated funds of enterprises, and people savings for investment purposes.
- Concentrating the capital investments on the most important projects and increasing the investment resource efficiency.

The government developed and is realizing the State Investment Program (1992), the main purpose of which is to involve international funds in priority projects realization. The program considers a project realization estimated at 474.2 million US$, 80% of which will be funded by foreign investors.

In 2002, direct investments in the republic were 4.5 times more, than in 2001. Over 140 million US$ of foreign investments are expected in 2003, which will be directed to the energy sector development 33%, industry reconstruction and re-equipment 24% (Tajik Aluminum Plant, "Azot" Joint Stock Company), road construction 14%, agricultural development 4%, etc.

The project of improving power supply in the Pamirs, considering a flexible tariff system, was managed to initiate with the support of the Aga-Khan Foundation and the International Finance Organization. A serious energy crisis was observed in this region for the past 10 years. Many villages were not provided with power in the winter period, despite the severe environmental conditions. People had to cut down forests. The current investments (26 million US$) will help to restore the Pamir energy systems, thus providing sustainable power supply for 260 thousand people. Since the specific cost of power production is too high for the local people, who have too low income, the project considers a flexible tariff system. The "Pamir Energy" Company was established on a concession agreement. This project is the first large non-governmental initiative in the energy sector of Tajikistan, which creates prerequisites for distributing this experience.

The government of the republic, together with the Asian Development Bank, developed a program of structural reforming the energy sector. New tariff plans are being introduced, the problem of debt settlement is being solved, measures on improving payment collection are being taken, work on establishing joint-stock companies and privatization of energy enterprises is being planned. Foreign investments amounting 2 million US$ will be directed to constructing small HPPs, 20 million US$ - to the Sangtuda HPP.

The current foreign investments in the industries have the following ratios:

- Non-ferrous metallurgy 23%
- Construction 8%
- Textile production 29%
- Precious metal mining and processing 28%
- Other industries 12%

The most important factor in winning the confidence of investors is the institutional quality and stability. Tajikistan is making efforts in developing, creating and legally registering market economy institutions, though there are still unsolved problems in this sector.

The institutional factors, equipment transportation issues, and inadequate terms of national bank crediting erect barriers in the investment development in Tajikistan. There is a problem of decision-making non-transparency and lack of an effective legal regulation of bankruptcy procedure; the policy, concerning competition, accounting, and audit, has to be reformed.

Realizing investment projects in the sphere of hydropower and production capacity rehabilitation seems the most important task. The GDP is expected to increase by 4 times for the period of 2001-2015. The development rate being high, the industrial production will increase by 4.2 times, agricultural

production by 2.2 times, by 2015. The poverty level will be lowered to 11%. The industries are supposed to develop by involving internal and foreign investments, the amount of which will be 5-10 times as much as the current level. To stabilize the economic situation, the annual average inflation level should be: in 2001-2005 9.6%, in 2005-2010 7.4%, in 2010-2015 5.8%.

In the nearest future, the government of the Republic of Tajikistan is going to provide funds for joint project realization, with participation of international financing organizations, amounting 9 million US$, i.e. 6% of the total cost of investments projects.

The various stages of the following projects are planned to realize in 2003-2004 and 2005:

- Rehabilitating the energy sector: a) the Nurek HPP aggregates; b) power supply of southern rural areas.
- Reconstructing and building schools in rural areas.
- Restoring the Yavan water-distributing system.
- Constructing Murgab-Kulma road and the Zigar-Khostav-Shkev roadcut of Kulyab-Kalaikhum highway.
- Rehabilitating Dushanbe-Kurgan-Tube-Dangara - Kulyab highway.
- Irrigating the area of 600 hectares in the Dangara Valley.
- Providing water supply and sewage purification in Dushanbe.
- Restoring the rural infrastructure.

Increasing investments and foreign loans (30% direct investments, 70% - international credits) for the period 2003-2015 is supposed. The largest volume of credits is supposed to use in the hydropower (50%) and transport (27%) sectors. The oil and gas complex will use over 50% of direct investments.

In order to promote a creation of integral economic space, Tajikistan joined the Eurasian Economic Community and Shanghai Cooperation Organization. Joining the World Trade Organization is planned.

A joint use of water, energy, and other resources, and transport infrastructure will give economic advantages to the Central Asian countries. Hydropower resource exploitation will decrease dependence on fossil fuels, thus reducing the impact on the environment. In this connection, Tajikistan could be an exporter of cheap hydropower.

6.2. The Strategy of Investment Involvement and Project Development

Measures on climate change mitigation can be more effective, if they are combined. These include:

- Setting emission rates and counting emissions.
- Carbon (greenhouse gas) emission and energy taxation.
- Incentives and privileges in using environmentally sound technologies.
- Technology standards and quality standards.
- Requirements for energy-saving and cleaner technologies
- Voluntary agreements on emission reduction.
- The state support of research work and new technology initiatives.
- International investments.

Involving international investments in climate change issues will considerably promote the implementation of the UN Framework Convention commitments, the socio-economic development, and new technology transfer.

The internal investments in environment protection in recent years are inconsiderable, making 0.07% of the GDP. The foreign support of environmental protection includes funds for policy planning and implementation in particular economic branches.

The economic reforms being realized have not reached the level, which could make it possible to save resources for internal investments in safer and more effective technologies, to reduce the share of energy-consuming and greenhouse gas emitting industries, and to transit to more efficient methods of production.

The role of environmental foundations in Tajikistan has decreased by the present time, because the real amount of funds, accumulated by these foundations, decreased due to inflation. Moreover, the current rates of environmental payments are too low, so enterprises have no incentive to reduce emissions. The difficult financing and economic situation in the republic does not allow payment increasing. Thus, environmental foundations cannot provide internal investments in climate change project realization for the time being.

The greater part of investments for environmental protection come from the industry's own funds, or as investments on account of payment for emissions, which are transferred to environmental foundations.

Actually, the updating of the available technologies can be expected through:

- Investments for environment protection.
- Investments in technologies, which provide economic and environmental benefits, e.g. energy efficiency, energy-saving, greenhouse gas emission reduction.
- Demonstration projects and experience distribution.

To involve investments, the following should be realized:

- Further reforming the energy sector, including improving the energy resource tariff system.
- Applying economic and legal incentives to use safe and resource-saving technologies.
- Improving the institutional and legislative base, developing and determining taxation and other privileges, and increasing the expertise level.

Extremely important is creating a mechanism of information exchange. To gain practical experience and to further develop the potential, the most probable strategy could be a realization of demonstration projects and medium-scale projects. The most important initial need is appointing a responsible body. It is necessary to provide effective coordination of state departments and interested parties, decision-making transparence, and distinct determination of responsibility at the institutional level.

Tajikistan in the nearest time should come to a political decision on joining the Kyoto Protocol to the UN Framework Convention on Climate Change. This, on the one hand, will show the loyalty of the republic to the process of the UN Framework Convention realization on the international scale, on the other create possibilities for involving investments in applying environmentally sound technologies in the economic branches of the republic.

The RT National Action Plan on climate change mitigation points to the necessity and advisability of joining the Kyoto Protocol.

The Kyoto Protocol includes three flexible tools of emission reduction: international quota trade, joint implementation, and clean development mechanism (CDM). They promote a creation of emission reduction units, which are used by developed countries for implementing their Kyoto Protocol quantity commitments.

The CDM was developed especially for non-Annex 1 countries, which were not committed to reduce emissions, so that they could have benefits resulted from applying technologies transferred or increasing investments in the energy, forestry, and other sectors.

The industrially developed countries invest projects in developing countries, which possess the emission reduction potential, e.g. energy efficiency improvement, renewable energy sources use, forest rehabilitation, etc. CDM investments can be in the form of financial contribution (grant), credit, leasing, and agreement on buying emission-points. A project implementation results in a formation of certified emission reductions, which are transferred to an investor. Certified emission reductions are approved by an authorized state body and the CDM Executive Council of the UNFCCC. CDM investments should contribute to the sustainable development of an invested country.

The guiding principles of CDM realization are developed within the framework of the international negotiation and consultation and approved by the UNFCCC Conference of Parties. The official CDM information, including project database and guiding principles, is on the UNFCCC Secretariat's web-site (http://unfccc.int/cdm).

The CDM has both positive and negative aspects. The positive aspects predominate over the possible negative ones. The main task of the CDM project implementation is greenhouse gas emission reduction promoting the global purpose of climate change problem solution. The CDM projects also result in harmful emission (CO, NO_x, SO_2, dust) reduction, aimed at improving the local environment. Efficient energy technologies favour resource saving. A development of renewable energy sources promote deforestation risk decrease and the living standards improvement. As the analysis shows, the CDM negative aspects are related to the implementation of the cheapest and effective emission reduction projects, resulted in a lower potential for emission reduction in the country in the long-term prospect, the expenses for its own emission reduction being increased; so the projects may be less attractive for investors. However, the greenhouse gas emissions in Tajikistan considerably reduced, compared to the 1990 level, so the above statement can be neglected. It is more essential for the countries, where emissions did not change or increased.

To realize CDM projects in Tajikistan, the initial stage should include:

- Joining the Kyoto Protocol.
- Creating an institutional base, an authorized official body to register and realize projects on greenhouse gas emission reduction within the framework of CDM and other initiatives.
- Developing a strategy for CDM project implementation.
- Determining priorities and the potential of CDM project realization, including social, economic, and environmental benefits and risks.
- Organizing cooperation with the CDM Executive Council and bodies certifying greenhouse gas emission reduction.
- Promoting the CDM participants' potential at the national level.
- Promoting exchange of information at the private or state level on the issues related to involving foreign investments and CDM project realization.

According to the Marakesh agreements (COP-7 UNFCCC), the CDM participants should appoint a specially authorized coordinating body (DNA) to discuss and approve the proposed CDM projects at the national level. This step is important both for the country, as a CDM participant, and for an investor, interested in a project approval by invested country and necessary official information.

Various strategies of creating the CDM institutional base are possible:

- Coordinating state body and the UNFCCC National Coordinator, who has the authority to solve CDM issues.
- Governmental Working Group.
- New state body or institutional unit.

No CDM projects have been implemented in Tajikistan till the present time, because, on the one hand, the republic is not a Kyoto Protocol party, on the other there is no potential for project management. As stated above, the country has good possibilities for involving foreign investments in CDM, so active work on practical realization of these projects should be done.

The basic line of projects should be calculated, considering emissions, which may occur if a proposed project is not realized. It is very important that the amount of emissions after a project realization would be less, than in case of project non-implementation, and would not be redistributed among other sectors or other areas. A project should be in line with the country's priorities in the social, economic, and environmental policy, and with sustainable development objectives.

The initial stage of the Kyoto Protocol CDM priority projects can include:

- Increasing energy efficiency.
- Renewable energy sources and transition to safe fuels.
- Reducing greenhouse gas emissions in the industrial and transport sectors.
- Forest rehabilitation.
- Improving agriculture and land management.

The climate change problem is a priority thematic direction of the Global Environment Facility (GEF), which serves the Framework Convention

financial mechanism. Projects, funded by the GEF, should address the global environment conservation and provide local benefits for environment and development. The GEF funds are managed by the authorized agencies: UNDP, UNEP, and World Bank.

The GEF Coordinator in Tajikistan is the Minister of Environment Protection, who gives a general guidance of work, discussion and submission of projects to the GEF. National coordinators in thematic areas, including climate change problem, and the GEF Coordinator are cooperating on preparing and selecting priority projects.

The GEF operational programs on climate change include:

- OP-5 "Removing barriers in energy efficiency and energy-saving".
- OP-6 "Promoting applying renewable energy sources by removing barriers and reducing project introduction costs".
- OP-7 "Reducing long-term expenses for energy technologies with low greenhouse gas emissions".
- OP-11 "Promoting the development of environmentally safe sustainable transport".

The GEF financing is extra funding. The principle of additional expenditure is in the GEF support provided for countries to the benefit of the global environment in addition to what is necessary for the national development. Thereby, the GEF projects should be in line with national environmental programs and policy.

According to amount of funds, the GEF projects are subdivide into:

- full-scale (1 million US$ and more);
- medium-scale (up to 1 million US$);
- small grant program (up to 50 thou. US$);

A project for funding by GEF should:

- be approved by the government of the country, which implements the project;
- provide real global benefits;
- keep within the framework of the corresponding operational program;
- provide participation of all interested groups and access to information;
- have a high scientific and technological potential;
- promote co-financing involvement from other sources.

