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INTEGRATED WATER RESOURCES MANAGEMENT AS BASIS FOR FLOOD PREVENTION IN THE KURA RIVER BASIN

1. Introduction

a. Geographical location of the basin.

On some morphological and hydrological characteristics the river Kura shares on three parts: 1) From Kizil-Giadik in Turkey up to the city of Borzhomi in Georgia, 2) From Borzhomi up to Mingachevir in Azerbaijan, and 3) From Mingachevir up to Caspian sea in Azerbaijan. From the beginning up to the city of Borzhomi this river is mountain, after this point it is already rather flat river. After Borjomi Kura pass between Great and Smal Caucasus.

A Kura rivers main feeder is Aras. The Araz river also originates in eastern Turkey in Erzurum province. It flows along the Turkey-Armenia border, along the Iran-Armenia border, along the Iran-Azerbaijan border, before flowing into Azerbaijan where it joins the Kura near the Caspian. Feeders from Armenia flow south into the Araz. The Araz divides just before meeting the Kura, and one branch flows directly into the Caspian. The total length of the Kura river is 1515 km and the total area basin of the Kura-Araz basin 188 000 km^2, occupying the greater part of the South Caucasus. This area is distributed amongst the five countries as follows: Iran – 40 000 km^2; Turkey – 28.900 km^2; Azerbaijan 52.900 km^2; Armenia – 29.800 km^2; and Georgia – 36.400 km^2 (R.Mamedov, M.Mansimov, Kh Ismatova.R. [4]). Population in this largely mountainous area is approximately 7 million.

b. Types of floods, examples of recent flood events and vulnerability factors. In territory Azerbaijan exists various types of flooding. The larger river systems of Azerbaijan include the Kura, Araz, Qanix, has rivers of the Kura-Araz Basin, and the main rivers of the Samur and Astara River Basins. Their floodplains can be categorized as having flat gradients and meandering, relatively stable, waterways. Their natural floodplains are extensive and flooding prior to flood protection works would be prolonged for periods of weeks and months. Many of the tributary rivers in Azerbaijan also have large catchments and extensive natural floodplains and these are characterized differently by their steeper floodplains that have a network of diverging waterways and relatively active alluvial processes. The headwaters of these tributaries rise in the mountain ranges and are termed mountain streams. Their floodplains are characterized by very steep slopes, diverging waterway networks, highly active and unstable waterways and incorporate the distinctive convex debris cones where the upper streams join their alluvial plains.

Features of a hydrological mode of the rivers of republic are in detail investigated by S.Rustamov [5]. Conditions of formation of the maximal charges of water of the rivers not only Azerbaijan, but also all Caucasus have been in details studied by M.Mamedov [2].

Peak flows of the large rivers and their larger tributaries are caused by combinations of snow melt and widespread rainfalls in the upper catchments and occur typically in late spring from April to June. Mountain stream and tributary floods which occur mostly in the period from April to October can coincide with Kura floods but this is not always the case. The total catchment of the Kura-Araz basin is approximately 198,300 sq. km (USAID, 2006) and Azerbaijan, including occupied territories, occupies approximately 33.2 % of the area of this basin.

Fig. 1. Flooding village in mouth area (left, 12.05.2005) of Kura river and in district of Sabirabad (right, 11.05.2010)

According to stationary hydrometric measurements outstanding floods in river basin Araz took place in 1936, 1938, 1946, 1951, 1963, 1968 and 1969 years. In April, 1968 the catastrophic flooding caused intensive snow thowing and loss of showers was observed. For April, 16-18th in pool Araza 50-100 mm of deposits have dropped out. The peak of a high water has been fixed on April, 18th and 19. Low sites поймы by width up to two km as the channel was unable pass a plenty of water have been flooded.

In various REFERENCES it is underlined the flooding which are taking place in floodplain Araz in the last century. There are data on flooding 1858, 1868, 1879, 1896. During strong flooding the river Araz changed the channel. Such changes were observed during flooding in 1858 and 1896. The figure 2 shows situation in the end of 19 centuries Is New-Araz lake - river systems.

