



Optimization of the Systematic Observation and Promotion Research in the Aspect of Climate Change

10.1. The rationale for improvement and development of systematic observation network

Systematic and in-depth observations of climate are needed to improve understanding of the global climate system, and mechanisms causing climate change. Study of climate system elements and their dynamics can promote the making of effective and proved economic, technical and social decisions. In this connection, the existing global climate observation networks, including GCOS, require improvement and further development.

The improvement of systematic observation is determined by the UN Framework Convention (Article 5) as one of the priorities in research on the global climate system, indicators of climate changes and its adverse consequences.

Hydrological and meteorological information is necessary for sustainable agriculture, definition of optimum harvesting dates, protection of crops from hailstones, designing buildings, bridges, roads, canals, ensuring the safety of cargo and passenger traffic, etc. Control and forecasting of extreme weather events reduce to an extent the scale of their adverse impacts and allow the prevention of damage.

10.2. Main tasks and structure of hydrometeorological service

The network of hydrometeorological observations in Tajikistan has been developing basically for the satisfaction of the national economy's needs in hydrometeorological information, with the purpose of planning activities and making decisions on risk and damage reduction that is caused by adverse hydro-meteorological phenomena.

Hydrometeorological monitoring includes systematic observation of local hydrometeorological conditions, as well as collection, processing, analysis, generalization of information, and forecast production.

Main tasks of the hydrometeorological service are:

- Supply targeted organizations with information on hydrometeorological conditions in the places of observation, both real-time and archive data;
- Warning of targeted organizations about dangerous and spontaneous atmospheric phenomena;
- Supply data for hydrometeorological forecasts, and prevention of extreme weather events;
- Accumulation and generalization of objective data about the hydrometeorological condition of the territory of the republic.

For performance of the designated tasks, the hydrometeorological service should have the appropriate organizational structure and optimum observational network.

The structure of the hydrometeorological service includes a central management body, specialized divisions on services of observation network, gathering, processing, transfer and storage of hydrometeorological information, regional centres, network of hydrometeorological stations and gauges (fig. 10.1).

10.3. Participation of Tajikistan in international observation networks

Tajikistan has two stations representing the global climate observing system (GCOS). Tajikistan belongs to the Region II WMO (Asia). The World Weather Watch (WWW) WMO involves 10 Tajikistan's stations, including 2 stations that conduct upper air observations (tab. 10.1).

Climatic data by means of "CLIMAT" telegrams are transferred daily via channels of Global Telecommunication System (GTS). Since 2001, Tajikistan transfers in GTS channels the data from 12 stations, including 2 GCOS stations, which are accessible to WMO and world data centres.

Table 10.1.

Meteorological stations which participate in the system of the international exchange

Station	Coordinates	Attitude	GCOS	WWW	IHN CIS
Dushanbe	38° 33' NL 68° 47' EL	800 masl		+	+
Isambay	38° 03' 68° 21'	563			+
Istravshan	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 (2002)

Because of financial difficulties two WWW stations are temporarily closed. Three stations do not transfer data because of communications damage. The most perceptive WWW stations are: Khujand, Khorog and Istravshan that have been conducting observations since the end of the 19th century.

The interstate hydrometeorological network of CIS (IHN CIS) is intended to exchange the data of meteorological, upper air, hydrological and other observations necessary for preparation of hydrometeorological forecasts and warning about dangerous hydrometeorological phenomena. The observations of that network in Tajikistan consist of 14 meteorological stations, 11 hydrological gauges on rivers, lakes and reservoirs.

10.4. Operational status of observation network and measures for improvement

In Tajikistan, the most advanced network of hydrometeorological observations had existed till 1990. After, there has begun a steady reduction in the number of stations and gauges and the volume of observations.