Projects within the GEF operational programs can be implemented by: (i) government and its institutions, (ii) UN agency, (iii) NGO. For details, go to the GEF Secretariat's web-site (http://www.gefweb.org).

The Carbon Foundation, managed by the UNFCCC financing mechanism, supports the national-level activity on increasing the potential of carbon accumulation by natural absorbents, mainly forests.

There are other international sources of climate change project funding. International development agencies in developed countries support initiatives, aimed at solving a wide circle of problems: from greenhouse gas emission reduction, energy efficiency improvement, renewable energy sources, to the development of systematic climate observations. Canada, Japan, and Western European countries show interest for Tajikistan. International donors support work on raising the public awareness and measures on improving access to climate change information, e.g. through Internet resources.

Thus, there are a great variety of possibilities for involving international funds in climate change projects in Tajikistan. However, applicants are often not aware of or do not consider priorities and requirements of international financing agencies, preventing further development and positive assessment of proposals.

The investigation carried out made it possible to identify the main economic sectors and particular technology needs for reducing greenhouse gas emissions and increasing energy efficiency and climate change adaptation. As a result of the investigation, project proposals on the main discussed issues were selected and submitted to potential donors.

The CO_2 emission reduction potential of the selected projects is over than 800 thousand tonnes a year. The main volume of investments for the project implementation covers the energy and industrial sectors, which have the greatest possibilities for emissions reduction. The projects also include climate change adaptation issues, decrease of

natural disasters risk, and systematic observation improvement.

The ordinary project cycle includes the following stages:

- Selecting a project and formulating a project concept according to the requirements.
- Assessing the emissions reduction potential and developing a project document.
- Selecting an approving a project in the country.
- Submitting a project to investors and international financing organizations.
- Discussing and possible approving a project.
- Implementing a project and assessing results and benefits gained.

The main criteria, which are advisable to use in the process of technology identification and regional distribution, are:

1. Benefits for development:
- Potential increasing (the scientific and technological base development, institutional development, personnel training, new technologies development and application).
- Employment and improvement of the poor people well-being.
- Investments involvement.

2. Social acceptability (project conformity with the objectives of the socio-economic policy and sustainable development).

3. Reducing the negative impact on the environment (non-climatic aspects: forest cutting reduction, decrease of impact on ecosystems, environmentally balanced development, decrease of air contamination).

4. Impact on climate:
- Greenhouse gas emission reduction potential.
- Energy-saving potential.
- Adaptation potential.

5. Market potential:
- Economic efficiency.
- Commercial accessibility.
- Local resource use.
- Reproduction and potential area of use.

The main factors of realizing emission reduction projects are:

- The current level of technological development.
- Technology transfer issues.
- Investment potential.
- Barriers in technology application.
- Institutional and legislative base.
- Personnel potential.

The specific expenditure for greenhouse gas emission reduction is an important criterion for projects, particularly when they are discussed at the international level. Developing countries, like China, India, propose a great variety of projects; many of them show the least specific expenditure for emission reduction, which is attractive for investors (3 US$ per 1 tonne of CO_2-equivalent). In this connection, projects, proposed by the republic, should be market-oriented, considering the international situation, and demonstrate environmental, economical and other associated benefits basing on the country's priorities. Of special importance is approving the projects by state departments and the coordinating body.

The expenditure and efficiency analysis considers a calculation of all capital and operating costs within the framework of a particular project and a discounting of received inflow, aimed at determining the reduced expenditure cost. By this procedure, alternative methods of project implementation are evaluated, and a version with the lowest reduced cost is chosen. The purpose of the economic analysis is to find out if the project can give more profits, than other versions, including the project non-implementation.

The environmental assessment of a project is to show whether the discussed project versions, providing benefits from greenhouse gas emission reduction, are environmentally feasible, providing a stable state of environment, and promoting sustainable development. The environmental assessment helps to determine the conformity of projects with the country's priorities and their relation to strategies, programs, and action plans, aimed at environmental protection. As other countries' experience shows, that implementation of many projects on greenhouse gas emission reduction is fully justified economically, socially, and environmentally.

6.3. The Role of Participants in Technology Transfer Mechanism and Project Realization

To effectively participate in the international mechanism of climate change mitigation, including technology transfer, it is important to determine partnership areas inside the country.

The state bodies may provide a general guidance, technology transfer coordination, and, in many cases, internal and international investment involvement. In particular, their role and functions can be described as follows:

- Providing access to, distribution, and exchange of information.
- Setting minimum requirements to projects on climate change mitigation.
- Developing and applying rates and branch standards.
- Compiling a list of project priorities.
- Co-financing projects.
- Developing the infrastructure for project registration, coordination, and realization.
- Developing strategies of project realization.
- Assessing and monitoring of project realization.
- Providing support in the potential creation and expertise level increase.

The process of privatization and market reforming promotes a growth of the non-state economic sector. The business and private sectors will probably play a key role in implementing projects on greenhouse gas emission reduction, while the role of state bodies will be increasingly regulating, focusing on supporting social and scientific projects. In particular, the role of the business and private sectors in the process of technology transfer and project implementation may include:

- Planning and developing projects on green-house gas emission reduction.
- Managing and implementing projects.
- Monitoring of greenhouse gas emissions reduction and basic lines assessment.
- Reporting on project implementation.
- Cooperating with state bodies and evaluating the policy and measures effectiveness.

The public and NGOs are the most important beneficiaries of projects on climate change mitigation. They may be important through:

- Raising the public awareness on climate change issues, including new technology application, state policy, etc.
- Identifying projects (including demonstration ones) and taking part in project realization.
- Evaluating effectiveness of project realization.

A participation of the above parties in the technology transfer process will be determined for the most part by energy sector reforms, and improvement of the organizational and legislative base to involve investments and to realize climate change measures. In this respect, to remove or minimize barriers seems important.

6.4. Identifying Barriers in New Technology Transfer and Project Realization

New technology transfer and realization of projects on climate change mitigation may be difficult due to various barriers. Evaluating potential barriers and identifying possible ways of their removal make it possible to decrease associated risks and promote the potential development and investment involvement. The potential barrier analysis is given in table 6.1.

Table 6.1.

Barriers in new technology transfer and possible solutions

Potential barriers	Possible solutions
Country's competence: • Since Tajikistan has not joined the Kyoto Protocol, it may not participate in implementing projects of Clean Development Mechanism (international quota-trade).	• Joining the Kyoto Protocol.
Financial: • Poverty, enterprise low solvency. • Undeveloped system of environmental funds. • Insufficient financing of science. • Deficiency of capital for updating technologies and environmental measures. • Inadequate tariff policy in the energy sector. • Lack of greenhouse gas emission payment system. • High costs of non-traditional renewable energy sources. • Difficulties of investment involvement	• State support, involvement of local and international investments. • Improving the tariff policy in the energy sector. • Reforming environmental funds. • Identifying financing sources, with international donors involved. • Establishing special development funds. • Financial support of integration processes in science and education. • Discussing a possibility of partly refunding enterprises' waste and emission payments, so that they could fund works on emission reduction and waste recycling.
Legislative and program: • No incentives or privileges are provided in realizing measures on climate change mitigation. • The interaction of economic development plans with climate and atmosphere protection policy purposes is not shown. • No greenhouse gas emission rates or commitments on emission control and reduction are provided. • Understated penalty sanctions and payments. • There are no standards of energy efficiency in the construction and industrial sectors. • There is no framework legislation in the renewable energy sector. • There is neither a strategy of energy and industry development, nor a concept of rational use of energy resources and recycling raw materials and waste products. • No CDM strategy, criteria and procedures of project discussion, registration, and realization are developed.	• Improving the legislation in sectors related to climate change. • Providing privileges for emission reduction or voluntary commitments to reduce emissions and apply new technologies. • Developing and applying rates and reports on greenhouse gases. • Bringing the national legislation to conformity with international rules. • Developing and amending available taxes, penalties, and payments. • Applying the main NAP regulations on climate change in investment project implementation. • Developing and including projects on energy efficiency and emission reduction in the Program of State Investments. • Creating conditions for reaching specific rates of energy consumption. • Developing strategies and programs of the energy and industry sector development, combining issues of climate and atmosphere protection.

continuation of Table 6.1.

Potential barriers	Possible solutions
Institutional: • Undeveloped system of compiling a national cadastre of greenhouse gas emissions. • There is no institutional base for CDM implementation. • Insufficient support at the local level for encouraging low-energy projects, etc. • Non-transparent mechanisms of management and property in the energy sector.	• Developing a state mechanism of greenhouse gas emission management. • Re-organizing available structures of the energy complex management.
Market: • Undeveloped structure of new technology market. • Low rates of reforms in the energy sector. • There are no real possibilities for developing private property in the energy sector, primarily small energy. • Prevailing interests of large energy producers and consumers. • Indistinct dynamics of energy-carrier costs.	• Developing legal mechanisms, permitting a leasing and long-term purchasing of small energy enterprises.
Technological: • Outdated technologies. • Lack of technological maintenance. • Lack of or inappropriate state of air emission purification facilities. • Lack of the industrial production of small energy devices and the infrastructure. • Lack of forest monitoring. • Risk of technical breakage preventing reaching the rated capacity. • High maintenance costs.	• Technology updating. • Assessing the potential of non-traditional renewable energy sources in districts and economic zones. • New technology purchase (transfer). • Organizing a local production and maintenance of small energy appliances. • Implementing demonstration projects.

continuation of Table 6.1.

Potential barriers	Possible solutions
Information, publicity, and education: • Short of skilled personnel. • Lack of updated scientific-technological and research base. • Limited access to recent technological information. • Poor awareness of business circles, officials, and the public of climate change mitigation technologies, non-traditional renewable energy sources, etc. • Lack of open discussions and referendums on the energy development and management. • The teaching programs do not consider climate change issues.	• Training personnel, teaching people at all levels. • Scientific research in priority trends. • Developing technology database. • Entering information on project proposals in Internet. • Popularizing climate change issues in mass media, organizing training and seminars. • Raising the authorities awareness of greenhouse gas emission problem. • Involving industrial enterprises and the private sector in applied research. • Popularizing energy issues. • Establishing press-service in ministries. • Organizing public discussion of energy policy documents before these are adopted.

7 Participation in Systematic Observation Networks

Systematic and comprehensive climate observations are aimed at improving the interpretation of the global climatic system and mechanisms causing climate change. Studying the climatic system elements and dynamics will considerably contribute to effective and well-grounded economic, technological, and social solutions. In this connection, the available Global Climate Observing Systems (GCOS), including the GCOS component in Tajikistan, need improvement and development.

The hydrometeorological information is required to develop sustainable agriculture, determine the best time for crops sowing and harvesting, protect harvest from hails, design buildings, bridges, roads, and canals, provide cargo and passenger transportation security, etc. Monitoring and forecasting natural hydro-meteorological phenomena reduce their negative impact and prevent damages.

Adequately using hydrometeorological data in the national economy gives a high economic effect. The economic effectiveness of hydrometeorological service is 20:1, in critical years up to 50:1.

The economic branches of Tajikistan are much affected by the arid continental climate of Central Asia. Severe winters are a disaster for distant pasturing. Unusually hot summer after almost snowless winter causes a dramatic impact on agriculture, cattle breeding, hydropower sector, etc. Summer heat is trying for people. Hails cause damage to cotton areas and gardens. Heavy rains and mudflows wash out both crop areas and settlements; snow avalanches block roads, destroy infrastructure and industrial units. Shifting glaciers block up rivers and cause potentially threatening situations.

7.1. Hydrometeorological Observation Service

Natural disasters, related to weather and climate, are repeatedly causing human deaths, food production reduction, food and water reserve contamination, as well as destruction of many constrictions and household infrastructures. The role of hydrometeorology in 21 century is very important. The hydrometeorological activity is aimed at improving the well-being of the people. This work on the atmosphere and the ozone layer protection, providing special meteorological and hydrological service in the agricultural sector, fresh water resources conservation (including fresh water supply), flood mitigation and timely warning, early warning of extreme meteorological and hydrological phenomena, hydrometeorological observations and scientific research will provide security and well-being of the society in future.

The National Hydrometeorological Service (NHMS) of Tajikistan is a specially authorized state body carrying out systematic observations of the climatic system and environment. The observation data are used in taking measures on minimizing damages caused by natural hydrometeorological phenomena and preventing negative human impact on the environment.

The main purposes of NHMS are:

- Providing systematic observations of the climatic system and the environment affected by natural and human factors.

- Providing the government, organizations, and the public with information of actual and forecast state of environment.