Flow frequency information for large rivers is shown in Table 1. The Kura River “flood of record” in recent memory was a flood in 1969 and is assessed by the above analyzes at close to the 1 in 100 year flood in both the Araz and Kura Rivers. Following some improvements in 2003, the Kura River dike system downstream of the Araz junction has a design capacity of 2000 m^3/sec or between a 1 in 20 and a 1in 50 year flood. However, this system has not been tested against such a large flood. The capacity of

the Kura River dike systems upstream of Sabirabad is stated to be between 700 and 1,000 m^3/sec (Source, AAIC) and the probability of occurrence of these flows is not available.

Last biggest flooding was in May, 2010 in the plat watercourse the river Kura in territories Sabirabad and Hadjikabul of administrative areas. A damage from it flooding has been estimated 300 million AZN.

Additional information on the flood hydrology of the mainstream rivers is presented in Figure 3 and table 1. This figure shows the basic variability of the hydrology of the Kura River on a monthly basis and how tributary inflows, reservoir operation, extractions for irrigation, and Araz inflows combine to form the total flow at Salyan.

In Azerbaijan flooding are observed basically on the rivers the Kura and Araz. Figure 4 shows records of Kura and Araz Rivers for April and May 2010 during a period of significant flooding. The extended duration of large flows is highlighted and is claimed to be the cause of drainage difficulties and associated flooding during those months. It is indicated that for a considerable part of the time, the flow was below the peak value that occurred in early May 2010 and there was opportunity to discharge external accumulated floodwaters or more tributary flows, had suitable works been in place. Examination of the data reveals:

Table 1: Available Flood Data and Analyzes for Large Rivers

	Peak Flow (m^3 sec-1)								
Average Return Period (years)				4	10	20	5	100	1000
Annual Exceedance Probability, %				25	10	5	2	1	0.1
Year		1969	2003						
Location		Catchment area (sq m^2)							
Kura River									
Qiragkesemen	37,000	na	1715						
Inflow to Mingechevir	a	na	na	1,900	2,200	2,400	2,620	2,780	3,500
Before Mingechevir (1953)									
Kura R at Surra (before Mingechevir)				2,130	2,480	2,710	2,990	3,190	na
Kura R at Salyan (before Mingechevir)				2,150	2,580	2,870	3,220	3,470	
Kura R at Surra		2680	1,648						
Kura R at Salyan	188,000	2,350	1,600	1,280	1,606	1,862	2,150	2,458	na
Kura R at C.B. Bank		2,160							
Araz after Araz headworks									
Araz River at Karala (1)	46,000 pprox.	1,690	na		769	1,187	1,349	1,509	
Araz River, Araz headworks inflow					1,100	1,260	na	1,650	2,260
Araz River at Giziwang (1)		2,230	na	na	1,298	1,577	1,784	1,990	
Araz River, Saatli	100,000	2,600/ 2,700	869	604	803	950	1,170	2,071	2,545

na- information not available, (1) from Nespak, (2) approximate

- discrepancy between the Surra and Salyan flows late in May 2003 is noted (Salyan minimum flow is less than Surra minimum flow). Part of the difference may be irrigation abstractions but the more likely cause is a change in the rating curve during the flood event or errors in the rating curve for one or both locations for lower flows (Salyan too low or Surra too high);
- volumes recorded at Yevlakh in April and May of 1,900 km3 compared with 4,900 km^3 crossing the Georgian border. The large difference highlights a significant data deficiency that will need to be addressed in flood forecasting. Data is not available for tributary inflows downstream of the border, the change in storage volume of reservoirs (Mingechevir has an active volume of 8,220 km^3) and outflows through the irrigation system of the Shirvan and Garabakh canals (potentially 1,300 km^3);

- tributary inflows between Yevlakh and Surra, excluding Araz River at Novruzlu, of some 1,800 km^3, which must have originated from inflows from mountain streams, drainage return flows and possibly groundwater seepage. The need for inclusion of these inflows in analyzes and forecasting is indicated

