Uzbekistan

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Observational hydrometeorological network in Uzbekistan: Status , data acquisition and control

(submitted by Aleksandr Merkushkin, Uzhydromet, Uzbekistan)

Summary and Purpose of Document

The document given had been compiled in correspondence with requirement the ongoing pilot project to enhance the availability and quality management support for national meteorological and hydrological services in surface, climate and upper-air observations. The purpose of this document is to give brief information on status of existing observational ground hydrometeorological network in Uzbekistan as well as to outline the main principle of data acquisition and data control provided. Also the some issues related to improvement of existing data collecting, monitor and data dissimilation infrastructure are briefly discussed.

1. Observation networks

Critical water management within the five central Asian republics (CAR) of the former Soviet Union requires access to reliable climate and hydrological data. Under the Soviet Union an extensive network of manual climate stations was operated within the region. This network provided some of the essential climate data required for water resource management and forecasting. The network included stations throughout most of the region including remote stations within critical precipitation accumulation areas.

A significant reduction in capacity of the CAR governments to provide this vital data has followed the collapse of the Soviet Union. Many of the remote stations in significantly accumulated areas have been abandoned or are staff by minimally qualified observers. The snow survey program has been significantly reduced. Most remaining climate stations are concentrated outside of significant snow and precipitation accumulation areas. Quality control and maintenance procedures are difficult to enforce. The legacy radio, telephone and Teletype communication network is obsolete.

Four principle period might be distinguished on the way of evolving observational hydrometeorological network in Uzbekistan.

The first period is related to Tashkent's astronomical and physical observatory establishment at 1870's.

Then the primary meteorological and hydrological network had been deployed and hydrometric department was established. Under umbrella of department given the hydrometric and meteorological services were united.

The second period had been lasting from 1918 till 1945. During this period the centralized weather service had been established and some particular researches related to national economic interests had been initiated. Observational network was deployed including marginal and high-mountain sites and status of the operational observational stations was considerably raisen.

During the third time period that lasted from 1945 till 1991 the hydromeorological network in Central Asia was significantly affected with technical progress fruits like new equipment and coming of the computers. The favourable economical and financial conditions were pushing incentives to observational network extension. The maximum population of the hydrometeorological station was namely related to the end of this period.

The long-term degradation of observational hydrometeorological network is characteristic for the forth period. The stable degradation of hydrometeorological network had run at the end of 1990's and being resulted in the collapse of the former socio-economical and political system is still ongoing. Spite of objective hassles on the way of observational network prevention Uzbekistan has overcome the situation with minimal losses in respect to other Central Asia countries (see table below)

Table 1

The dynamic of population the meteorological stations in Central Asia for the last decades

Country	**Number of meteorological stations**		
	1985	**1996**	**2004**
Kyrgyzstan	**95**	**62**	**31**
Tajikistan	**64**	**51**	**47**
Turkmenistan	**51**	**51**	**48**
Uzbekistan	**91**	**75**	**78**

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t is remarkable that only Uzhydromet is the authorized body to collect, process and disseminate data have been gathering by its observational network in Uzbekistan so far. As well Uzhydromet accepts and bears the responsibilities on quality and timing of data service available.

The observational networks of Uzhydromets consist of 79 meteorological stations and 130 hydrological water gages and stations. Also it includes 84 surface water quality control gages.

Data come from 21 meteorological stations are included to the international data exchange cycle for World Weather Centres needs.

Nowadays the big project on development of Doppler radar facilities for such airports as Tashkent, Samarkand and Nukus is underway.

1.1 Surface observation (including AWS)

1.1.1 Number of station:RBSN,RBCN,GSN,manned stations and AWS

	RBSN	RBCN	GSN	Manned stations	AWS stations
number	**78**	**78**		**78***	**7***

*Seven AWS installed at operational climate stations that were staffed by NHS observers.

The territorial allocation of the both manned and automated weather observational networks is given on the Fig.1 and Fig.2 correspondingly.