The main objectives of NHMS are:

- Providing observations of the climatic system, atmospheric air contamination, surface water and soil pollution, and control of radiation and ozone concentrations.
- Providing served organizations with data on hydrometeorological situation at observation points both in real time and in historic observation series.
- Providing observation point operation (carrying out systematic observations, keeping station surroundings safe and invariable).
- Supplying the observation network with equipment for receiving and transferring information.
- Providing a proper technological level, unity, and comparability of measurement results.
- Processing, statistical analysis, and summarizing of information.
- Providing governmental bodies, the population, and economic sectors with forecasting hydrometeorological service.
- Providing data for hydrometeorological forecasting and warning of expected unfavorable phenomena.
- Warning served organizations of threatening atmospheric phenomena.
- Assessing the climatic system state and changes, agro-climatic resources, and surface water resources.
- Collecting and summarizing impartial data of the hydrometeorological regime of the republic area.

The Tajikistan NHMS activity is based on legislative and strategic documents, which determine its commitments and powers:

- RT Law on Nature Protection (1994);
- RT State Environmental Program (1998);
- UN Framework Convention on Climate Change (1998);
- Agreement on Intergovernmental Council on Hydrometeorology (2000);
- Provisions on Tajik Met Service (2001);
- RT Law on Hydrometeorological Services (2002);
- The RT National Action Plan for Climate Change Mitigation (2003)
- Resolution of RT Government on Appointment of WMO Permanent Representative (1996);

Climate protection is regulated by Article 52 of the RT Law of Nature Protection. According to the article, climate change observation should be organized, and long-term programs on climate issues should be developed.

According to the RT Law of the Hydrometeorological Services (Article 3), the priorities in this area should be:

- forming and managing the state observation system;
- determining state-level works on hydrometeorology; organizing and controlling their realization;
- providing the state observation system protection;
- providing Tajikistan's participation in international cooperation on hydrometeorology.

Article 8. The RT Law of Hydrometeorological Services determines the main principles of the hydrometeorological service:

- providing global and continuous observations of the environment;
- using uniform and comparable methods of the environment observation, as well as methods of collecting, processing and disseminating information received as a result of observations;
- providing safe implementation of work on actively influencing the meteorological and other processes;
- integrating with in-country and international environment monitoring systems;
- providing conformity of the hydrometeorological service with the objectives of public health, environmental protection, and environmental security.

According to the RT Law of Hydrometeorological Services (Article 12), the following kinds of environment observation should be used:

- surface meteorological;
- hydrological;

- glaciological;
- agro-meteorological;
- actinometrical and heat balancing;
- aerological;
- meteorological radar;
- ozonometrical;
- air, water, soil, land, snow cover, and vegetation pollution.

Being a member of the World Meteorological Organization, the Republic of Tajikistan provides the international meteorological community with the national observation service data through its NHMS and receives information from NHMSs of other states. This activity is regulated by Resolutions 25 and 40 of the WMO Congress (XIII).

The Hydrometeorological Observation Network of Tajikistan (fig. 7.1) was developed mainly to satisfy economic needs of the republic in hydrometeorological information for planning economy and making decisions on reducing the risk and damage caused by unfavorable hydrometeorological phenomena. The network currently consists of 58 hydrometeorological stations and 126 hydrological, meteorological, and agrometeorological points and posts of environment pollution observation (photo 7.1-7.2).

The Global Climate Observing System (GCOS) includes 2 Tajik stations. Tajikistan belongs to WMO Region II, Asia. The WMO's World Weather Watch involves 10 national stations, including 2 stations that conduct upper air observations (table 7.1 and 7.2, fig. 7.2).

Two stations (Isfara, Kulyab) are temporarily closed due to financial difficulties; three stations (Parkhar, Pyanj, Shaartuz) do not provide information because of bad communication. In the nearest prospect, it is planned to restore operation of the closed stations or, if it is impossible, to replace these by other stations with similar climatic conditions. The most prospective WWW stations, are the Khujand, Khorog, Istravshan (Ura-Tube) stations, having been conducting observations since the end of the 19th century.

The National Hydrometeorological Service does not have enough financial and technical resources to keep the network in stable operation or to develop it. This situation is negatively reflected on the quality of climate information, hydrometeorological forecasts, including floods and other threatening natural disasters, and prevents a development of climate change studies. The

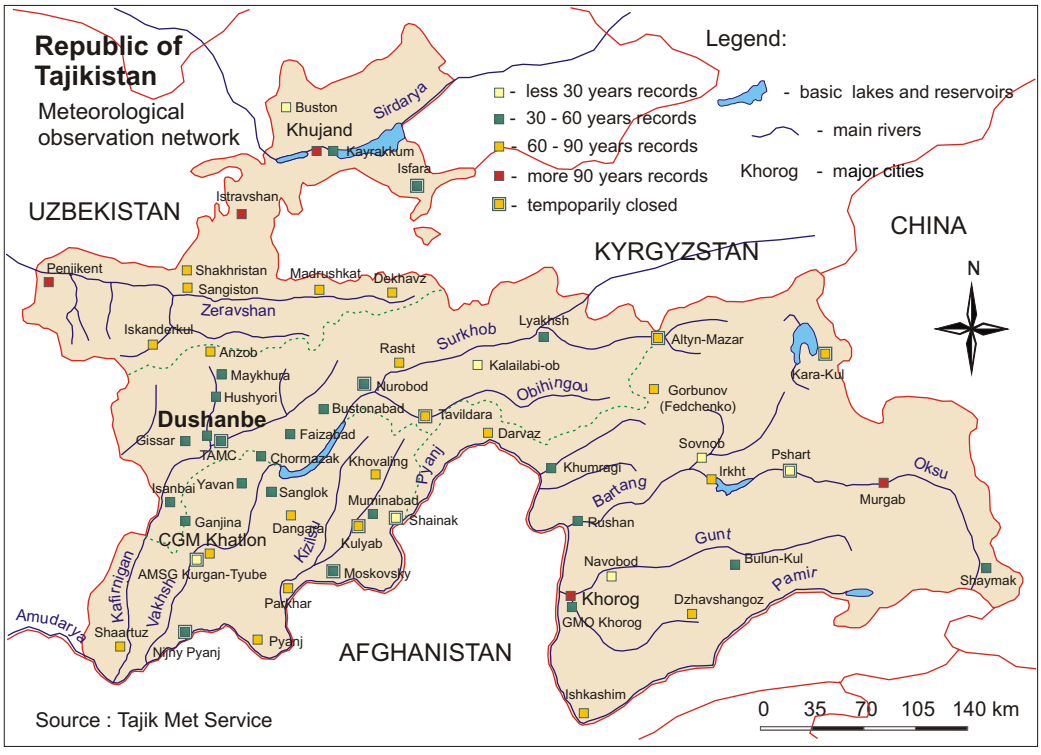

Fig. 7.1.

7.1. Meteorological station in Navabad

7.2. River gauging station on the Iskanderdarya River

Table 7.1.

Meteorological stations participating in the International data exchange network

Station	Coordinates	Altitude, *masl*	GCOS	WWW	IHN CIS
Dushanbe	38° 33' NL 68° 47' EL	800		+	+
Isambay	38 ° 03' 68 ° 21'	563			+
Istaravshan	39 °54' 69 °69'	1005		+	+
Isfara	40 °08' 70 °36'	873		+	+
Kulyab	37 °55' 69 °47'	659		+	+
Kurgan-tube	37 °49' 68 °47'	429	+	+	+
Lahsh	39 ° 17' 71 °32'	1998			+
Parhar	37 °29' 69 °23'	448		+	+
Penjikent	39 °30' 67 °36'	1015			+
Pyanj	37 °14' 69 °05'	363		+	+
Khovaling	38 °21' 69 °59'	1468			+
Khorog	37 °30' 71 °30'	2077	+	+	+
Khujand	40 °13' 69 °44'	427		+	+
Shaartuz	37 °19' 68 ° 08'	380		+	+

Source: Tajik Met Service

Table 7.2.

River gauging stations participating in the International data exchange network

No	Name	Water object
1	Nizhni Pyanj	Pyanj
2	Tigrovaya Balka	Vakhsh
3	Tartki	Kafirnigan
4	Dzharosurkh	Shirkent
5	Akdzhar	Syrdarya
6	Khudzhand	Syrdarya
7	Penjikent	Zeravshan
8	Iskanderkul	Lake
9	Kayrakkum	Water basin
10	Komsomolabad	Vakhsh
11	Kyzyl-Kishlak	Syrdarya

Source: Tajik Met Service

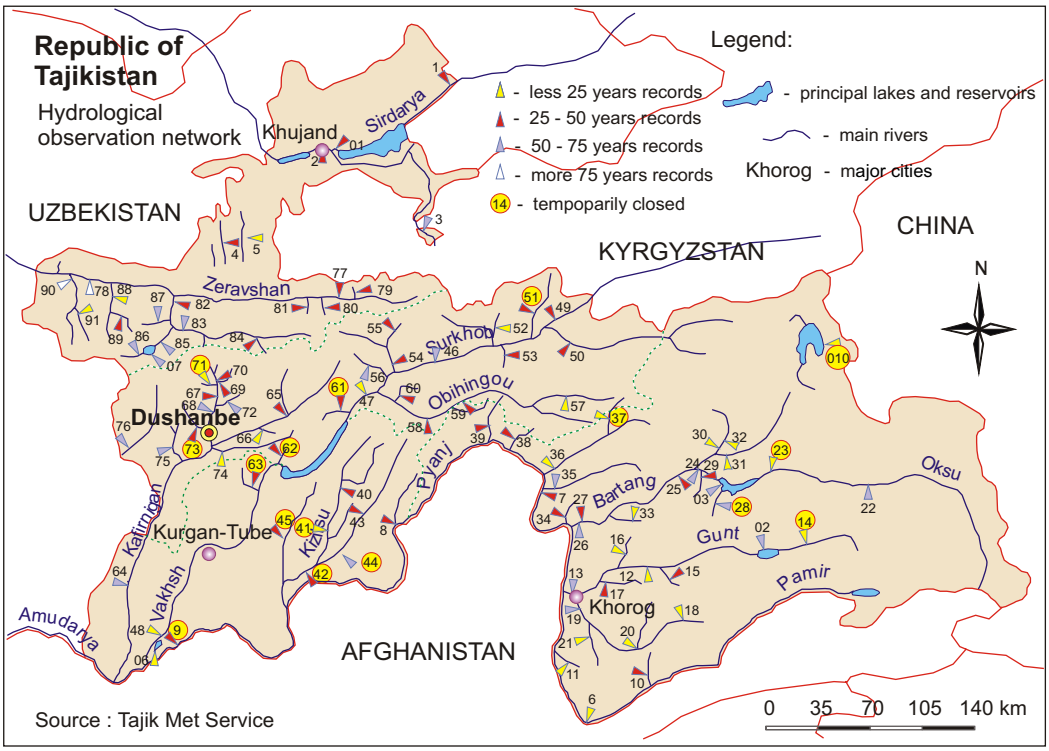

Fig. 7.2.

following measures should be realized: improving the observation network to preserve the most important observation points; minimizing the expenses for maintaining and bringing it in line with the modern requirements of management, technical equipment, and forms of consumers' hydrometeorological equipment.

Over 80 stations and 20 points have been opened in Tajikistan for the whole period of meteorological observations. Some of these were departmental, aimed at short series of specialized observations. The economic situation caused a reduction of the meteorological observation system due to the lack of equipment and materials.

At present, 11 of 58 stations do not operate . Some stations were temporarily closed because of lack of specialists. The stations difficult to access (including the unique Central Asian Academician Gorbunov meteorological station at the Fedchenko Glacier, 4168 m above sea level) were temporarily closed due to the lack of means necessary to maintain these and information which is present main importance for the flow rivers forecast, climate change observation, weather forecast and other.

Joint efforts of NHMS of Tajikistan, USAID and Swiss Mission on the Aral Sea have resulted in establishment of the automatic weather stations (photo 7.3).

At the last time the network of automated meteorological equipments begin to develop as in the distant mountains regions, thus and in densely populated advantage agricultural regions of republic. There are 9 AWS installed in different climatic zones

7.3. AWS mounting at the Academician Gorbunov Meteorological Observatory, Fedchenko Glacier

and altitudes. The data from the network of automatic weather stations is used for the operative serve of consumers and in regular action of NHMS.

Since the territory of Tajikistan is the zone of forming flows of Amudarya river and also Sirdarya and Zeravshan rivers, the main role is to conduct Hydrological observation and conditional estimation of the snow cover in the mountains for the forecast of watering rivers.