Fig. 2. Situation in the end of 19 centuries in New-Araz lake - river systems

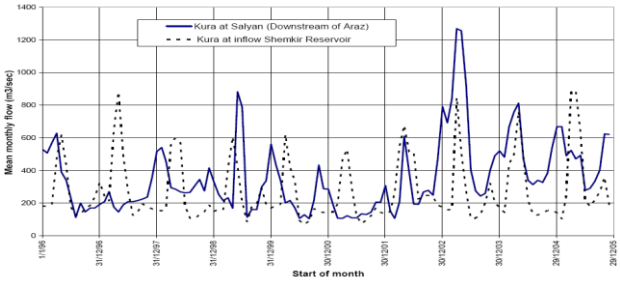

Fig. 3. Kura River Monthly Flows

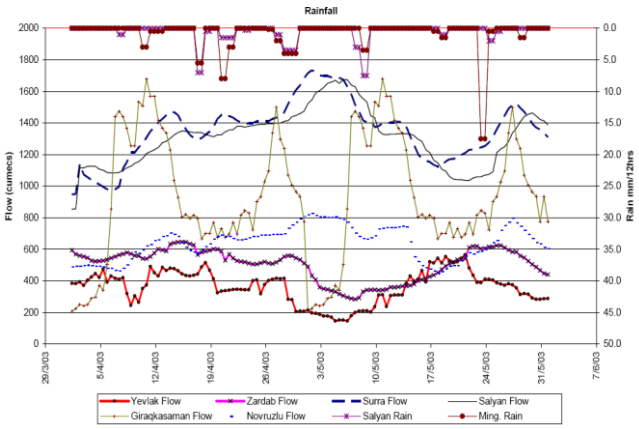

Fig. 4. Kura Flood Flows

However, not all from annually observable high waters lead to the destructive consequences, many of them do not cause flooding. Catastrophic character of a high water or a high water can be caused by excessive intensity snow thawing, aggravated by loss of the rains imposed on thawed snow, and also loss in the summer or autumn of short-term storm and intensive rains. In both cases in channels of the rivers the waters which have accumulated from all reservoirs which break through coast do not hold or are poured through them, flooding coastal spaces and bringing frequently a serious material damage to economy.

Major flooding of the Kura floodplains outside the dikes, as recently as 2010, is believed to have been caused by a combination of local rainfall runoff, seepage through the dikes, accumulated groundwater and possibly some surcharging of the above-mentioned spillways that overload the normal drainage system. Based on an examination of flow data and advices received, it appears that there has not been any substantial collapse or overtopping of the main dikes during the 2003 or subsequent floods. Local floodplain drainage is impeded by high river levels in the Kura causing during non-flood conditions and these are caused by combinations of high Caspian Sea levels, channel siltation and regulated flows to supply irrigators in the Water Farms in the Lower Kura area. Persistent flooding causes damage to agricultural lands and urban areas.

The flood capacity and morphology of the mouth of the Kura River has recently been greatly impacted by a rise in Caspian Sea levels 2.5 meters during 1978-1995 years [3]. Surveys that can indicate the extent of recent situation are not available but situation caused by the sea level rises is likely to be located near to the mouth. Other situation may have occurred along the Kura River due to natural processes.

c. Institutional responsibilities and counterparts across borders. Ministries with the greatest responsibility for water resources management in Azerbaijan are:

- Ministry Ecology and Nature Resours
- Azerbaijan Amelioration and Irrigation Company (AAIC)

These organizations have administrative divisions as well as scientific-research institutes which carry out monitoring of water resources condition, execute scientific-research works and undertake other specified activities and investigations.

Other agencies are involved in devising plans and programs related to water resources protection and use and these include:

1. Ministry of Industry and Energy (water use for power generation)
2. AzerSu (drinking water supply company)
3. Ministry of Health (drinking water quality – health and hygiene)
4. Water User Associations (Irrigators and farmers).

The following organizations participate in implementation of scientific-research and other works related to water resources protection:

1. Geography Institute of Academy of Sciences;
2. Azerbaijan Hydraulic and Amelioration Science-Production Unit
3. Azerbaijan Science and Research Water Problems Institute
4. National Committee on International Hydrologic program UNESCO;
5. Environmental NGOs.

d. Role of water basins in reduction flood risk.

In spite of the fact that during Soviet time solid means for protection against high waters were allocated, still it is not possible to prevent a significant material damage from flooding. Construction of water basins, dams and embankments has improved protection against flooding and has reduced their scales, but other kinds of intervention of the person, such as alignment river floodplains and irrational land tenure have caused strengthening risks and probabilities of the undesirable phenomena. Building and settling in downstream, some of which are located in zones where high waters are frequent, also does many settlements vulnerable for flooding.