1.1.2 Station map

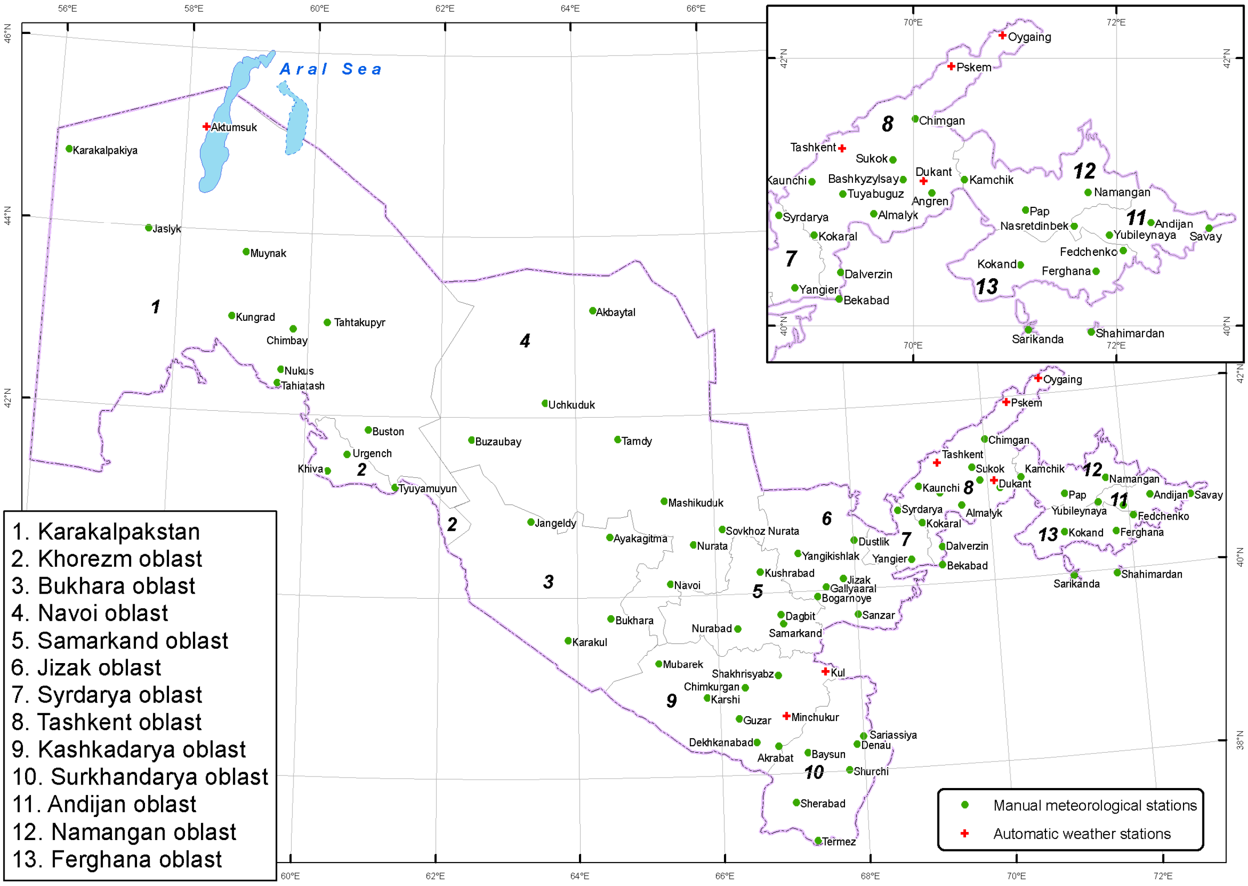

Fig.1 Scheme of observational meteorological network of Uzbekistan

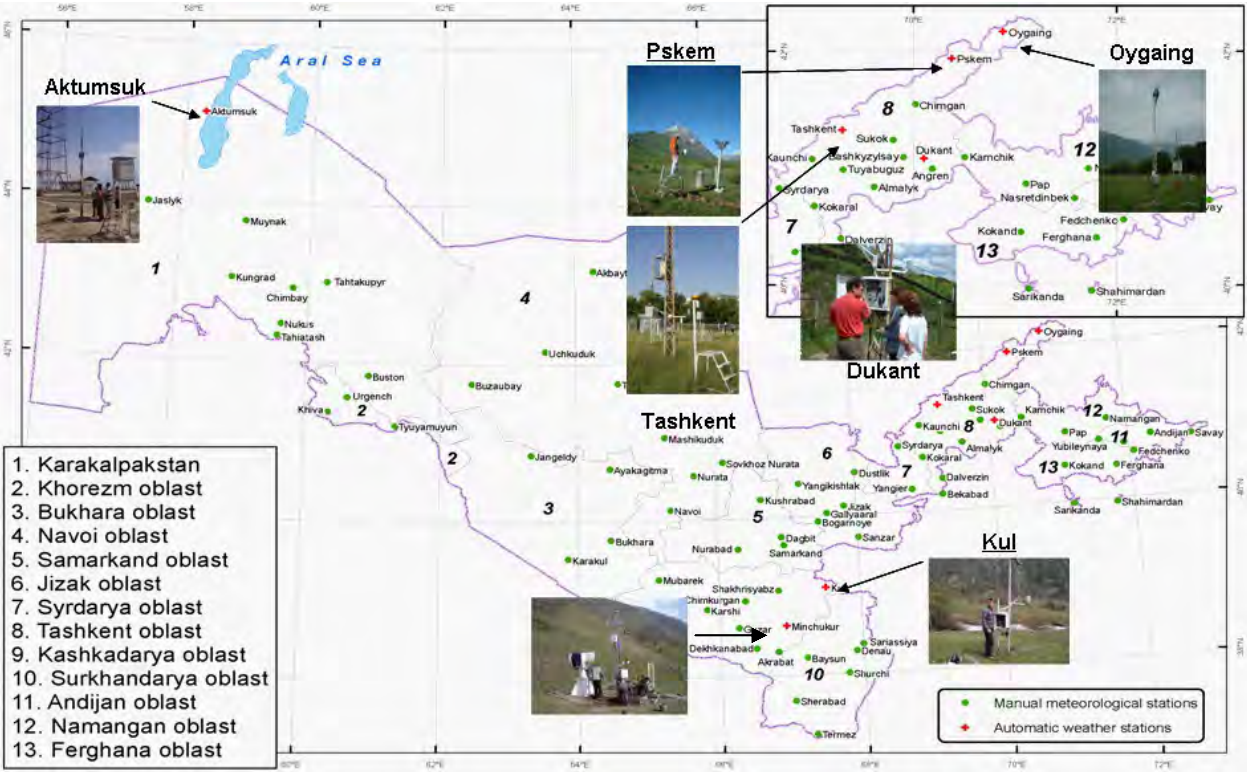

Fig.2 Scheme of observational automated weather stations network of Uzbekistan

1.1.3 Time and frequency of observations

Per WMO description on time and frequency of surface observation stated at cf. *2.3.2.11* .(WMO-No. 544) meteorological data are acquired on the regular 3 hours regular basis (8 times per 24 hours) over the all observational meteorological network in Uzbekistan
The meteorological observations in Uzbekistan are conducted in accordance with the following observations timetable:

☒ 00 UTC	□ 01 UTC	□ 02 UTC	☒03 UTC	□ 04 UTC	□ 05 UTC
☒ 06 UTC	□ 07 UTC	□ 08 UTC	☒09 UTC	□ 10 UTC	□ 11 UTC
☒ 12 UTC	□ 13 UTC	□ 14 UTC	☒15 UTC	□ 16 UTC	□ 17 UTC
☒ 18 UTC	□ 19 UTC	□ 20 UTC	☒21 UTC	□ 22 UTC	□ 23 UTC

1.1.4 Data flow to users and archives

Meteorological data are acquired on the regular 3 hours regular basis (8 times per 24 hours) over the all observational meteorological network in Uzbekistan.
Data come to Uzhydromet from observational network via short waves radio channels through the local centres of communication (so-called Bush CommCentres). Bush CommCentres send data to CommCentre where data pass preliminary data control and data processing. These data are stored with data storage CommCenter resources no longer then 3 days. Final data processed are stored as hard copies of tables (TMC-84) and monthly meteorological report in which the main meteorological characteristics are compiled .
CommCenter provides the communication link to informational resources for end users of meteorological information and maintains the operational status of communication facilities.
Servers and software of CommCentre provide data routing, preliminary data quality control and data storing.
Operative Weather Service and the Hydrometeorological Data Support Service provide wide spectrum of services the hydrometeorological data provision for end users.
There are agreed list of governmental bodies and organizations that are provided with free meteorological data. Users that are out of that list are provided with paid data.