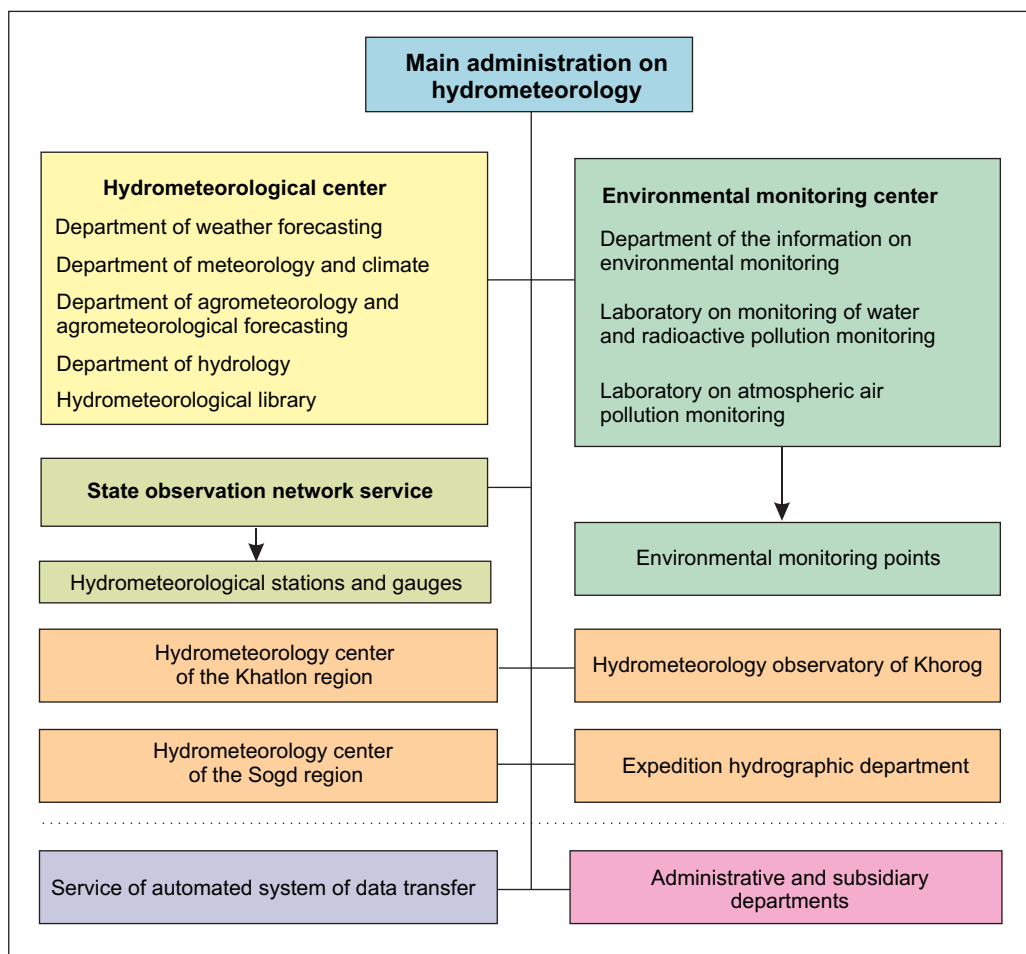


Fig. 10.1.

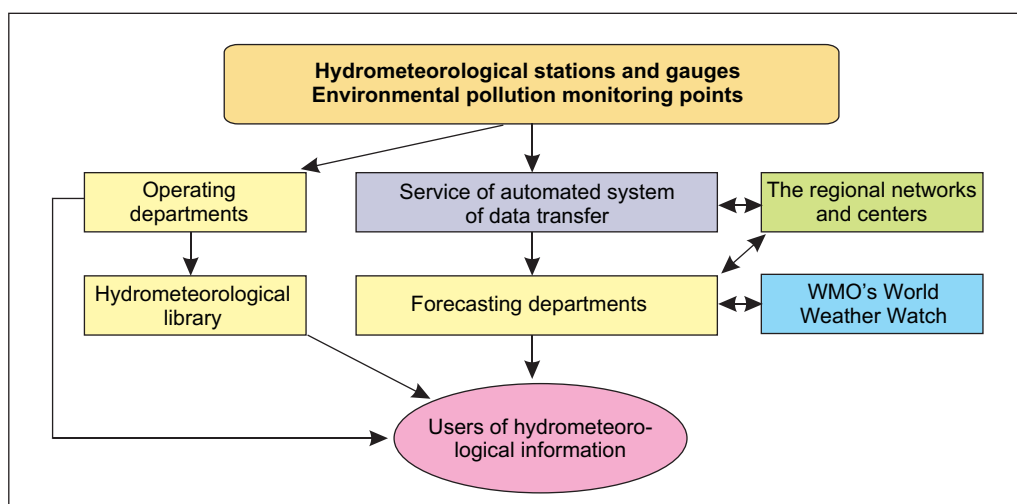


Fig. 10.2.

At present, the hydrometeorological observation network of Tajikistan includes 58 hydrometeorological stations, and 126 hydrological, meteorological and agrometeorological gauges and environmental pollution monitoring points. However, the state of the network does not meet modern requirements and the effective participation in the Global Climate Observing System appears to be inconvenient.

The national hydrometeorological service does not have enough resources to maintain the network to be able to develop it or keep it in working order. Therefore, a number of stations and gauges have reduced or completely stopped observation altogether. The majority of stations are equipped with out-of-date devices and instruments, and in the last decade, the updating of the network with modern equipment has not been conducted. The difficulty with using outdated equipment and ensuring appropriate accuracy of measurements, results in deterioration of data quality and its reliability.