In territory of Azerbaijan on the rivers Kura and Araz five large water basins with the purpose of development of the electric power have been constructed (Table 2)

Table 2. Main Characteristics of Reservoirs on the rivers Kura and Araz in Azerbaijan

#	Names of Water Storage	Built	River Basin	Total capacity , mln.m3	Surface Area SA (km2)	Dam Height DH (m)	Location
1	Varvara	1952	Kura	62.00	21.40	12.00	Yevlakh region
2	Mingachevir	1953	Kura	15,730.00	605.00	80.00	Mingachevir city
3	Shamkir	1983	Kura	2,677.00	115.00	70.00	Shamkir region
4	Yenikand	2000	Kura	158.00	22.61	24.00	Shamkir region
5	Araz	1971	Araz	1,350.00	145.00	40.00	Nakhchivan AR

From time of construction Mingachevir of a water basin at Kura (in 1953) and Araz on the river Araz (in 1970) scales of flooding were considerably reduced. However intensive regulation of a drain does not rescue the population from danger of flooding. The increased frequency of flooding and strengthening of superficial erosion in pools of the rivers the Kura and Araz accelerate filling these water basins and reduces them again flooding effect. So, maximal depth Mingachevir of a water basin has decreased about 83 m. up to 63 m.

Because of absence of the necessary hydrometeorological information from other countries of pool of the Kura, large water basins are maintained inefficiently to what results of flooding in the bottom current of the Kura in 2003 testify

2. Joint flood risk management planning and implementation

a. Internal activity for reducing flood risk.

Lack of knowledge does not allow to make a full estimation and the universal analysis of influence and consequences of flooding. It is necessary to note especially mentioned below:

Insufficient amount of stations of hydrological monitoring and inefficient data exchange between the coastal countries;

Absence of the authentic and effective forecast of flooding. Existing approaches do not meet modern requirements. The out-of-date technologies and the equipment are used.

Absence of data about frequency and scale of the flooding which have happened for last twenty years in view of an inefficiency of systems of hydrological monitoring, i.e. it is impossible to estimate influence of global warming;

For warning of flooding and their reasons investments which should be directed first of all on rehabilitation existing systems are required. In addition to it is necessary to develop strategy on management of risks of flooding, and also national and regional plans on universal rehabilitation противопаводочных systems in all pool of the Kura.

In Azerbaijan, as well as in other countries of pool of the Kura, there is an experience of prevention of flooding by means of structural measures, i.e. engineering constructions (water basins, dams, coast constructions, etc.). Unfortunately, not enough attention is given not structural measures (an early warning system, forecasts of flooding, insurance upon flooding, etc.).

b. Regional cooperation and joint activity

The total available water resources from rivers in Azerbaijan averages 31.23 km³/year, whilst in a drought year (95% probability, or 1 year in 20), the available water is reduced to about 20.3 km³. However, only about 10 km³ (30% of this water) originates within Azerbaijan, whilst the remainder is obtained from trans-boundary inflows.

Azerbaijan is concerned about its position relative to other countries sharing the Kura- Araz river basin. The Government has signed a number of international conventions covering international watercourses and water bodies (lakes), but has not developed specific agreements with neighboring countries on freshwater in recent years. An agreement, dating from the Soviet period applies to the Araz River between Azerbaijan and Iran, and a further agreement has been made between Azerbaijan and Russia for the Samur River.

Azerbaijan became a signatory to the UN 'Convention on the Protection and Use of Trans-boundary Watercourses and International Lakes' in March 1992, but neither Georgia nor Armenia are signatories because of the potential implications from the "Convention for Upstream Pollution".