Consumers of meteorological information are:

- the population, through mass media;
- Republican legislative and executive bodies;
- force structures;
- transport;
- bodies preventing and combating emergencies;
- agriculture;
- fuel and energy complex;
- construction;
- households;
- other structures.

Consumers are provided with:

- data on regular observations at stations and points;
- meteorological, hydrological, agrometeorological, and specialized forecasts; warning of natural disasters;
- many-year record and characteristics of hydrological regime.

Ways of product delivery to consumers:

- daily hydrometeorological newsletter;
- providing weather forecasts through mass media; the Central TV and Radio broadcast weather forecasts and warnings of threatening weather phenomena several times a day;
- providing consumers with information through teletype, telephone, and e-mail;
- providing access to confidential reference information in the Hydrometfund reading-room.
- making excerpts and calculations at consumer's request.

7.2. The Main Barriers in Developing Hydrometeorological Observation Service

The best developed hydrometeorological observation system existed in Tajikistan until 1990; since then, both the station and point network and the observation volume have been steadily reduced. In 1991-2002, the hydrometeorological observation system of Tajikistan was reduced by 20%, as compared to the decade of 1981-1990. The most unfavorable consequences are observed in the mountainous regions, where hydrometeorological observations seem most important, and in densely populated settlements, where observations of the environmental pollution is particularly urgent. The current state of the system does not meet the requirements, so the effective participation in the Global Climate Observing System and other networks appears difficult.

The National Hydrometeorological Service does not have enough means to maintain the system operation and development. The present funding and material-technological equipment of the service makes 5-10% of required amount. Thus, a number of stations and points were closed, some of observation points considerably reduced the volume and number of environment measurements. Most stations have outdated and obsolete instrumentation and equipment; the system has not been provided with new equipment for the recent decade. The difficulties with providing new instruments and realizing works on carrying out measurements of proper precision may result in low-quality and invalid data.

The current economic situation in the Republic was the main reason for skilled specialists quitting the hydrometeorological service, and no young specialists coming. The available specialists are not properly trained, for the present requirements of serving consumers, and providing and processing information are much higher. There are many vacancies, which has a negative impact on carrying out and processing the results of hydrometeorological observations.

The problem of training skilled personnel is very acute at the present time. A Department of Meteorology is established at the State National University; however, the technological base is too weak to train specialists in aerology, agrometeorology, actinometry, and radio operators of stations equipped with their own means of communication.

The Main Administration is short of specialists in forecasting, hydrology, agrometeorology, and computer operators. Of special concern is providing the observation network with specialists. Many workers of the stations have no special education; no seminars or advanced training courses have been organized for heads of stations in recent years. There are great difficulties in training medium-level specialists in agrometeorology and aerology.

The network is staffed only by 64%. Engineers (hydrometeorology) make 37% of the full strength, technician-meteorologists 64%, technician-hydrologists 67%, engineer-chemists 48%, communication engineers 81%.

To improve the staff potential, support in training specialists (weather forecasters, hydrologists, and climatologists) at specialized hydrometeorological educational institutions and services in near and far foreign countries is needed. It is necessary to organize courses of training observers of hydrometeorological stations should be organized; exchange and participation of specialists in training seminars on developing and applying new forecasting methods, using digital information from satellite in weather forecasting and forecast analyzing, using hydrometeorological means, improving the efficiency of working with data, and studying the climate change processes. However, lack of finance is a serious barrier in the potential improvement in this area.

The hydrometeorological observation system underwent considerable changes in the recent decade, which is a serious barrier. In 1988, the agrometeorological observations were carried out at 29 stations (two of these were specialized stations) and 14 points, while by 2001, their number reduced to 21 stations and 8 points, of which 7 points do not conduct any agrometeorological observations. The work is restricted to observing the phases of agricultural crop development and meteorological conditions in small areas. Reports from the network do not come in time. No aerovisual or satellite observations of pasture vegetation have been carried out in recent 11 years.

Earlier, aerological observations were carried out at 3 stations (Khujand, Dushanbe, and Khorog) in 4 standard periods. Since 1996, this work was stopped at all stations, due to the lack of consumables and outdated radar equipment.

Of five actinometrical stations, observations are conducted at two stations (Hissar MS and Kairakkum Reservoir MS). Lack of instrumentation systematic calibration (which was made earlier in the Crimea and Uzbekistan) makes the actinometrical observations less precise.

Till the 1990s, hydrological observations were carried out at 11 stations and 138 points. Hydrological forecasts (daily, for decade, month, vegetation period) were made over 5 main river basins. A regular hydrological year-book was issued. In the late 1990s, the number of observation points and the volumes of work reduced to 89 (2001).

In recent years, ozonometric observations were not conducted due to lack of specialized tables for processing the observations, damaged instrumentation, and lack of specialists.

In 1993-1997, the number of points and the observation program were reduced. At the present time, a monitoring of air pollution in the republic is being carried out according to a reduced program at 5 permanent points only in Dushanbe and Kurgan-Tube. The available instrumentation is quite obsolete and outdated.

Since 1990, the situation with snow-measuring observations in the mountains, without which the precise assessments of the current water resources and forecasts in a region are impossible, has been worsened. No annual list of avalanches and mudflows is issued.

The level of observation automatization is low in Tajikistan. Most parameters (hydrological and

meteorological) are measured by an observer, followed by writing down the data in special notebooks. Then, the data are encoded and transferred over means of communication to the informational processing center. The main shortcomings of the available system of collecting the observation data are: the high cost of telegram transmission, the great number of errors in preparing and transmitting telegrams from the stations, and the lack of feedback with most of stations and points.

This situation may produce a negative impact on the quality of climatic information and forecasts of weather and river flow, including floods and other dangerous natural phenomena. It prevents a development of climate change investigation, its impact assessment, and integration of Tajikistan into the Global Observing System.

7.3. Potential Development Needs

The improvement of systematic observation of the climatic system is determined by the UN Framework Convention (Article 5) as one of the priorities in studying the global climate, its change factors and consequences.

Hydrometeorological information is necessary to provide sustainable agriculture, to determine appropriate time for crop sowing and harvesting, to protect harvest from hailstones, to design buildings, bridges, roads, and canals, to provide safe cargo and passenger traffic, etc. The monitoring and forecasting of severe hydrometeorological phenomena reduce the scale of their adverse impacts and allow the prevention of damage.

Considering the great importance of agrometeorological observations for sustainable agriculture under the climate change conditions and the high value of instrumental observations of vegetation phenology, which is a factor of climate change, the following work is required:

- Rehabilitating observations at the station and point network, particularly in areas prone to unfavorable natural phenomena and highly vulnerable to climate change;
- Providing the station and point network with gauges and equipment;
- Applying new methods of forecasting and modeling the vegetation status and capacity;
- Rehabilitating aerovisual and surface observation of pasture vegetation, with efficient methods being used;
- Connecting to the satellite system of the Earth surface observation (vegetation and soil monitoring) and using updated computer means for decoding and processing the satellite information;
- Developing and applying effective mechanisms of interaction with consumers of agrometeorological information and encouraging the development of volunteer-observers' network in rural areas, particularly in the arid plain and mountainous zone of the republic.

Considering the importance of aerological data for weather forecasts and aeronavigation, it is necessary to:

- restore the atmosphere radioexploration in the republic, with further expansion of the aerological station network;
- provide the available aerological stations with new equipment and expendables, enough to carry out regular observations;
- rehabilitate the pilot-balloon observations at airmeteorological stations.

To renew and develop the actinometric observation network, aimed at a more detailed studying of the solar radiation regime, the following work should be done:

- calibrating the instruments at the operating stations according to the internationally accepted standards;
- rehabilitating actinometric observations in the southern republic (Kurgan-Tube) and at the high-

mountain Academician Gorbunov station (Fedchenko Glacier), with new instrumentation and equipment being installed;

- create conditions for processing observation data at the Main Administration on Hydrometeorology, in cooperation with the Main Geophysical Observatory named after Voyeikov (St.-Petersburg, Russian Federation).

To update and further develop the network of hydrological observation points, in relation to improvement of forecasting, accounting, and managing the water resources, and effective participation in the global system of observing the hydrological cycle, it is urgent to:

- assess the location of points and the representation of the available hydrological observation network and develop recommendations on optimization;
- restore hydrological points and stations, suffered from floods and other natural disasters, and change the location of some observation points;
- renew the operation of temporarily closed hydrological gauges;
- pay special attention to hydrological observation points, which are important for transboundary accounting of water resources at the regional level and highly valuable for studying the hydrological cycle of the Aral Sea basin, including the river flow and flood forecasts;
- purchase necessary instrumentation and equipment for particular stations, and provide their installation and proper exploitation;
- restore the full volume of surface and aerovisual observations of the snow cover in the mountains and its water capacity;
- develop a network of automatic hydrological gauges and early warning systems, particularly in the upper reaches of river basins, prone to forming mudflows and floods, and in almost inaccessible mountainous areas with stable riverbeds for sustainable operation of instrumentation;
- promote providing the network with automatic observation instruments, including water level recorders;
- provide the stable mechanism of observation data transfer from gauges to interconnecting stations and then to the Main Administration.

The ozone-measuring observations are very important for assessing the atmospheric air quality and studying the climate change; in this connection, it is necessary to:

- rehabilitate observations at the Dushanbe station;
- expand the network of ozone measurements, with new equipment being applied, including that for studying the stratospheric ozone layer (using surface means of observation and TOMS data);
- create conditions for computer processing and storing observation materials at the Main Administration on Hydrometeorology.

Considering the great importance of the environment pollution observation data for monitoring of greenhouse and other harmful gas emissions, and assessment of their impact on the environment, it is necessary to:

- restore the proper level of monitoring the environment pollution, including the observation number and quality;
- calibrate the available instruments and equipment, and ensure the measurement quality conformity with the international standards;
- equip the network with new automatic instrumentation, expendables, and spares for the instruments used;
- optimize the location of environment pollution monitoring points;
- include the measurement of greenhouse gas concentration and the assessment of intensity of emissions from stationary sources;
- organize a CO_2 concentration measurement point in the mountainous area, mainly at 2000 masl or higher, at a maximum distance from greenhouse gas emission sources;
- apply updated methods of forecasting the environment pollution and compiling year-books.

To restore and further develop specialized observations, it is necessary to:

- optimize the system, methods, and routes of observations, with the climate change being considered;

- fill up staff vacancies of the hydrographic expedition department, and provide it with updated measuring means, expeditionary equipment, and data processing systems;
- restore the proper level of observations of forming the snow cover and its water capacity, including those using surface, aerovisual, and satellite methods;
- develop the system of observing the glacier regime and dynamics;
- rehabilitate observations of outburst-dangerous lakes and constructions;
- improve observations of mudflows and avalanches.

An alternative of the available observation data collection system is transition to new computer technologies, which will allow automation of information collection from the observing system, further reduction of the process cost, and data quality improvement. In his connection, it is necessary to:

- ensure maintenance and renewal of the available means of information transfer at all observation points;
- pay special attention to the station and point network, included in the regional and global observing systems, provide these with computerized receiving and transferring equipment, and create stable communication lines;
- equip the central communication knot with a computerized meteorological telecommunication system to provide automated collection, checking-up, and dissemination of meteorological information both inside the republic and among the regional and global meteorological telecommunication centers;
- ensure the autonomy of information transfer and exchange systems;
- install an advanced very high-resolution system of receiving satellite meteorological information (AVHRR), in order to improve the reliability and completeness of weather forecasts, environment pollution monitoring, assessment of snow stock and vegetation, and observation of water flow and glacier dynamics.

To improve and automate the system of processing, checking-up, and storing information, it is necessary to:

- apply a computerized system of weather and river flow forecasting, based on digital information, received from satellites, and surface observation data, particularly from mountainous regions;
- introduce computer means, networks, and software for processing and storing observation data in the regular activity of Tajik Met Service specialized departments;
- create databases of hydrometeorological observations and environment pollution, with perfect mechanisms of time-and-space monitoring and data representation forms.