Such a situation can be negatively reflected on the quality of climatic information, weather and drainage forecasts, including floods and other dangerous phenomena. This situation interferes with the development of research on climate change, its impacts and integration of Tajikistan into the global observation network.

The development and implementation of measures to optimize the observation network, conserve the most important points of observation, minimize expenses, and ensure its conformity to the modern requirements in terms of management, technical conditions and distribution of information among consumers is required. This will allow Tajikistan's contribution to the global observation network in the given region.

There is a need to develop the National program on optimization of systematic observation network.

10.4.1. Meteorological observation

During the whole period of meteorological observation in Tajikistan, more than 80 stations and 20 gauges have been opened. The individual stations were departmental, intended for a short number of specialized researches.

The meteorological observation in the republic is carried out 24/7 and includes the measurements of temperature, humidity, air pressure, temperature of soil, precipitation, definition of cloud type and quantity, meteorological range of visibility, direction and speed of wind and various types of atmospheric phenomenon. Current weather information is provided to the republican hydrometeorological center. The data transmission is carried through the Ministry of Communications and own communication facilities (radio stations).

Economic reasons have resulted in the reduction of the meteorological observation network, and have been reflected in the deterioration of equipment and materials.

For the period of 1991-2002, the activity and coverage of the meteorological observation network in comparison with the 1980s has decreased by 20 %.

Now, 11 stations out of 58 stations do not operate. The individual stations are temporarily closed because of the absence of specialists. Remote stations are temporarily closed because of financial impoverishment, including unique to the Central Asian region, the meteorological station named after Academic Gorbunov on the Fedchenko Glacier (4,168 masl).

The situation has resulted in part of the Sogd region and some areas of Southern and Central Tajikistan no longer being observed meteorologically.

The data on snow cover in aggregate with real-time information on intensive rainfalls are the basis for short-term and mid-term water level forecasting and flood warnings. The standard snow cover observations by meteorological stations are carried out in small volume. In difficult mountain conditions of the republic, the available data on the dynamics of snow cover and its water equivalent is obviously not enough. Automatic precipitation gauges are absent in remote regions.

The lack of instruments at some stations forced to stop observations of extreme temperatures of air and soil, the height of clouds, wind and visibility. There are difficulties with observational data entry and sending of observation reports to the Main administration of hydrometeorology in the required time frames.

Observation and recording of initial data by automatic means are practically not used. There is a small number of devices, which record on paper the data on air temperature, pressure, relative humidity, intensity of precipitation, sunshine duration, however this does not solve the problem, as this data then needs to be processed manually.

To improve and develop the national meteorological observation network and enhance participation in the Global Climate Observing System and interstate hydrometeorological observation network of CIS, it is necessary:

- To maintain an existing network of meteorological stations, taking into account, that there are long-term observations on climate, the observations are conducted under the multi-purpose programs and the data of many stations are directly used by national economy of the republic;
- To pay special attention to high-mountainous meteorological stations that have a valuable use for weather and water level forecasting and study of global climate change;
- To research and analyze the information on network optimization and to prepare appropriate recommendations, including methods, tools of observation and location of observation points;
- To restore the destroyed gauges and stations and to carry out repair services and residential premises at acting observation points;
- To get missing devices and equipment for separate stations, and to ensure their installation and appropriate operation;
- To carry out check and calibration of all types of devices and equipment used and to conform with international standards;
- To expand the network of snow gauges and equip with devices for automatic measurement of snow cover thickness and its water equivalent, and also expand the network of automatic precipitation gauges with real-time data transfer to hydrometric stations or directly to the hydrometeorological center;
- To develop a network of automatic weather stations, especially in remote regions, for reduction of gaps in scientific knowledge and improvement of forecasting of weather conditions and natural disasters, including floods;
- To promote equipment of a network by automatic observation devices;
- To ensure the steady mechanism of observational data transfer.

10.4.2. Agrometeorological observation

Agrometeorological observation is being carried out to assess the development, growth, status and productivity of agricultural plants, temperature and humidity of soils. Aerovisual observations are used for definition of pasture productivity.

The network of agrometeorological observation for the last decade has undergone significant changes. Like this, in the year 1988 agrometeorological observation was carried

out at 29 stations (including 2 specialized) and 14 gauges, by the year 2001 its number was reduced to 21 stations and 8 gauges, from them on 7 points agrometeorological observation has not been conducted. The observations are limited only on the phases of development of agricultural crops and local meteorological conditions. The reports from the network do not arrive in time. Aerovisual inspections of pasture vegetation during the last 11 years have not been carried out. The lack of agrometeorological information has had negative effect on forecasts of phenology and productivity of agricultural crops.