On the inter-state level there occurs sharing by hydrometeorological information between NHMS of the region. 75 hydrological stations,water gages and 280 meteorological stations are included into the process of inter-state operational data exchange . 3 meteorological stations (Tashkent? Tamdy and Chimbay) are included into Global Observation System network that data are transmitted via CLIMAT cable to the GOS on the monthly basis.
Per WMO request the NHMS of Uzbekistan had run data transmitting for 9 more stations to the GOS. Nowadays data for 12 stations are available not for WMO only but for all world informational centres since January1, 2001.

2. Siting and metadata

Existing observational meteorological network is spatially imbalanced. The highest density of stations population is dated to territories with elevations in 0-1500 m.a.s.l. interval .Figure 3 shows the distribution of the numbers of meteorological stations by elevation intervals. From that it is obvious that there is insufficient coverage with meteorological observations high-mountain and the runoff forming zones.

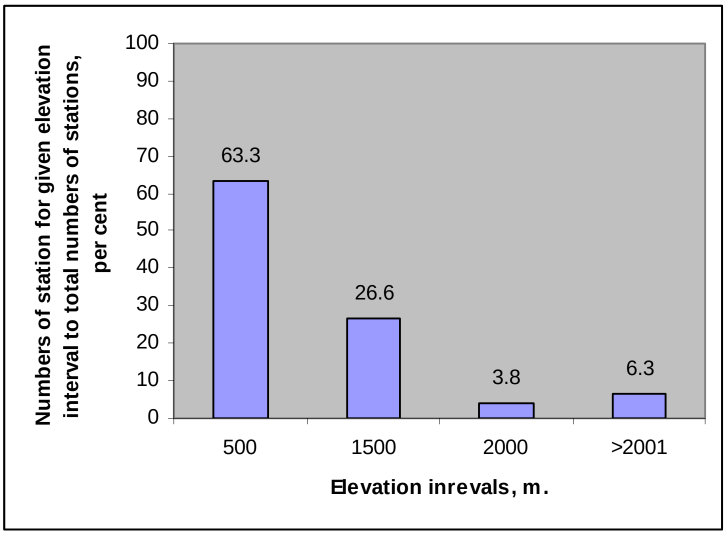

Fig.3 Distribution of the numbers of meteorological stations by elevation intervals.

As it was mentioned above the data processed are stored as hard copies of tables (TMC-84) and monthly meteorological report in which the following meteorological characteristics are compiled :

Content of TMC-84

3 hours data observations	
1	Air temperature, soil temperature, dew point temperature
2	Partial pressure of aqueous vapor
3	Relative humidity
4	Aqueous vapor saturation deficit
5	Atmospheric pressure
6	Rate of visibility and cloudness
7	Type of weather
8	Wind speed/direction
9	Precipitation (measured at 03 and 15 MGT)
Daily data	
1	Air temperature: average,max, min, min of dew point
2	Soil temperature: average, max, min
3	Partial pressure of aqueous vapor

4	Relative humidity :average, min
5	Aqueous vapor saturation deficit: average, max
6	Atmospheric pressure
7	Wind speed:average, max
8	Totalized precipitation
9	Snow depth
10	Solar radiance duration (data on 20 stations available)
11	Soil temperature profile (data on 14 stations available)
12	Ice crust deposits
13	Type and duration of precipitation

Meteorological monthly and yearly books content

№	Type of observations
1	Air and soil temperature (average,max, min)
2	Humidity (relative, absolute)
3	Visibility&cloudness
4	Wind speed (average, max gust)
5	Wind direction due to 16 compass points
6	Wind direction due to 8 compass points
	Atmospheric pressure
7	Precipitation
8	Precipitation measured on the water gage stations (it is published in the meteorological monthly book)
9	Daily and by 10 days period totalized precipitation (it is published in the meteorological monthly book)
10	Атмосферные явления, число дней, количество часов Atmospheric events (number of days/hours)
12	Pluviograph records (data from 10 stations)
16	Hazardous phenomena
17	Snow depth and snow condition
18	Solar radiance duration (data on 20 stations available)
19	Soil temperature profile (data on 14 stations available)
25	Ice crust deposits (it is published in the meteorological monthly book)