To update and further develop the national meteorological observing system and to improve the efficiency of points of the Global Climate Observing System and the Inter-Governmental Observing System, it is necessary to:

- conserve the available meteorological observation stations, considering the presence of long-term series of climate observations; the observations are carried out according to many-purpose programs, the data from many stations being used directly by the economic branches of the republic;
- pay special attention to the high-mountain meteorological stations, which are very important for weather and water flow forecasts at the regional level and valuable for global studying the climate change;
- carry out investigation of and analyze information on the network optimization, and work out relevant recommendations, including methods, observation instruments, and observation point location;
- rehabilitate the damaged points and stations and repair offices and residential rooms of the available observation points;
- purchase necessary instruments and equipment for particular stations and provide their installation and proper maintenance;

- examine and calibrate all the instruments and equipment used and bring these into conformity with the international standards;
- expand the network of surface snow-measuring points and provide them with equipment for automatic measuring the snow cover thickness and its water equivalent, as well as precipitation by precipitation-measuring instruments with quick data transfer to meteorological stations (hydrometric stations) or directly to Tajik Met Service;
- develop a system of automatic meteorological stations, particularly in almost inaccessible areas, in order to reduce gaps in scientific knowledge and to improve forecasting of natural disasters, including floods;
- promote equipment of the system with automatic observation instruments;
- provide a stable mechanism of observation data transfer;
- ensure access to high-precision satellite information and weather maps.

To develop the potential, it is necessary to realize purposeful projects and measures on optimizing the observing system in order to preserve the most important observation points, minimizing expenses for its maintenance, and bringing it into conformity with new requirements on management, equipment, and forms of providing consumers with hydrometeorological information. This will add to the global observing system in the region and considerably improve the quality of service.

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Abbreviations

ACSEP	- Automatic Control System of Engineering Process
AWS	- Automatic Weather Stations
CDM	- Clean Development Mechanism
COP	- Conference of the Parties
DRS	- Districts of Republican Subordination
GBAR	- Gorny Barakhshan Autonomous Region
GCOS	- Global Climate Observing System
GDP	- Gross Domestic Product
GEF	- Global Environment Facility
GHG	- greenhouse gas
GIS	- Geoinformation System
HP	- heating plant
HPP	- hydroelectric power plant
IFAS	- International Fund for Saving the Aral Sea.
IPCC	- Intergovernmental Panel on Climate Change
JV	- joint venture
ME	- Ministry of Emergency
NAP	- National Action Plan
NGO	- non-governmental organization
NHMS	- National Hydrometeorological Service
NHP	- natural hydrometeorological phenomena
OP	- operational program
PFC	- perfluorocarbon
RT	- Republic of Tajikistan
SHPP	- small hydroelectric power plant
TadAZ	- Tajik Aluminum Plant
TNA	- Technology Needs Assessment
TPP	- thermoelectric power plant
TT	- technology transfer
UN SPECA	- United Nations Special Program for the Economies of Central Asia
UNDP	- United Nations Development Program
UNEP	- United Nations Environmental Program
UNFCCC	- United Nations Framework Convention on Climate Change
USAID	- United States Agency for International Development
WHO	- World Health Organization
WMO	- World Meteorological Organization
WWW	- World Weather Watch

Chemical symbols:

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

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Annexes

Projects for financing in priority sectors

Part 1. Reducing greenhouse gas emissions and increasing energy efficiency

Project No.1

Project Name: Updating the heat supplying system in Dushanbe.		
Purpose: Reducing non-production heat losses in the heat supplying system of Dushanbe and increasing the energy resource efficiency.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Energy	500 thou. US$
Description: No work on repairing or reconstruction of the Dushanbe heat supply system was carried out in the past decade, which caused a destruction of heat-insulation layer and pipe corrosion. This is the reason for heat transportation loss and emergency situations. Updating the heat supply system, including network and consumer's devices, and reconstructing boiler rooms are required.		
Expected results: • Heat losses reduction by 10-15%. • Sustainable energy resource management. • Greenhouse gas emission reduction. • Improvement of energy supply for the population.		
Required technologies: High-efficiency heat-insulating materials application in heat supply system.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 15 thou. tonnes a year.		

Project No.2

Project Name: Applying a solar heat supply system in the Dushanbe residential sector.		
Purpose: Using solar energy in hot water production and house heating.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Energy	250 thou. US$
Description: The amount of solar energy in Dushanbe is sufficient to effectively use it all year round. The sunshine duration in Dushanbe is 2800 hours, with solar radiation being from 95 w/square meter in winter to 317 w/square meters in summer. The solar heating technology is widely used all over the world. Its applying in Tajikistan is advisable for energy supply improvement and fossil fuels saving. The project considers solar collectors installation, with the total area of 2000 square meters.		
Expected results: • Replacement of fossil fuels by solar energy. • Heat energy and hot water supply, equivalent to 3 million kwh. • Greenhouse gas emission reduction. • Demonstrated possibilities of using non-traditional renewable energy sources.		
Required technologies: High efficiency solar collector application.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 700-1000 tonnes a year.		

Project No.3

Project Name: Installing natural gas counters.		
Purpose: Rationalizing consumption rates and increasing efficiency of natural gas consumption.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Energy	12,5 million US$
Description: At the present time, almost all private natural gas consumers have no counters. Gas consumption considerably exceeds the rates, on which payments are based. There is uneconomic and unreasonable natural gas consumption. To provide a reliable control of gas consumption by the population, 264 thousand domestic gas counters should be installed. People have no possibilities to buy and install gas counters, because of their low incomes. The project is a priority within the state investment program.		
Expected results: • 100-150 million cubic meters of natural gas saved annually. • Greenhouse gas emission reduction. • Reasonable use of gas fuel.		
Required technologies: Purchasing and installing domestic gas counters.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 85 thou. tonnes a year.		

Project No.4

Project Name: Installation of standard gaseous fuel equipment in transport and development of infrastructure for its maintenance.		
Purpose: Reducing greenhouse gas emissions from transport in Dushanbe and increasing transport safety.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Energy	300 thou. US$
Description: Currently, part of the public transport in Dushanbe is provided with gas equipment. This promotes a considerable reduction of harmful substance and greenhouse gas emissions. However, the transport machinery is provided with non-standard and inefficient equipment, which makes it unsafe for passengers. There is no special-purpose infrastructure to maintain and fuel vehicles with gas. To apply efficient and safe systems and expand gas fuel use in transport is prospective in terms of greenhouse gas emissions.		
Expected results: • Harmful substance and greenhouse gas emission reduction. • Increasing gas transport safety. • Gasoline fuel replacement and energy saving.		
Required technologies: Standard gas equipment for transport. Gas filling technology and infrastructure.		
Potential reduction of GHG emissions*: Greenhouse gas emission reduction by 20 thou. tonnes a year.		

Project No.5

Project Name: Applying energy-saving household devices in the Dushanbe residential sector.		
Purpose: Reducing electric energy consumption by the population.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Energy	100 thou. US$
Description: People use energy-consuming domestic electric appliances: incandescent lamps (100-150 w), technologically outdated heating and conditioning systems (1-2 kw). This causes energy over-consumption and energy resource deficiency, particularly in the winter period. Using and demonstrating effective application of little power-consuming domestic devices will create prerequisites for their wide use and production in the republic.		
Expected results: • Electric power consumption reduction. • Higher efficiency of energy use. • Energy resource deficiency decrease.		
Required technologies: Applying compact fluorescent lamps (CFL), low-energy-consuming heating devices, etc.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 5 thou. tonnes.		

Project No.6

Project Name: Introducing biogas low-power installations to produce electric and heat power for rural schools.		
Purpose: Reduction of methane emissions from waste products and associated energy production.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Energy	50 thou. US$
Description: The RT ministries and departments, in cooperation with international organizations, take part in constructing, reconstructing, and computerizing rural schools. In many villages, however, lack of electric power occurs, which to a considerable degree decreases the effectiveness of measures realized. Applying biogas devices will promote this problem solution, and provide methane emission reduction due to utilization of waste products accumulated in rural areas. The project will create prerequisites for distributing the experience to other regions of the republic.		
Expected results: • Methane emission reduction. • Electric and heat power production for rural schools. • Waste recycling. • Improvement of rural area socio-economic development.		
Required technologies: Standard low-power biogas installation.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 300 tonnes annually.		

Project No.7

Project Name: Constructing “Sangikar” small HPP.		
Purpose: Supplying remote Garm District areas with electric power, and reducing forest cutting.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Energy	410 thou. US$
Description: Consumers of inaccessible regions are currently insufficiently supplied with power. This results in a low socio-economic development level of the regions; people there use forest as a source of power. Forest cuttings are associated with increasing erosion processes and natural disaster risk, and biodiversity reduction. Constructing a small HPP at the Sangikar River, Garm Region, will supply people with hydropower, improve their social conditions, and promote the economic development.		
Expected results: • Providing people with 3 million kwh of hydropower annually. • Forest cutting reduction. • Fossil and wood fuel consumption reduction.		
Required technologies: **Small HPP equipment with the following characteristics:** • Installed capacity (N) **-** 500 kw. • Rated height (H) **-** 25 m. • Estimated flow (Q) **-** 2,5 cubic m/sec. • Number of generating sets - 1.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 3.5 thou. tonnes a year, compared to fossil and fire-wood fuels.		

Project No.8

Project Name: ”Tutek” small HPP construction.		
Purpose: Providing people in remote Garm District areas with hydropower and reducing forest cuttings		
Country	**Sector**	**Amount of Funds***
Tajikistan	Energy	676 thou. US$
Description: The difficult to access areas are not practically supplied with electric power at present. This resulted in a decline of the socio-economic development of these areas; the population of these areas uses forest resources as an energy source. Forest cutting is associated with increasing of erosion processes, risk of natural disasters, and biodiversity reduction. Constructing SHPP at the Tutek River in the Garm District will provide the population with hydropower, improve their social conditions, and promote the economic development.		
Expected results: • Providing people with hydropower (3.9 million kwh a year). • Forest cutting reduction. • Fossil fuel and firewood consumption reduction.		
Required technologies: **Small HPP equipment with the following characteristics:** • Installed capacity (N) **-** 650 kw. • Rated height (H) **-** 35 m. • Estimated flow (Q) **-** 2,25 cubic m/sec. • Number of generating sets – 2.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 4 thou. tonnes a year, compared to fossil and firewood fuel.		

Project No.9

Project Name: "Khorma" SHPP construction.		
Purpose: Providing people in remote Boljuvan District areas with hydropower and reducing forest cuttings.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Energy	462 thou. US$
Description: The difficult to access areas are not practically supplied with electric power at present. This resulted in a decline of the socio-economic development of these areas; the population of these areas uses forest resources as an energy source. Forest cutting is associated with increasing of erosion processes, risk of natural disasters, and biodiversity reduction. Constructing SHPP at the Khorma River of spring origin in the Boldjuvan District will provide the population with hydropower, improve their social conditions, and promote the economic development.		
Expected results: • Providing people with hydropower (2.1 million kwh a year). • Forest cutting reduction. • Fossil fuel and firewood consumption reduction.		
Required technologies: Small HPP equipment with the following characteristics: • Installed capacity (N) - 360 kw. • Rated height (H) - 48 m. • Estimated flow (Q) - 0.96 cubic m/sec. Number of generating sets – 1.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 2.5 thou. tonnes a year, compared to fossil and firewood fuel.		

Project No.10

Project Name: Switching of coal boilers in the northern areas of the republic to environmentally safe fuel "ECOWOOT"		
Purpose: Reducing harmful substance and greenhouse gas emissions from coal boiler-rooms.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Energy	800 thou. US$
Description: There are considerable coal resources in the northern areas of Tajikistan, which (with the current energy resource deficiency) makes it possible to apply technologies of high-efficient coal use in boilers, basing on "ECOWOOT" fuel. The "ECOWOOT" fuel is a fine-dispersed mixture, based on coal and water, which can be used instead of traditional coal fuel at thermoelectric power plants, in boiler-rooms, and other enterprises, without considerable reconstruction of boilers and furnaces. "ECOWOOT" fuel is environmentally safer, than traditional coal fuel; it possesses a greater heating value and burns with minimum harmful emissions.		
Expected results: • Improvement of energy supply of the population. • CO_2 and harmful substance emission reduction. • New technology application with minimum expenses.		
Required technologies: Constructing an installation for "ECOWOOT" fuel production. Boiler-rooms reconstruction to use "ECOWOOT" fuel.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 50 thou. tonnes a year.		

Project No.11

Project Name: Switching from cuprammonium purification technology to a more advanced technology of converted gas purification from CO_2 and CO at “Azot” Join-Stock Company.		
Purpose: Reducing carbon dioxide emissions from ammonia production.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Industry	1 m 500 thou. US$
Description: The capacity of ammonium production at “Azot” Joint-Stock Company is 124 thou. tonnes a year. One of the sources of CO_2 emissions is return gas resulted from regeneration of copper-ammonia solution. Because of the technologically obsolete equipment, depressurization of pipelines and destruction of heat exchanger pipes occur. It results in return gases, containing CO_2, emissions in atmosphere. The intensity of CO_2 emissions is 48 thousand tonnes a year. The project considers introduction of "know-how" technology of removing CO_2 and CO from converted gas.		
Expected results: • Greenhouse gas emission reduction. • Annual amount of saved electric power estimated at 165 kwh. • Improvement of technological process and resource saving. • Improvement of environmental security.		
Required technologies: Introducing the technology of methane purification of converted gas to remove CO_2 and CO.		
Potential reduction of GG emissions: CO_2 emission reduction by 57 thousand tonnes a year.		