The last agrometeorological directory was issued in 1987. Since then no agrometeorological directories have been composed.

Taking into account the large importance of agrometeorological observation for conducting sustainable agriculture in climate change conditions and the high value of instrumental observations on the phenology of vegetation that is a characteristic indicator of climate change it is required:

- Restoration of observation network, especially in the areas vulnerable to extreme weather events and to projected climate change;

- Supply the observation network with necessary devices and equipment;

- Introduction of advanced forecasting techniques and modeling of herbal productivity;

- Renewal of cost-efficient aerovisual and land observations of pasture vegetation;

- Access to satellite observation system (monitoring of vegetation and soil cover) and use of computer-aided means for decoding and processing of satellite information;

- Development and introduction of effective mechanisms of interaction with the consumers of agrometeorological information and encouragement of development of a network of volunteers in rural areas, especially in droughty plains and in mountains.

10.4.3. Upper air observation

Upper air observation network is intended for study of meteorological parameters of the atmosphere at heights up to 30-40 km. Upper air information is used for drawing up of weather forecasts, service of aviation and other sectors, analysis of atmospheric processes.

Upper air observation was earlier carried out at 3 stations (Khujand, Dushanbe and Khorog) in 4 standard terms. Since 1996, because of lack of supplies, failure of out-of-date radar-tracking equipment these observations have been terminated at all stations.

Alongside with radio sounding of the atmosphere, there were also balloon observations (direction and speed of wind up to height of 12 km) at 9 stations being carried out. Now these observations are not being conducted.

Taking into account the importance of upper air data for weather forecasts and air navigation the following measures are necessary:

- Renewal of radio sounding of the atmosphere in the republic, with perspective expansion of upper air observation network;

- Supply of existing upper air stations with modern equipment and supplies, sufficient for continuation of systematic observations;

- Renewal of balloon observations at aviation meteorological stations.

10.4.4. Actinometrical observation

The network of actinometrical observations is intended for obtaining data about solar irradiation over the territory of the republic.

Out of 5 sites of actinometrical observation, 2 stations are working (Gissar and Kayrakkum). Absence of systematic equipment calibration (that had previously carried out in Crimea and Uzbekistan) potentially reduces the accuracy of actinometrical observations. In connection with change of structural subordination, observational data is not duly processed and simply recorded on paper.

For restoration and development of actinometrical network, with the purposes of more detailed study of solar irradiation it is necessary to:

Calibrate the equipment according to internationally recognized standards at stations currently in use;

Renew the actinometrical observation in the south of the republic (Kurgan-Tube) and at the high-mountain station named after Academic Gorbunov (Fedchenko glacier) with the installation of new equipment;

Create conditions for observational data processing in the Main Administration on hydrometeorology of Tajikistan in cooperation with Main Geophysical Observatory named after Voekov (St. Petersburg, Russian Federation).

10.4.5. Hydrological observation

The hydrological observation network is intended for gathering data about the state of inland water objects. Hydrological data is necessary for studying spatial-temporary regularity of the hydrological cycle; conducting the state account of waters and water inventory; control of water balances and water resources of separate watersheds and the assessment of anthropogenic impacts on the water resources.

In Tajikistan, where 50% of water resources of Central Asia originate, the exact control, analysis and forecast of stream flow is important. The average density of existing gauges on 7 basic river basins makes 0.8 gauges per 1000 sq.km. It is optimum on the rivers Shirkent, Kafirnigan, Zeravshan, Kyzylsu. Low density of river gauges are in the basins of Syrdarya (0.04), Pyanj (0.33), Vakhsh (0.52). In addition, many river gauges within these basins do not operate.

The river gauging network conducts the following types of observations: water level and water discharge, water temperature, ice thickness, chemical composition of water, suspended sediment concentrations, currents and choppiness on lakes and reservoirs.

Until the 1990s, hydrological observation was carried out at 11 stations and 138 river gauges. The hydrological forecasts were made daily, for one decade, for one month, and for vegetation period on 5 river watersheds. A hydrological yearbook was regularly issued. At the end of the 1990s, the number of river gauges and the volume of observations had substantially reduced (tab. 10.2).

Table 10.2.

The number of river gauges

Observation	1975	1980	1985	1990	1995	2001
Planned	104	132	138	138	97	97
Actual	104	132	138	107	61*	89*

Source: Tajik Met Service (2002)

* - limited programme of observations

In view of the lack of finances, necessary equipment and instruments have not been obtained. Poor computerization does not allow the prompt process of observational data for the composing of hydrological yearbooks. Lack of specialists is a problem too. The last hydrological yearbook was issued in 1991. Yearbooks for the following years are in the process of compilation.