3. Instruments, sensors, upgrade, maintenance, instrument intercomparisons and traceability

As part of the effort to strengthen trans-boundary water resources management within the region, the US Agency for International Development's (USAID) Natural Resources Management Program (NRMP) funded a pilot automated climate data collection network. Sixteen automated weather stations (AWS) were installed within Tajikistan, Kyrgyzstan, Kazakhstan, Uzbekistan and Turkmenistan during the period from February 2002 to September 2003. Similar equipment is deployed throughout the world. Ease of use, low operational cost, suitability for remote unmanned operation, proven reliable collection of high quality data and capability to electronically store and transfer data are the primary reasons for utilizing automated climate monitoring instrumentation. Most of these stations use the USAID sponsored meteor burst radio communications to provide real time data telemetry and acquisition.
Two basic types of automated weather stations (AWS) were deployed within the five central Asian republics. Thirteen of the stations were designed to provide a complete array of typical climate parameters used for water resources management. These stations provide measurements needed for precipitation and evaporation estimation. In addition, the stations provide climate information typically provided for World Meteorological Organization synoptic observations. In addition, three of the stations were designed to also provide continuous monitoring of frozen precipitation. The stations were modeled after the SNOTEL monitoring

network located in the western United States and provide accumulated precipitation and snow water equivalent measurements in addition to the climate parameters provided by the other stations. Table 1 is a summary of the instrumentation that was installed at the stations.

Table 2

Measured meteorological parameters and deployed sensors for NRMP automatic weather stations.

Meteorological Parameter	**Sensor**	**Manufacture Reported Operating Range and Accuracy**	**Notes:**
Data logger and Control Module	Campbell Scientific CR10X	-55..+85°C ±0.1 of Full Scale Range @ (-25 to 50 °C)	
Air Tem-perature	Vaisala HMP45D w/ Pt 100 IEC 751 enclosed in RM Young 41003 Multi-Plate Radiation Shield	-40..+60°C ±0.2 °C @ 20 °C ±0.5 °C maximum within Range	Additional error is introduced due to heating of radiation shield and is dependent on wind speed and radiation intensity
Relative Humidity	Vaisala HMP45D w/ HUMICAP® 180	0..100% ±1% against factory references ±3% field calibration	Maximum error occurs between 90% and 100%
Atmo-spheric Pressure	Vaisala PTB100 Analog Barometer	600.. 1060 mb ±0.5 mb @ +20°C ±6 mb maximum within -40.. +60 °C Range	Measures absolute pressure and uses equation to calculate pressure at sea-level
Wind Speed and Direction	RM Young 05103	Wind Speed 0..60 m/s Gust survival 100 m/s ±0.3 m/s Wind Direction 0..355° ±3°	
Solar Radiation	Kipp & Zonen CM3	0..2000 W/m^2 ±10% for daily sums	Second Class thermopile type pyranometer Standard ISO 9060.
	LiCOR LI200X	0..3000 W/m^2 ±5% maximum absolute error in natural daylight ±3% typical	High stability silicon photovoltaic detector. Comparable to a first class thermopile pyranometer.
Preci-pitation (Rainfall)	Texas Electronics 525M Tipping Bucket Rain Gauge	0.1 mm resolution 1.0% < 25 mm/hr +0..-3% 25..50 mm/hr +0..-5% 50..75 mm/hr	Not suitable for measurement of snow. Heated tipping bucket rain gauges are not recommended by WMO.
Prec-ipitation (Accumulated)	Storage Gauge w/ Druck 1230 Submersible Pressure Transducer	7m H_2O 2 cm H_2O resolution	Requires annual recharge of antifreeze. Pressure transducers are subject to mechanical non-linear drift.
Snow Water Equivalent	3 meter Hypalon® Snow Pillow w/ Druck 1230 Pressure Transducer	7m H_2O 2 cm H_2O resolution	Extremely sensitive to placement. May be under representative because of snow bridging.
Ground Tempe-rature	CSI T-107/8 Thermistor	T-107: -35°..+50°C ±0.4°C for range of –24°..48°C T-108: -5°..+95°C ±0.3°C for range of –3°..90°C	Sensitive to solar radiation heating when sensor exposed to sunlight