Project No.12

Project name: CO2 emission utilization in chemical production.		
Purpose: Organizing soda ash production at "Kimiyo" Joint Stock Venture (JV), based on CO_2 emission utilization in chemical industry.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Industry	1 m US$
Description: There is the largest plant in Central Asia - "Kimiyo" JV - producing chloride-bearing substances, including chloride of lime and burned building lime, etc. The lime production capacity is 85 thousand tonnes a year. Currently, CO_2 resulted from the lime production is not utilized, being completely emitted in the atmosphere (more than 100 thousand tonnes a year). Other chemical enterprises ("Azot Joint-Stock Company) also emit considerable amounts of CO_2 emissions, which can be utilized in production.		
Expected results: • Introduction of new technology of calcinated soda production. • CO_2 emission utilization in chemical industry.		
Required technologies: To utilize CO_2 emissions in chemical industry, organization of calcinated soda production is suggested. Purchasing and mounting of production equipment is required.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 100 thousand tonnes per year.		

Project No.13

Project name: Introducing the technology of thermo-insulating materials production to be used in building industry.		
Purpose: Creating conditions to reduce heat losses in residential sector and heating mains.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Industry	500 thou. US$
Description: Using high-efficient thermo-insulating materials in building houses and constructions and laying heating mains allows a reduction of heat losses by 30%, compared to traditional technologies, and electric power consumption for heating, if there is no central heating system. Because of energy use inefficiency, the power consumption in the residential sector increased by 5 times. A greater part of thermo-insulation is worn out or absent. It is urgent to improve energy efficiency and to reduce heat energy losses.		
Expected results: • Improving the efficiency of building and heating main thermo-insulation. • Reducing energy consumption for heating. • Reducing CO_2 emissions.		
Required technologies: Introducing technology of thermo-insulating material production, based on local raw materials.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 100 thousand tonnes a year.		

Project No.14

Project Name: Transition of the Dushanbe Cement Plant from "wet" to "dry" method of cement production.		
Purpose: Reducing greenhouse gas emissions and energy expenditure in cement production.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Industry	20 m US$
Description: The Dushanbe Cement Plant applies a traditional technology of cement production by "wet" method. The plant capacity is 1 million tonnes, though its annual output is 30-100 thousand tonnes of cement at present. According to this method, raw material is crumbled up, mixed, and blended; the raw charge is supplied to the furnace, with water being present, which requires additional energy for its further removing. The production modernization excludes water use, allows reducing of energy consumption in cement production and negative impact on the environment.		
Expected results: • Reduction of energy specific consumption. • CO2 and harmful substance emission reduction. • Increase of cement production.		
Required technologies: Introducing a technology of cement production by "dry" method, i.e. technological operations with clinker and charge are performed without using water, and the raw product is supplied to the furnace for sintering.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 200 thou. tonnes a year.		

Project No.15

Project Name: Introducing an industrial technology of solar water-heating collector production.		
Purpose: Providing private and corporate consumers with solar collectors of local production and developing a service infrastructure.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Industry	300 thou. US$
Description: At present, the republic has no capacities for solar collector production, their import being considerably limited due to the high cost of these installations. The access to solar heat supply appliances is very limited. The weather and climatic conditions allow effective using of solar energy to heat houses and produce hot water. The project considers purchasing of processing line for solar panel assembling and heat exchanger and pipeline network production.		
Expected results: The project realization will promote the local production of solar panels and make them available for consumers. Their use will allow reducing of fossil fuel consumption. The annual production of heat and hot water will be equal 1.5 million kwh from 1 thousand square meters of panels.		
Required technologies: Providing a processing line for solar panel production at local machine-building enterprises.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 300 tonnes a year from 1000 sq.m of panels.		

Project No.16

Project Name: Introducing inhibition to decrease baked anode oxidability in the process of electrolytic production of aluminum.		
Purpose: Reducing greenhouse emissions through increasing baked anode inertness.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Industry	600 thou. US$
Description: The Tajik Aluminum Plant, with capacity of 450 thousand tonnes of aluminum a year, is the largest industrial source of greenhouse gas emissions. In aluminum production by electrolysis, anode oxidation occurs as a result of interaction of anode carbon with air oxygen. The total amount of emissions resulted from anode oxidation is 300-400 thousand tonnes annually. Using of inhibition will allow reducing of anode oxidability and greenhouse gas emissions.		
Expected results: • Greenhouse gas emission reduction. • Reduction of anode specific expenditure for aluminum production.		
Required technologies: New technology of baked anode production with inhibition.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 40-50 thou. tonnes a year.		

Project No.17

Project Name: Optimization of coke calcination regime in aluminum production to reduce carbon dioxide emissions.		
Purpose: Reducing of greenhouse gas emissions, based on coke "Calcination" Process Control System in the mixing-press shop of the Tajik Aluminum Plant.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Industry	150 thou. US$
Description: In raw coke calcinations of baked anode production, the unrated temperature regime results in coke waste and greenhouse gas emissions. In this production, burning of natural gas is another source of CO2 emissions.		
Expected results: • Coke waste reduction by 30-40%. • Natural gas consumption reduction by 10-20%. • Greenhouse gas emission reduction.		
Required technologies: Advanced technology of coke calcination, based on "Calcination" Process Control System.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 4 thou. tonnes a year.		

Project No.18

Project Name: Improving "Electrolysis" Process Control System in one of the workshops of the Tajik Aluminum Plant.		
Purpose: Reducing greenhouse gas emissions by optimization of aluminum production engineering process.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Industry	700 thou. US$
Description: In the electrolytic production of aluminum, CO_2 and perfluorocarbon emissions, with high potential impact on the climatic system, occur. The ineffective technology promotes high volumes of greenhouse gas emissions and high power inputs. The "Electrolysis" Process Control System improvement, including a development of software to minimize anode effects, is urgent.		
Expected results: CO_2 emission reduction by 10%. PFC emission reduction by 30-40%.		
Required technologies: Improving "Electrolysis" Process Control System, with automatic raw material supply appliances being introduced.		
Potential reduction of GHG emissions*: Greenhouse gas emission reduction by 100 thou. tonnes a year.		

Project No.19

Project Name: Applying transplanting method of rice cultivation.		
Purpose: Reducing methane emissions from rice growing on flooded fields.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Agriculture	300 thou. US$
Description: At present, the area of rice plantations in the republic is 30 thousand hectares. Rise is grown by a traditional method, promoting methane emissions. Rice crop areas are increased every year, which explains the need of methane emission reduction and improvement of rice growing technologies. Considering the soil and climatic conditions of Tajikistan, the transplanting method of rice cultivation is an acceptable and efficient technology.		
Expected results: • Methane emission reduction. • Introduction of an efficient technology of rice cultivation. • Increasing of the vegetation period by 30-40 days.		
Required technologies: Introducing of the transplanting method of rice growing and farmers training.		
Potential reduction of GHG emissions*: Methane emission reduction by 15-20%.		

Project No.20

Project Name: Introducing installations of methane recuperation from manure at large cattle-breeding farms.		
Purpose: Reducing methane emissions from cattle-breeding waste products.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Agriculture	600 thou. US$
Description: Cattle-breeding waste products are sources of methane and nitrous oxide emissions. The annual amount of methane emissions in this sector of the republic is 8 thousand tonnes. The project considers equipping of two large cattle-breeding farms (the number of livestock being 400 to 800) with methane recuperation appliances. These appliances will allow producing of 20-25 cubic meters of biogas from each farm annually and using it in electric power generation and thermal power production.		
Expected results: • Methane emission reduction. • Electric and thermal power production. • Saving of fossil and wood fuels. • Waste utilization.		
Required technologies: Industrial installation of methane recuperation from livestock manure.		
Potential reduction of GHG emissions*: CO_2 emission reduction by 4 thousand tonnes per year.		

Project No.21

Project Name: Planting erosion-preventive forest areas in the Ramit and Karatag canyons.		
Purpose: Increasing carbon absorption by wood biomass.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Forestry	400 thou. US$
Description: The total area of afforestation zones is 400 hectares. The zones of proposed forestation are the slopes of 12-30° steepness, prone to intensive water erosion.		
Expected results: • Increasing of carbon absorption by forest plants. • Reduction of carbon losses from forest soils. • Minimization of erosion processes.		
Required technologies: Within the project, slope terracing and forest planting of totally 500-1000 seedlings per 1 hectare is considered. The main tree varieties in forest planting are: Bukhara almond, walnut, poplar, and apple.		
Potential reduction of GHG emissions*: The estimated average annual stock is 200 tonnes of CO_2 per 1 hectare. The total amount of atmospheric carbon absorption will be 4 thousand tonnes.		

Project No.22

Project Name: Developing a system of field-protective forest shelterbelts on irrigated lands.		
Purpose: Increasing of carbon absorption by wood biomass and reducing the impact of wind erosion on agricultural soils.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Forestry	400 thou. US$
Description: In the 1990s, forest shelterbelts occupying the area of 4.5 thousand hectares, were completely cut down by the population and used as firewood, due to the deficiency of energy resources. Forest shelterbelts prevent wind erosion of soils and increase their fertility. Forests plantations under the conditions of irrigation are highly productive, being a considerable absorbent of atmospheric carbon.		
Expected results: Agricultural afforestation of 400 hectares of area, using quick-growing tree varieties, will allow increasing of carbon absorption by forest plants. The effective time of plant functioning will be 50 years on the average. The project will promote a reduction of wind erosion impact on agricultural soils and improvement of land productivity.		
Required technologies: Forest shelterbelts will be based on planting elm, apricot, oleaster, poplar, and other tree varieties according to the developed scheme.		
Potential reduction of GHG emissions*: Average annual stock estimated at 200 tonnes of CO_2 from 1 hectare is expected, the volume will increase as soil fertility improves and forest grows. The total amount of atmospheric carbon absorption will be 4 thousand tonnes per year.		

Part 2. Adaptation to Climate Change

Project No.23

Project Name: Reducing the risk of malaria development.		
Purpose: Realizing effective measures on combating malaria in the conditions of climate warming and hydrological regime change.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Public Health	200 thou. US$
Description: Climate change, against the background of worsening sanitary-and-epidemiological situation, results in increasing risk of infectious and parasitic diseases, particularly malaria. The irrational use of water in agriculture will promote increasing of malaria water reservoirs in Tajikistan. The project considers assessing of the republic area according to malaria risk, developing and realizing purposeful effective measures on combating malaria development.		
Expected results: • Assessment of the risk of malaria development. • Realization of measures on malaria prevention. • Raising the public awareness of reducing malaria areas and malaria development prevention. • Development of requirements to water-consumers to improve the hydrological regime of rivers and reservoirs.		
Required technologies: • Improving the collector-drainage and irrigation systems, particularly near settlements. • Implementing malaria-preventive works in malaria areas and water reservoirs.		

Project No.24

Project Name: Applying water-saving methods of irrigation in agriculture.		
Purpose: Reducing water resource and irrigated agriculture vulnerability in the conditions of climate and hydrological regime change.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Water Management	500 thou. US$
Description: The irrigated agriculture yields 90% of plant-cultivation product and is the main consumer of Tajikistan's water resources. According to long-term climate change models, the river discharge in the below located agricultural areas can be decreased under the influence of climate change, which will promote a deficiency of water resources for agricultural irrigation. Increasing of evaporation intensity in climate warming will promote increased water consumption. In these conditions, the agriculture and water vulnerability increases and new irrigation technologies need to be applied. The project considers implementing measures in the demonstration zone in the southern republic, where the major agricultural crops are cultivated.		
Expected results: • A 40% saving of water resources. • Increasing the potential of agriculture adaptation. • Reducing irrigation erosion and ravine-formation.		
Required technologies: • Drip irrigation. • Intrasoil irrigation and other advanced technologies.		

Project No.25

Project Name:
Restoring the available and constructing new bank-protecting and antimudflow structures with the improved safety level.

Purpose:
Reducing the risk of and damage caused by catastrophic mudflows and floods in the conditions of climate change.