On all operational gauges, the volumes of observation have reduced. The observation of evaporation from water surface is carried out only at one station. Out of 53 automatic water level recorders, only 4 installations operate effectively. 46 river gauges measure water discharge. Hydrological observational data arrives irregularly.

The status of the Kairakkum hydrological observatory (formerly leading scientific and methodical center) has downgraded to a standard gauging station. Observations on the small rivers with a length between 10-25 km have not been conducted for a long time.

For the rehabilitation and development of the hydrological observation network, in the aspect of forecast improvement, enhancing of water resources management and participation in the Global Hydrological Cycle Observing System (HYCOS), the following measures are necessary:

- Feasibility assessment of gauges' location and functionality of hydrological observation network and development of recommendations on improvement;

- Restoration of river gauges that were damaged by floods and other natural disasters, and changing of location of some observational points;

- Renewal of temporarily closed hydrological gauges;

- To pay special attention to hydrological observation points that have a large value for transboundary water resources control and high value of observations for the study of the hydrological cycle of the Aral Sea basin, including flood and stream flow forecasting;

- To get missing equipment and instruments for separate stations, and to ensure their installation and appropriate operation;

- Restoration to full capacity land and aerovisual observations over formation and water content of snow cover in mountains;

- To develop the network of automatic hydrological gauges and early warning systems, especially in river heads that are prone to floods and in remote mountain regions with a stable river channel for steady functioning of equipment;

- To replace equipment of the network by automatic observation instruments, including automatic water level recorders;

- To ensure the steady mechanisms of observational data transfer from gauges to regional stations and further to the Main Administration on Hydrometeorology.

10.4.6. Surface ozone observation

Surface ozone observation in Tajikistan is carried out in Dushanbe and includes the measurements of ozone concentrations in the lower atmosphere. Earlier, observational data were transferred for the verification and processing to Russian Federation. Now, because of absence of finances the data is stored at Dushanbe station as the hand-written tables of observations.

During the last years, surface ozone observation is not carried out because of absence of special tables for data processing, equipment damage and the lack of specialists.

Surface ozone observation represents the large importance for assessing atmospheric air quality and climate change study. In this connection, it is necessary to:

Renew observations at Dushanbe station;

Expand surface ozone observation network, with introduction of new equipment, including stratospheric ozone layer (land observations and TOMS);

Create conditions for computer processing and storage of observational data in the Main administration on hydrometeorology of Tajikistan.

10.4.7. Environmental pollution monitoring

The environmental pollution monitoring center using the data from special stations assesses atmospheric air pollution, surface water quality, soil and radiating conditions. The center provides a lot of organizations with archive, real-time information and forecasts on the state of environmental pollution and its likely consequences, and generalizes observational data in the form of reports and yearbooks. The center informs appropriate ministries and departments about extremely high levels of environmental pollution.

Till the 1990s, surface water pollution monitoring has been carried out on 46 rivers, 6 lakes and 1 reservoir, and the concentration of some 40 organic and inorganic polluting substances have been measured.

From 1994 till 1997, surface water pollution monitoring has not been carried out. From 1998, the observations were renewed and carried out on 21 rivers, with measuring of about 20 polluting components.

Till 1990s, the radiometric observations were carried out on 27 stationary points. Now measurement of gamma and beta activity of fall-out is being carried out at 16 stationary points. The selection of tests of radioactive aerosols, which are falling-out on the surface within a day, is not carried out.

Earlier, the measurements of concentrations of toxic chemicals in soils have been carried out at 25 points. Since 1994, the measurements are not carried out because of failure gas chromatograph, lack of finance for the delivery of tests to laboratory and necessary chemical supplies.

Till 1990, atmospheric air pollution observation has been carried out in 7 cities of Tajikistan on 21 stationary points for 21 harmful substances, including heavy metals. Some 7 air pollution observation points were functioning in Dushanbe, in Tursun-Zade - 3 points, Kurgan-Tube - 3 points, Yavan - 2 points, Kulyab - 1 point, Khujand - 3 points, Sarband - 1 point. Air pollution monitoring on the base of mobile laboratory "Atmosphere-2" has been implemented using the method of emission source monitoring with the purpose of more detailed study of local atmospheric air pollution.

In 1993-1997, the number of observational points and the volume of observation were reduced. Now observation on atmospheric air pollution in the republic is being carried out only in the cities of Dushanbe and Kurgan-Tube on 5 stationary points under the reduced program. The existing devices and equipment have the large deterioration and became morally outdated.