Over the last years of this pilot program the AWS stations have demonstrated the capacity to provide reliable and consistent climate observations. The devices have required minimal maintenance while providing high quality regular observations. It is not recommended that

automated monitoring replace historical manual climate observation stations. However, automated stations can provide a cost effective and sustainable means for establishing a more comprehensive climate-monitoring program in the Central Asian Republics.
Electronic sensors evaluate the same physical phenomenon using different physical properties. For example, a liquid thermometer determines temperature by measuring the change in liquid volume where a Platinum Resistance Thermometer measures the change in electrical resistance. Sensor measurement time constants are different and the interaction of the sensor to site placement and enclosures will be different. Traditional calibration methods may not be suitable for calibration of electronic sensors. Field evaluation and calibration techniques are available for assessment of the operation of the sensor, but require a higher level of technical skill to perform than the more traditional sensors. Periodic calibration may require sophisticated offsite or lab evaluation. Electronic sensors require the inclusion of an analog to digital converter that may introduce additional error. Periodic maintenance and data quality evaluation will still need to be followed in order to assure the quality of the AWS data. Automatic operational alarms and periodic data quality review procedures must be implemented in order to assure the timely repair of equipment failure. Emergency maintenance trips may be warranted as review of the data indicates abnormal station operation.

Because of the recognized differences, AWS instrumentation is not typically considered for replacement of manual instrumentation for historical climate stations. Simultaneous operation can help define some of the differences in the change of station, but simple correlation will not be sufficient for defining all of the differences due to the inherent noise in climatic data.
Differences were evaluated between the simultaneously and automated collected data. Hourly data was compiled and compared at various time intervals for the four stations.
In general, climate observations of the automated equipment over the approximately two-year operation agreed very well with the manual observations. Differences in the mean temperatures for the three-hour temperature ranged from 0.030 to 0.220 °C. Differences between the temperature extremes ranged from 0.049 to 0.595 °C. Relative humidity differences ranged from 1.2% to 0.5%. Atmospheric pressure ranged between 0.482 to 0.936 millibars. Except for temperature there appears to be no bias in the observations.

Over the last two years of this pilot program the AWS stations have demonstrated the capacity to provide reliable and consistent climate observations. The devices have required minimal maintenance while providing high quality regular observations.
The results of comparative statistical analysis say that:

1. Only daily averaged measurements by sensors look like as confident in terms of statistically proven homogeneity in respect to manual data series.
2. Data come from sensors with 3 hours resolution cannot be merged to the manual data series as being a replenishment of that data series without adequate data processing because the risk of heterogeneity.
3. Variance sensor data-manual data can be minimized via mitigation the ambient influences.

4. Quality assurance / quality control (real-time, non-real time)

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Per WMO requirements to data control Within the framework of the Global Observing System (GOS). (WMO-No. 544) the following successive data control are applied in operative Uzhydromet practice:

- **In situ level** (before data transmitting to Communication Centre) : Observer's preliminary data control doing per experience and logical considerations.
- **Communication centre level** (before bulletin is formed and transmitted to GTS) : The data preprocessing of data received to check the compliance data coded with coding rules per WMO's telegrams coding requirements.
- **Synoptic Operational Service level** (within 1 hour after bulletin has been formed and transmitted to GTS) : Synoptic operational shift staff collates data after mapping and makes any amendments if need per its experience, logical current considerations and via immediate

feedback to observational network. Any reliable amendments are sent to GTS as delayed compliments to bulletin sent earlier.

- **Data processing centre level**: Comprehensive data control and analysis doing before meteorological data monthly books publishing.For data processing the program modules of PERSONA-mis and PERSONA-IB are used.