Country	Sector	Amount of Funds*
Tajikistan	Water Management	50 m US$

Description:
Every year, mudflows and floods cause considerable damage to the economy of the republic and are the main source of losses of lives and property in natural disasters. In 1998, 2002, and 2003, dramatic floods and destructive mudflows occurred. The most dangerous areas in this respect are the lower reaches of the Vakhsh, Pyandj, Kafirnigan, and Zeravshan rivers. The main reason of the damage caused by mudflows and floods is the lack of or low efficiency of antimudflow structures. Assessing the risk of potentially dangerous mudflow areas, developing and constructing effective protective structures, and restoring the existing structures need to be implemented.

Expected results:
- Protecting of human life and property, particularly of the poor, in vulnerable areas.
- Reducing the damage caused by catastrophic mudflows and floods.
- Improving the adaptation potential to the impact of destructive natural disasters.

Required technologies:
- Applying high-efficiency antimudflow engineering structures.
- Reconstructing the existing antimudflow and bank-protecting structures.
- Constructing mudflow-catching canals.

Project No.26

Project Name:
Using data of long-term climate forecasting in agriculture.

Purpose:
Decreasing agriculture vulnerability to unfavorable climatic conditions.

Country	Sector	Amount of Funds*
Tajikistan	Agriculture	100 thou. US$

Description:
The modern climate change models allow determining with fine precision of potentially dangerous climatic changes and phenomena, like drought, high and low temperatures, and intensive precipitation. Integrating methods of agriculture management with climate change models will promote decreasing of agriculture vulnerability to unfavorable climatic conditions and is a base for taking preventive and adaptive measures.

Expected results:
- Reducing agriculture vulnerability.
- Receiving information to take adequate preventive measures.

Required technologies:
- Numerical climate change models with high resolution.
- Assessment models of climate change impact on agriculture.
- Training of specialists and seminars.

Project No.27

Project Name: Increasing the efficiency of combating agricultural pests in the conditions of climate warming, based on biological methods.		
Purpose: Reducing the damage caused by agricultural and forest pests in the conditions of climate change.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Agriculture	500 thou. US$
Description: In particular years, the climatic conditions are favorable for agricultural and forest pests, causing considerable economic and biological damage. It is known, that the risk of pests impact increases with climate warming. In this connection, technologies of agricultural land biological protection from pests should be applied. These methods are developed and tested in normal climatic conditions of Tajikistan. These technologies should be adapted to climate warming and widely applied.		
Expected results: • Reducing the agricultural damage caused by pests. • Application of environmentally safe methods of cultivated plant protection.		
Required technologies: • Efficient biological methods of combating agricultural pests.		

Project No.28

Project Name: Restoring the existing and constructing new protective structures at the main motorroads of the republic.		
Purpose: Reducing the risk of and damage caused by unfavorable climatic phenomena in the transport sector.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Transport	15 m US$
Description: The mountain motorroads are prone to climatic factors (daily and seasonal temperature amplitudes, precipitation) and natural disasters (mudflows, avalanches, and landslides). This leads to road paving destruction, make the motor transport risky, and limits access to remote settlements. Every year, more than 300 km of motorroads are prone to the above impact, which causes considerable economic damage. Technologies of transport and road infrastructure protection from natural hydrometeorological phenomena should be applied.		
Expected results: • Reduction of damage caused by unfavorable climatic phenomena. • Improving the transport sector safety.		
Required technologies: • Antiavalanche structures. • Antimudflow structures. • Water-way structures. • Slope-protecting structures.		

Project No.29

Project Name: Providing the central and local emergency bodies and headquarters with advanced means of communication.		
Purpose: Timely informing the population of and responding to emergencies of natural and anthropogenic character.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Natural Disaster	60 thou. US$
Description: Natural disaster consequences can be considerably reduced, due to the timely warning of the population and realization of preventive measures. The available communication system of emergency bodies functions with irregularity, being equipped with outdated means of radio communication. There are 13 radio stations in all. Many potentially dangerous areas of the republic have no means of communication. This decreases the adaptation potential in case of natural disasters. The central and local emergency bodies and headquarters need to be equipped with advanced reliable means of communication.		
Expected results: • Providing dependable communications between ME units. • Improving the preparedness and awareness of the population of natural disasters.		
Required technologies: • Advanced means of radio communication.		

Part 3. Improving Systematic Observations

Project No.30

Project Name: Developing a numerical map of avalanche risk, based on the geoinformation system (GIS).		
Purpose: Introducing the GIS-technology of avalanche risk monitoring and reduction in the command-and-control activity of the Tajikistan National Hydrometeorological Service.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Hydrometeorology	20 thou. US$
Description: Every year, avalanches cause damage to the national economy of the mountainous regions of the republic. The ministries and departments of the republic, working in conditions of highlands, are interested in receiving numerical on-line information of avalanches, based on GIS-technologies. Tajik Met Service possesses an adequate informational base. Assistance in entering data into electronic databases, providing computers and GIS software, and training specialists is needed.		
Expected results: The project realization will allow leaders of local administration and experts of ministries and departments of the republic to take timely preventive and technical measures on reducing the avalanche risk, to design constructed units (motorroads, power lines, mines, recreation zones, etc), to regulate national and international transportation, considering avalanche risk, and quickly respond to emergencies.		
Support requested: • Providing satellite information on avalanche risky areas. • Providing GIS software and computer. • Training of specialists, seminars.		

Project No.31

Project Name: Developing a numerical map of mudflow risk, based on the geoinformation system (GIS).		
Purpose: Introducing the GIS-technology of mudflow risk monitoring and reduction in the command-and-control activity of the Tajikistan National Hydrometeorological Service.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Hydrometeorology	20 thou. US$
Description: Every year, more than 80% of the republic area are prone to mudflows, which cause damage to agricultural crops, roads, dams, bridges, and other economic units. The ministries and departments of the republic, working in conditions of highlands, are interested in receiving numerical on-line information of mudflows, based on GIS-technologies. Tajik Met Service possesses an adequate informational base. Assistance in entering data into electronic databases, providing computers and GIS software, and training specialists is needed.		
Expected results: The project realization will allow leaders of local administration and experts of ministries and departments of the republic to take timely preventive and technical measures on reducing the mudflow risk and damage caused to dams, collector-drainage systems, bridges, motorroads, etc. The regional hydrometeorological services will gain access to information of the mudflow risk in the regions of the republic		
Support requested: • Providing satellite information on mudflow risky areas. • Providing GIS software and computers. • Training of specialists, seminars.		

Project No.32

Project Name: Studying shearing movements of pulsating glaciers and minimizing the associated risk.		
Purpose: Developing a methodological base to forecast pulsation of the Medvezhy Glacier and other potentially dangerous glaciers and applying this in the control activity of the regional hydrometeorological services on preventive measure implementation and glacial mudflow risk reduction.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Hydrometeorology	100 thou. US$
Description: There are 30-35 pulsating glaciers in the republic. Particularly dangerous for the economy and population is the Medvezhy Glacier, the Western Pamirs, the shearing time of which is 10-15 years. The pulsating glacier shearing results in forming dangerous glacial mudflows. Tajik Met Service possesses an adequate informational and methodological base, however assistance in studying the international practice, electronic processing of data, training specialists, and developing forecasting models is needed.		
Expected results: The technique will allow timely forecasting of a potential risk of pulsating glacier (particularly the Medvezhy Glacier) shearing movement, informing of the population, and taking of response measures. It will also promote a deeper understanding of glacier shearing movement caused by climate change, wider application of experience accumulated by WMO members, and development of joint investigations.		
Support requested: • Helicopter lease for aerovisual observations (15 hours of flight time). • Purchasing expedition equipment. • Providing satellite information on particular research areas. • Providing GIS-technology and computer for technique development. • Training specialists, seminars.		

Project No.33

Project Name: Automating the on-line activity of the Tajik Met Service, based on the automatic job network.		
Purpose: Creating an automatic job network (AJN) at the Tajik Met Service: satellite, weather forecaster, agrometeorologist, hydrologist, and meteorologist.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Hydrometeorology	30 thou. US$
Description: At present, the on-line information and hydrometeorological forecasts are processed manually; the poor technological equipment prevents from timely and high-quality serving of consumers. Assistance in introducing electronic data processing at the Tajik Met Service departments, based on AJN.		
Expected results: The project realization will considerably reduce the volume or routine manual operations, increase the quality of data processing, allow applying of computerized technology of hydrometeorological forecasting, quick exchanging of meteorological forecasts at the regional level, and to a considerable degree improving of providing consumers with hydrometeorological information. The project will promote an on-line exchange of forecasts with hydrometeorological services of the region.		
Support requested: • Purchasing and installing AJN: Satellite, Weather Forecaster, Agrometeorologist, Hydrologist, and Meteorologist. • Providing expert's service on AJN installation and training local specialists.		

Project No.34

Project Name: Improving the Communication Commutation Center (CCC) at the Main Administration on Hydrometeorology.		
Purpose: Introducing advanced computerized system of transceiving and initial processing of hydrometeorological information (CCC).		
Country	**Sector**	**Amount of Funds***
Tajikistan	Hydrometeorology	50 thou. US$
Description: Until 1989, the computer-based system of data transfer ("Cyclon" type) was operating, providing two-way twenty-four-hour communication with the CCC of the Tashkent Regional Met Service and weather stations. Due to the obsolete and broken equipment, the system was dismantled. At present, information is provided over the radio system, teletype and telephone; at the regional level - by telegraph (75 b/sec.). The system efficiency is very low. There are no electronic carriers and data processing software. All operations are carried out manually. A computerized system of collecting/processing information to maintain up to 200 stations, including automatic ones, access to Internet, and information duplication by alternative means of communication need to be provided.		
Expected results: The project realization will allow applying of modern numerical systems of receiving/providing and processing information and quick exchanging of hydrometeorological information at the regional and global levels. The forecasting departments will receive and provide on-line information of weather in the republic and in neighboring countries. The quality of information processing is improved.		
Support requested: • Purchasing, transportation, and installation of equipment for the computerized CCC and training of local specialists. • High-speed access to Internet.		

Project No.35

Project Name: Providing equipment for radioactive pollution observation		
Purpose: Providing a regular radiation monitoring of the environment at stationary observation points and improving the preparedness for emergencies (damages or radioactive leakages).		
Country	**Sector**	**Amount of Funds***
Tajikistan	Hydrometeorology	5 thou. US$
Description: The radiation monitoring is part of hydrometeorological service responsibility. In the Central Asian region, there are grounds for nuclear-waste disposal and capacities for recycling radioactive materials, which cause potential threat. Due to the existing risk of increasing radiation background, caused by anthropogenic or natural factors, regular radiation background measurements are carried out. Information is transmitted to the communication center. However, the instrumentation used is low-efficient. Tajik Met Service needs assistance in providing new instrumentation for stationary systematic observations of radiation background.		
Expected results: The project realization will allow improving of knowledge of policy-makers on the problem of radiation (environmental) safety, and informing of the population.		
Support requested: Instrumentation and equipment for: • Observing the radiation background of locality (monitors). • Determining water radiation pollution. • Determining radiation pollution of atmospheric precipitation.		

Project No.36

Project Name: Improving forecast assessments of climate change.		
Purpose: Introducing and testing climate change models of high resolution and applying these to assess the impact on the economic branches, natural resources, and human health in Tajikistan.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Hydrometeorology	30 thou. US$
Description: Special programs and computers with fine-resolution capacity are used for climate modeling. Depending on scenarios of increasing greenhouse gas concentrations, they allow developing of long-term climate change scenarios. Tajik Met Service possesses an adequate informational base and experience in using global models. Assistance in providing computers and software for fine precision modeling, and training of specialists is needed. The models are developed by Hadley Center, Canadian Climate Change Center, and other research organizations. The project is a priority within the activity on climate change study and modeling in the republic.		
Expected results: Introducing a regional model of climate change in Tajikistan will allow providing of a detailed, more accurate assessment of climate change effect on economic branches, natural resources, and health of the population, and developing of adaptation measures. The project realization will also improve the general preparedness to unfavorable natural phenomena, like drought, flood, etc.		
Support requested: • Providing computers and software for climate modeling. • Trainings of specialists, seminars.		