Taking into account the large importance of environmental pollution observation for the control of emissions of greenhouse and other harmful gases, and environmental impact assessment it is necessary to:

Optimize the location of environmental pollution monitoring points;

Restore the extent, volume and quality of environmental pollution monitoring;

Calibrate used devices and equipment and to ensure conformity of data quality to international standards;
Equip the network with a new automated devices, supply materials and spare parts for used devices;
Introduce into the atmospheric air quality monitoring program the measurement of greenhouse gas concentrations and rating intensity of atmospheric air emissions from stationary sources;
Launch CO₂ concentration measurements in mountains at an altitude of 2,000 masl or higher, ensuring maximal remoteness from GHG emissions sources;
Introduce modern methods of environmental pollution forecasting and yearbooks compiling.

10.4.8. Specialized observation

The hydrographic expedition department is carrying out hydrographic research of river basins, special study of various hydrological phenomena and processes (glacier mode, snow cover distribution, river-stream processes, inspection, forecasting and mapping of avalanches, floods phenomena, outburst risk on glacier lakes), snow measuring expeditions in mountains, geodesic activities on glaciers. The forecast of avalanche and flood risk covers the period from December till July. Forecasting methods developed by hydrographic expedition department are used for avalanche warning and possible Medvezhi Glacier shearing movements.

The situation with snow observations in mountains has worsened since 1990 (tab. 10.3). The exact water resources assessment of the region on present time and forecast for prospect cannot be done without it. Annual inventory of avalanches and mudflows is not compiled.

Table 10.3.

Expeditions of hydrographic department

Expeditions	1990	2001
1. Inspection of glaciers (the number)	18-20	3-4
2 (a). Inspection of glacial lakes with outburst risk, land	3-4	0-1
2 (b). Inspection of glacial lakes with outburst risk, aero visual	10-15	0
3. Inspection of avalanches (the number of basins)	15-18	2-3
4. Inspection of mudflows (the number of basins)	10-15	2-3
5. Routing snow surveys (the number of basins)	3-4	2
6. Aero visual observation of snow cover	15-18	2
7. Inspection of remote snow scales	15-18	2-4
8. Inspection of stations and points	8	2
9. Opening of total precipitation gauge	36	0

S o u r c e : Tajik Met Service (2002)

The instrumental regular observations of glacier mode, snow cover, floods and avalanches in the aspect of climate change are a basis for development of indicators and improvement of climate change consequences projection.

Restoration and development of the specialized observations requires:

Optimization of the system, methods and routes of observations in light of climate change considerations;

Completion of the hydrographic expedition department by specialists and equipping of the department with modern tools of measurements, expedition equipment and data processing systems;
Restoration the extent and volume of snow cover observations with regard to its formation and water content, including land, aerovisual and satellite methods;
Development of observation system on a glaciers mode and dynamics;
Renewal of observations on glacial lakes and objects with outburst risk;
Improvement of mudflow and avalanche observation and forecasting.

10.5. The system of data collection, processing, dissemination, and measures for improvement

The system of data gathering, processing and distribution is a basis for weather forecasts, dangerous hydrometeorological phenomena warnings and planning of measures in national economy, especially in the conditions of climate change. Therefore, accuracy, efficiency, completeness and format of information are the important factors for effective implementation of measures that indicated in the National Action Plan for Climate Change Mitigation.

10.5.1. Data collection, transmitting and regional exchange

The long-term practice of gathering and distribution of real-time hydrometeorological information has generated a sustainable system that takes into account geographical features and an existing level of telecommunication systems development. For the transfer of hydrometeorological information, stations and observation points depending on local conditions are equipped with various communication facilities: telephone, telegraph, radio. In addition, hydrometeorological service exchanges the information coming from stations and points of the Ministry of Water Economy and Ministry of Energy.

The interconnection method is used for the hydrological information gathering. The regional stations carry out the gathering of the reports from the river gauges within the appropriate region by an own communication facility, and completed reports are transferred further in the format of bulletin through the Ministry of Communications of Tajikistan.

The observation automation level in Tajikistan is low. Observers measure most parameters (hydrological and meteorological) manually with the further recording in special book. Then, the data is coded and transferred by communication facilities to the center of information processing (fig. 10.2).

The communication center ensures the operations of the automated system of data transfer and engaged in gathering and distribution of hydrometeorological information in the zone of its responsibility.

The gathering and distribution of hydrometeorological information is carried out through the Ministry of Communications using telephone, telegraph and radio communications. Tajikistan is connected to the main meteorological telecommunications network through the regional center in Tashkent and the World Data Center in Moscow, however the channel speed is very low.