5. Training

Two programs addressed to improvement the national meteorological service via installation three Doppler locators at main airports of Uzbekistan and to facilitate access to high resolution satellite images (purchase and installation of the High Resolution Picture Terminal for receiving satellite images processed by TERRA/MODIS) funded by government of Uzbekistan serial training programs are expected.

6. Statistics and applications

The major objectives of Uzhydromet are the development and improvement of the state system of hydrometeorological observations, hydrometeorological provision of the sectors of economy, scientific research activities, improvement of short-term and long-term weather forecasts, water availability of rivers, climate change.

The main meteorological characteristics measured or calculated are listed under item 2. Climate data as a product of processing the meteorological data that can mostly be derived from the available set of meteorological data. Post processed climate data had been published in the "Scientific applied climate handbook" and are available as only hard copies.

Operative data come from observational hydrometeorlogical network are mainly used for:

- Provision of the state management bodies and branches of economy with the information on the condition of natural environment and climate, current and anticipated changes in hydrometeorological conditions.
- Issuing the short-term (next day, with three-six days lead time weather forecasts)and long-term weather forecasts.
- Data Input provision for climate scenarios design and modeling
- Warning on the anticipated risk of hydrometeorlogical disasters
- Compiling the "Weather reviews" and "Ecological bulletins"
- Publications, scientific researches and engineering.

7. Current issues and future plan

The following issues as the main existing barriers on the way to full value use of data could be mentioned:

- **Insufficient representativeness of existing observational ground network from of both spatial and informational view points.** From that it is obvious that there is insufficient coverage with meteorological observations the runoff forming zones.

- **Data series gaps by different reasons like measuring instruments breakage, observer's faults, radio communications jams, electricity outages etc**.
- There are some gaps in the hydrometeorological data series that break homogeneity and continuity of data series. Those gaps can be explained by different reasons. Mainly they appear as results of observers negligence, measuring instruments breakage and radio communication faults. The suspicious data that have the mentioned above nature just filtered out from proved data series during data processing procedure but they are not restored.

- **Data available as only hard copied.** Data are storing as hard copies hinder the process of data preparation , process and control. It is really tiresome and laborious routine to transfer data from hard copies to electronic data storages. But it is to be proceeded anyway.

- **Insufficient data base design and existing data bases dissociation**.The process of unification the data base storage formats that would enable easy reciprocal data conversion has not been completed. Mainly existing data bases are stored as operational files for DOS only. Moreover existing data bases need to be fused into integrated informational platform. These archaic data storage is not able to support fast and efficient data exchange for operational hydrometeorological service current needs.
- **Insufficient automated stations network development**. Ongoing world wide progressive use of automated observational networks proves the beauties of this option of data acquisition and control . Rate of coverage the informational needs with data come from AMS is characteristic of readiness to meet advanced data acquisition and control requirements. There are only 7 sites equipped with AMS within observational hydrometeorological network of Uzhydromet that have't been included into CAR ComCentres data exchange contour yet.
- **High resolution picture terminal receiving facilities to receive process and disseminate high resolution digital satellite data unavailable.** To provide large scaled effective and reliable monitoring on glaciation change the high resolution satellite picture receiving facilities are to developed and installed. Uzhydromet has such facilities allow to gather information come from NOAA 18 with the best resolution as 1 km only. Such resolution doesn't enable recognition of natural objects with dimension equal or less than 1 km. At the same time such dimension is characteristic for the main number of glaciers in the region. Other recourses with resolution 250 m and higher were available on the irregular basis only.
- **Radio sounding upper air stations unavailable.** Upper air measurement got gradually stop after USSR collapse. There are no radio sounding upper air station now. That's why the informational shortage on vertical profile of the main meteorological parameters negatively affect to processes of data ingestion by dynamic modeling of upper air processes. Such data provision helps to improve and calibrate the developed models.

Proposed steps forward to improve the current status data acquisition and data control system

- Enhancing the spatial and informative capacities of the observational network.

- Data transfer from hard copies to the electronic data storages.

- Complete data statistical analysis to get reliable relationships to restore the existing data gaps .

- Improvement of existing data bases and ensure the integrated informational platform preconditions.

- Provision of the activities addressed to the rehabilitation of the operational status of the automated meteorological stations network and including them to the CAR ComCentres data exchange contour.