Project No.37

Project Name: Introducing a system of climatic data management at the Tajik Met Service of Tajikistan.		
Purpose: Increasing the efficiency of the Tajik Met Service activity on analyzing and processing climatic data and current meteorological information from the station and point network.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Hydrometeorology	15 thou. US$
Description: The observation data of the hydrometeorological network of Tajikistan are on paper carriers since 1997; no space-time control is being carried out. Data are processing manually. There is a risk of data loss. Tajik Met Service needs assistance in providing computers and software to enter data on electronic base and control the quality.		
Expected results: The project realization will allow the hydrometeorological service of Tajikistan to develop a climatic database. The transition to the update system will provide a complex approach to archive and manage climatic data, and allow expanding of area of data application both within the republic and on the global scale. The efficiency of climatic service provided for economic branches (agriculture, water management, construction, etc.) will be improved. The system introduction will considerably improve data management, quality control, and promote studying climate change issues.		
Support requested: • Providing computer equipment and software, network communications, and printing devices. • Training of specialists.		

Project No.38

Project Name: Providing instrumentation and expenditure materials to restore aerological observation network in Tajikistan.		
Purpose: Improving the system of observation and forecasting of atmospheric circulation processes and dangerous hydrometeorological phenomena.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Hydrometeorology	300 thou. US$
Description: The complex mountainous relief of Tajikistan creates local peculiarities of air mass circulation. That is why various atmospheric layers need to be characterized to make forecasts. Most methods of forecasting squalls, heavy precipitation, hailstones, storms, and other unfavorable phenomena, are based on actual and forecast data of air radiosounding within a radius of 50-100 km, which is confirmed by earlier investigations. During recent 10 years, aerological observations were not carried out, because of the obsolete and broken equipment. Tajik Met Service needs support in restoring two stations (Dushanbe and Kurgan-Tube) to conduct upper air observations and in providing expenditure materials at the initial stage.		
Expected results: The project realization will add to the information picture of the upper air in a particular region. The data received will be used in servicing aircraft, weather forecasting, and danger phenomena warning. The data will be available through the worldwide telecommunication network to hydrometeorological services of the region.		
Support requested: • Upper-air observation equipment, including means of computerized processing of information for the Dushanbe and Kurgan-Tube stations. • Set of expendables (for the initial stage of the project implementation). • Installing equipment and software, and training of specialists.		

Project No.39

Project Name: Providing equipment and expendables for atmospheric air quality monitoring.		
Purpose: Restoring the air quality monitoring network in large cities and in areas with intensive anthropogenic emissions into the atmosphere.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Hydrometeorology	300 thou. US$
Description: The project realization is very important for reducing the risk of anthropogenic impact on fragile natural ecosystems and for preventive health care. The greater part of the air quality monitoring network infrastructure of Tajik Met Service was damaged or seriously suffered in the 1990s. It needs support in instrumentation and equipment restoration and renovation, and introduction of computerized data processing system. The project is in line with the national actions on environmental protection and the State Environmental Program implementation.		
Expected results: Rehabilitation of the atmospheric air quality monitoring network will help to assess the atmospheric pollution level and intensity of emissions from transport and industry, and create prerequisites for air quality management.		
Support requested: • Instrumentation and equipment for atmospheric air pollution definition (20 stationary observation points, 1 mobile post). • Laboratory equipment (drying oven, reagent cupboard, thermometers, etc.). • Expendables (reagents, glassware) for laboratory research. • Computer and software for developing a monitoring database. • Training of local personnel on using instrumentation and equipment.		

Project No.40

Project Name: Providing equipment and expendables for Tajikistan surface water quality monitoring.		
Purpose: Improving the efficiency of surface water quality monitoring system.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Hydrometeorology	200 thou. US$
Description: The monitoring of surface water quality has been conducted in densely populated areas and areas of potential anthropogenic impact for over 20 years. This will allow reducing of risk for human health and planning of measures on anthropogenic impact reduction. At present, the monitoring instrumentation and equipment are obsolete. The observations are rare (once a decade or a month) and irregular, conducted according to a restricted program. Tajik Met Service needs support in renovating the monitoring instrumentation-technological base and providing expendables.		
Expected results: The project realization will allow removing of shortcomings in the current management of Tajikistan surface water quality, developing of a database, and providing of regular information service to interested organizations. Regional and international organizations will also have access to information of surface water quality in Tajikistan.		
Support requested: • Instrumentation and equipment for assessing surface water chemical contamination (5 river basins, 80 observation points). • Laboratory equipment (drying oven, reagent cupboard, thermometers, etc.). • Expendables (reagents, glassware) for laboratory research. • Computer and software for developing a monitoring database. • Training of local personnel on using instrumentation and equipment.		

Project No.41

Project Name: Providing Automatic Weather Stations (AWS), precipitation-measuring stations, and radio-transmitting equipment.		
Purpose: Increasing the network of advanced Automatic Weather Stations (AWS) and remote precipitation-measuring points in densely populated areas, areas difficult of access, of high mudflow, avalanche, and flood risk.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Hydrometeorology	300 thou. US$
Description: Earlier, there was a limited AWS network in Tajikistan; AWSs were highly efficient, particularly in reducing the risk of natural disasters, warning the population, and taking timely measures on natural disaster risk reduction. Natural disasters and unstable political and economic situation resulted in the stations destruction. Within the USAID program 6 experiment AWSs were installed in 2002. However, this number is not enough to receive representative information in the difficult mountainous conditions of the republic. Tajik Met Service needs support in providing AWSs and remote precipitation-measuring gauges for greater number of observation points, supplying AWSs with a transmitting and processing information system. The AWS observation range should include at least: air temperature and moisture, wind speed and direction, precipitation amount and intensity, solar radiation value. A long guarantee period of exploitation (3-5 years), set of spare parts, AWS operation in severe environmental conditions are important requirements.		
Expected results: The project realization will allow providing of more accurate information of weather conditions in potentially mudflow risky areas of the republic, and forecasting bodies will give more accurate and timely forecasts of natural disaster emergence. The national ministries and departments, emergency services, and the population will be provided with on-line real-time hydrometeorological information.		
Support requested: • Automatic Weather Stations (AWS) and transceiving equipment - 10. • Remote precipitation-measuring points, equipped with means of communication - 30. • Computer and software for processing information from AWSs - 1. • Training of local personnel on using instrumentation and equipment.		

Project No.42

Project Name: Improving hailstone protection efficiency.		
Purpose: Reducing economic damages caused by hailstone.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Hydrometeorology	300 thou. US$
Description: Until the 1990s, the hailstone-protective area exceeded 400 thousand hectares. Antihailstone service provided effective protection of economic branches, mainly agriculture, from hailstones. At present, antihailstone measures are actually not conducted due to the lack of technical means of detecting and preventing potentially dangerous processes. This resulted in a considerable economic damage caused by hailstones in 2002-2003. The antihailstone complex needs to be restored.		
Expected results: The project implementation will allow considerable reducing of damage caused by hailstones in agriculture, and improving of aircraft flights and other branches safety.		
Support requested: • Expendables (antihailstone cartridges, shells). • Hail detecting systems (radars, etc.)		

Project No.43

Project Name: Improving software to process and analyze hydrological data.		
Purpose: Developing systems of graphic-analytical and statistic processing, hydrological information analysis, and hydrological calculation.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Hydrometeorology	10 thou. US$
Description: At present, all operations on hydrological data processing at the Tajik NHMS are performed manually. With personnel deficiency and insufficient hydrological information, timely and high-quality processing of observation data and providing of users' needs appears impossible. To solve this problem, the Asian Development Bank provided computers and developed specialized software (MS Access) for processing hydrological information and accounting observation points. The last decade data were entered. However, at present, the system requires upgrade and new equipment to improve its functional capacities.		
Expected results: The project realization will allow reducing of time and excluding labor-consuming methods of hydrological data processing, improving of quality of hydrological work, calculations, and providing consumers with information.		
Support requested: • Restoring and improving of software. • Computer-database server. • Data archive and expendables set. • Training of local personnel on using software.		

Project No.44

Project Name: Providing a system of forecast development and distribution for mass media.		
Purpose: Providing the population with high-quality hydrometeorological and forecasting information through mass media.		
Country	**Sector**	**Amount of Funds***
Tajikistan	Hydrometeorology	30 thou. US$
Description: At present, the population does not receive a complete volume of information of current and expected weather conditions through mass media. The main reason is the lack of technologies on processing and visual presentation of information. Tajik Met Service needs support in providing TV-video system for hydrometeorological information presentation.		
Expected results: The project realization will allow raising of the population awareness of possible natural hydrometeorological phenomena and weather conditions. Introducing the system will promote an increasing interest of ministries, departments, and the population in hydrometeorological information.		
Support requested: • TV-video system. • Studio equipment. • Computer and software for information processing and presentation. • Training of local personnel on using instrumentation and equipment.		

Project No.45

Project Name:
Providing instrumentation and equipment to conduct overland observations of representative glaciers.

Purpose:
Studying the present status of Tajikistan glaciers and developing glacier overland observation database.

Country	Sector	Amount of Funds*
Tajikistan	Hydrometeorology	80 thou. US$

Description:
There are up to 8 thousand glaciers, occupying nearly 6% of the total country area. The glaciers retain nearly 550 cubic meters of fresh water, which makes almost half of the river runoff of Tajikistan. In recent years, under the influence of climate change, considerable glacier retreat has been observed. Actually, many small glaciers disappeared. In this connection, assessment of the current status of glaciers, based on representative glaciers, and long-term forecasts seem very important for planning water management in the rivers lower reaches. The last instrumental observations of glaciers were conducted 15-25 years ago, thus no reliable data on their current status are available. In this connection, it is necessary to carry out complex examination, study satellite photography of representative glaciers, and conduct geodetic, glaciological, and other works on glaciers. However, necessary instruments are either obsolete or unavailable, which decreases the observation reliability. Tajik Met Service needs support in providing new instruments and equipment to perform glaciological observations and satellite information.
The following glaciers should be examined:

- Zeravshan River Basin *(Ramam Tro, Diakhandang, Zeravshansky, GGP);*
- Muksu River Basin *(fedchenko, Mushketov);*
- Obikhingou River Basin *(Garmo, Skogach);*
- Vanch River Basin *(Medvezhy, RGO);*
- Kafirnigan River Basin *(Yakarcha).*

Expected results:
The project implementation will allow evaluating of the real status of glaciers and retreat values (compared to the geodetic and glaciological data of the 1960-1980s). After the field and laboratory works are carried out, the potential status of glaciers and released water runoff will be forecast. The project results will be of great scientific and practical importance in the light of climate change assessment (glaciers as climate change indicators), including that of the WMO and UNEP. The data received will be available to regional and international research centers studying climate change and glacier dynamics.

Support requested:

- Payment for helicopter use to conduct aerovisual observations and to maintain expedition units (30 hours).
- Expedition equipment, observation instruments and equipment.
- Computers and software, based on GIS-technologies.

Project No.46

Project Name:
Restoring hydrometeorological observation stations, destroyed or damaged by natural disasters.

Purpose:
Renewing hydrometeorological observations at stations and points, destroyed or damaged by natural disasters in 1992-2002.

Country	Sector	Amount of Funds*
Tajikistan	Hydrometeorology	288 thou. US$

Description:
The observation points are located mainly in highlands and mudflow-risky areas of the republic; their rehabilitation and operation will promote keeping an integrity of observation series and continuing monitoring of climatic system and natural disasters in potentially dangerous areas.

Expected results:
The project realization is important in observing the hydrometeorological regime of highlands and reducing the risk of natural disasters. The project implementation will allow providing of more reliable information of weather conditions in mudflow-risky areas of the republic; it will also allow forecasting units to more timely and accurately forecast natural hydrometeorological phenomena.

Support requested:
The following hydrometeorological and hydrological stations* need to be restored and reequipped:

- Dekhavz meteorological station MS (1928-2002)
- Lakhsh MS (1960-2002)
- Shakhristan Pass MS (1933-2002)
- Khumragi MS (1955-2000)
- Bustonobad MS (1948-2002)
- Faizabad MS (1942-2002)
- Tavildara MS (1932-1998)
- Vomardara-Rushan hydrological station HS (1939-1994)
- Murgab-Murgab HS (1913-1992)
- Khirmanjo-Pyandj HS (1966-1992)
- Bobokhonshaid-Kyzylsu HS (1955-1994)
- Somonch-Kyzylsu HS (1947-1994)
- Karboztonak-Yakhsu HS (1934-2002)
- Vose-Yakhsu HS (1928-1993)
- Shakhbur-Tairsu HS (1949-1993)
- Chinar-Kofarnigon HS (1928-1992)
- Ilyak-Yangiyul HS (1975-1993)
- Khanaka-Alibegi HS (1929-1994)
- Luchob-Luchob HS (1929-1993)

* MS – meteorological station, HS – hydrological station, figures in brackets – observation period.

* - indicators are tentative