The network of international and regional hydrometeorological information exchange includes 25 stations (SYNOP, CLIMATE, HYDRO). The reception of weather

maps is done by the system TV-INFORM-METEO, which does not function now in a view of high cost. Therefore, the Internet is being used as an alternative option. The observational data from neighbouring countries comes through the World Data Center in Moscow.

Tajik Met Service in Dushanbe carries out regular 24/7 receptions, primary processing and synoptic interpretation of analog information from polar-orbital satellites such as NOAA and geostationary satellite such as METEOSAT. The images from METEOSAT are represented as photosnapshots. Tajik Met Service uses the results of synoptic interpretation of satellite information for support of atmospheric processes synoptic analysis and weather forecasts.

The radio communication equipment now has become out-of-date and do not provide a necessary level of information interchange.

The stations that transmit the information through telephone lines, experience difficulties in view of damage of communication lines and disconnects as a result of debts.

The basic problems of existing data gathering system are high cost for transfer of the telegrams, plenty of mistakes during preparation and transfer of telegrams from stations, absence of the feedback with significant number of stations and gauges.

Alternative of existing data gathering system is the transition to new computer technologies that will allow automating data gathering process. It is essential to lower its cost and to improve data quality within the time. For this purpose, it is required to:

- Ensure repair and restoration of operation of existing information transfer means throughout the observation network;

- Pay special attention to those stations and gauges which are included in regional and global observation networks and to ensure computer-aided reception-transmitting equipment and to create stable channels of communication;

- Establish in the central communication center the computer-aided meteorological telecommunication system that provides automatic gathering, verification and distribution of the meteorological information, both inside republic, and in the regional and world meteorological telecommunications centers;

- Ensure the system autonomy of transfer and information interchange;

- Install the satellite system of high-resolution picture transmission (HRPT), with the purpose of the increase of weather forecasts reliability and completeness, monitoring of environmental pollution, snow stocks assessment, observation of vegetation, water resources and glaciers dynamics.

10.5.2. Data processing

Before, the mechanized data processing and spatial control were carried out in the Central Asian Regional Computer Center in Tashkent. Since 1997, with infringement of interdepartmental connections all observational material is unprocessed and is stored on paper carriers. The absence of automatic data processing and control now is one of the complex problems that require paramount decisions.

Practically all observation materials are being processed manually, and only small portion is entered onto electronic carriers. Therefore, there is a large delay in publication of meteorological and hydrological yearbooks.

The storage conditions on paper carriers in hydrometeorological library correspond a little to established requirements, and there is a risk of irrevocable loss of observation materials.

The improvement and automation of the system of data processing, control and storage requires:

Introduction of computer-aided system of weather forecasting and stream flow projection on the basis of satellite digital information and land observations, especially in mountain regions.

Supply the Tajik Met Service's specialized departments dealing with information with the computers, networks and software for processing and archiving of observation materials;

Development of hydrometeorological and environmental pollution database with advanced mechanisms of spatial-temporary control and forms of data presentation.

Priority directions are:

- a) Improvement of an existing database (DB) on meteorology "CLICOM", including the information on meteorological stations and gauges, air temperature, precipitation, other meteorological parameters, phenomena and extreme values. Integration of "CLICOM" with other software for preparation of meteorological yearbooks. Visualization of meteorological information using GIS-technologies.
- b) Improvement of an existing database (DB) on hydrology "Hydromet DB", including the information on hydrological stations and gauges, measured and calculated water discharge, water temperature and other hydrological parameters, phenomena and extreme values. Optimization of "Hydromet DB" for preparation of state water inventory and hydrological statistics. Visualization of hydrological information using GIS-technologies.
- c) Development (obtaining) and installation of DB "Snow cover" that include the information on the specialized snow cover observations, precipitation, height of seasonal snow border, water content in snow, etc.
- d) Development (obtaining) and installation of DB "Glaciers" that include the information on the catalogue of glaciers, data on aero and satellite photographing of glaciers.
- e) Development (obtaining) and installation of DB "Avalanches" that include information on avalanche monitoring stations, measured characteristics of the avalanches throughout the period of instrumental observation.
- f) Development (obtaining) and installation of DB "Mudflows" that include information on mudflow risk, the large mudflows passage possibility and historical information about catastrophic floods.
- g) Development (obtaining) and installation of DB "Environmental pollution" that include the information on pollution of atmosphere, soil, surface waters, etc.

10.5.3. Data dissemination

The consumers of hydrometeorological and environmental information are:

Mass media and general public;

State authorities;

Energy industries;

Civil aviation;

Rescue services;

Transport;

Agriculture;

Hydropower engineering;

Construction;

Residential services;
Public health services;
Other services.

The consumers are provided with:

Real-time data of systematic observation at stations and gauges;
Meteorological, hydrological, agricultural and special forecasts, and warnings on projected extreme weather events;
Long-term data and hydrometeorological averages.

The ways of data distribution to the consumers:

Daily hydrometeorological bulletin;
Broadcasting of weather forecasts through mass media. Central TV and radio stations broadcast weather forecasts and warnings on extreme weather events;
Data transfer through teletype, telephone, facsimile;
Granting access to the information in a reading room of hydrometeorological library;
Calculations of weather averages and specific data according to consumer orders.

Tajik Met Service prepares weather forecasts for one day, and subsequent 3-5 days, one month. Water level forecasts on basic rivers are being prepared for one decade, month, quarter, and vegetation period (April-October). Agrometeorological forecasts include projections of vegetation phenology and productivity.

Daily hydrometeorological bulletin includes weather forecast for coming day subsequent 3-5 days and warning on possible dangerous hydrometeorological phenomena. Besides, the bulletin includes the data recent hydrometeorological conditions and atmospheric pollution in the main cities of the republic.

Decade agrometeorological and hydrological bulletins and monthly meteorological weather forecasts are being issued.

There are agreements with various departments on data exchange. Altogether, the hydrometeorological center serves 18 governmental organizations. The population is notified on expected weather through mass media, including radio, TV, and press.

Currently, the dissemination of climate change information is basically focussed on scientific research centers and governmental organizations.

The results of weather analysis and forecasts are being distributed through communication channels to the hydrometeorological centers of neighbouring countries.

For increasing the efficiency of distribution of hydrometeorological information distribution, it is expedient to switch on commercial data use and to considerably expand the use of computers for electronic data distribution, including Internet.

10.6. Human resources and measures for improvement

Impoverishment of hydrometeorological service and severe economic situation in the republic has led to the leaving of many professionals and absence of young specialists. For the last decade, almost all staff has been completely renewed. At present time, there are a lot of vacancies that adversely affect the status of hydrometeorological observations in Tajikistan.

Now there is a crucial question on the preparation of professionals. At Tajik State National University the chair of meteorology is organized, however because of weak

technical base there is no opportunity of preparation of professionals in agrometeorology, actinometrical observation, upper air observation, and radio transmission.

In the Main Administration on hydrometeorology, there is deficiency of specialists in weather forecasting, hydrology, agrometeorology, and PC operators. Availability of personnel on the observation network cause certain concern. Many observers at stations have no special education, for the chiefs of stations within several years the workshops and courses of improvement of qualification were not carried out. There are large difficulties in the training of specialists in agrometeorology and upper air observation.

In general, the completeness of staff makes 64%. The completeness of engineering personnel in hydrometeorology makes 37%, in meteorology - 64 %, in hydrology - 67%, in chemistry - 48%, in communications - 81%. Few employees have no special education. However, retraining and improvement of professional skills of experts on the base of the Tajik Met Service, specialized centers of Russian Federation and Central Asia are being carried out at possible extent.

For the strengthening human potential, it is necessary to train the specialists (synoptic, hydrologists, climatologists) in hydrometeorological high schools and services abroad. It is necessary to arrange a series of trainings for observers at hydrometeorological stations, to ensure experience exchange and to promote training courses on development and introduction of new forecasting methods, interpretation of digital satellite information, operation of hydrometeorological equipment, enhancing climate change research.

10.7. International cooperation

International cooperation and participation of Tajikistan in regional projects promotes improvement and development observation network.

Tajikistan participates in the regional project on improvement of hydrological observations in the Aral Sea basin. Within the framework of GEF Aral Sea project there are have been rehabilitated and reequipped 6 river gauging stations.

Swiss Mission on Aral Sea helps to develop the methods of hydrological forecasting. Britain Government has given computers with CLICOM software for climate data processing in the frameworks of WMO voluntary cooperation programme. Asian Development Bank has assisted in development of software and hydrological database "Hydromet DB".

In 2002, the first experimental automatic weather station has been installed in Dushanbe with the purpose to assessment the efficiency of automatic weather observations in Tajikistan. The station has been granted by USAID Central Asia environment project.

The research on climate change and preparation of First National Communication has been carried out with GEF support.

Within the framework of international cooperation there are have been research on relationship between climatic factors, desertification processes and flood formation.

Hydrologists have attended the trainings on hydrological forecasting and data processing. The experts from Russian Hydrometeorological Service have conducted the trainings on the use of CLICOM software, courses of the improvement of qualification for weather forecasters. The young experts are sent to study at meteorological high schools of Russia.

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