It is proposed that Azerbaijan seek to establish working agreements with all neighboring countries, using the WFD and RBD principles as the basis for dialogue and the mutual introduction for good governance of shared water resources. Appeals should be made through international water management organizations to help bridge the divide between countries, by stimulating technical discussion and cooperation, as a prelude to concluding eventual political and internationally recognized agreements for effective management of internationally shared water resources.

c. Conclusions and suggestions:

The following recommendations are made to progress the interests of Azerbaijan in relation to international watercourses. In the short term in relation to Georgia, initiate establishment of cooperation forum at political level with view to develop an agreement on water resources of the Kura River;

- establish forum with ministers as representatives,
- agree with Georgia on forum support arrangements,
- identify supporting unit in Azerbaijan,
- present issues of concern for further discussion,
- initiate data and information exchange arrangements

Title of project	Organization	Period
South Caucasus Regional Water Management Project	USAID	2000-2002
Synergy	USAID	began in 1998
Joint River Management Programme	TACIS	2001-2003
Regional Environment Center	EU-TACIS, USEPA	began in 1999
Kura-Araks Coalition NGO	Giorgi Dzamukasvili	began in 1997
Cooperative River Monitoring among Armenia, Azerbaijan, Georgia and the USA	NATO Science for Peace Programme	2001-2005
Reducing Transboundary Degradation of the Kura-Aras River Basin	GEF	2005-2007
Supporting River Basin and Flood Management Planning Project	Asian Development Bank, Republic of Azerbaijan	2007-2008

In the short term in relation to Armenia, investigate monitoring requirements and act to strengthen monitoring capacity for water quality in the lower Araz River and western tributaries of the Kura River.

In the longer term in relation to Georgia, continue cooperation arrangements as follows:

- establish coordinating arrangements at technical and operation level,
- develop real time warning systems as required,
- develop agreement on waters of the Kura River.

Table 3. List of Regional Projects Related to Water Management in Kura river basin

In the longer term in relation to Iran, if assessment of flood impacts shows potential for significant further flooding in Azerbaijan:

- propose cross-border flood study,
- agree study results to be used as benchmark for further action,
- agree principles for further flood protection schemes, based on minimization of impact by both parties.

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წყლის რესურსების ინტეგრირებული მართვა როგორც წყალდიდობების პრევენციის საფუძველი მდ.მტკვრის აუზში/მამედოვი რ., ისმატოვი თ/საქართველოს ტექნიკური უნივერსიტეტის ჰიდრომეტეოროლოგიის ინსტიტუტის შრომათა კრებული -2011.-ტ.117.-გვ. 19-23.- ინგლ.; რეზ. ქართ., ინგლ., რუს.

სტატიაში განხილულია წყალდიდობების სიხშირე და მიზეზები აზერბაიჯანის რესპუბლიკის სხვადასხვა რეგიონებში. წყალდიდობების მართვისათვის მდ. მტკვრის აუზში, კერძოდ, აზერბაიჯანის ტერიტორიაზე, შემოთავაზებულია წყლის რესურსების მართვის ინტეგრირებული მეთოდი. ამასთან ერთად აღინიშნება იურიდიული და ორგანიზაციული ბაზის არარსებობა ამისათვის. წყალდიდობების მართვის ერთ-ერთი ძირითადი მომენტი არის დედამიწის ხელოვნური თანამგზავრების მეშვეობით მიღებული მონაცემების გამოყენება. შემოთავაზებული მეთოდის წარმატება დამოკიდებულია სათანადო ხელშეკრულებების დადებაზე და ინფორმაციის გაცვლაზე.
სტატიის ბოლოს წარმოდგენილია მდ.მტკვარზე წყალდიდობების და დატბორვების მართვის საინფორმაციო მოდელი.

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INTEGRATED WATER RESOURCES MANAGEMENT AS BASIS FOR FLOOD PREVENTION IN THE KURA RIVER BASIN./*Mammadov R.M., Ismatova Kh.R.*/Transactions of the Institute of Hydrometeorology, Georgian Tekhnical University. -2011. - т.117. – pp. 19-23. - .; Eng .; Summ. Georg.; Eng.; Russ

This article is directed at review of floods in Azerbaijan and recommended by the authors suggestions on improved water(flood) management in Azerbaijan based on creation of IWRM (Integrated Water Resource Management) oriented legal and institutional frameworks and implementation of flood prevention programs and satellite information at national level and for the whole Kura –Araz River Basin. This may be used to establish an institutional, legal and technical framework in order to overcome national level and trans-boundary water issues in the Caucasus region.

After the collapse of the Soviet Union, the countries of the South Caucasus gained their independence. However, they faced with the problems associated with national and trans-boundary water management. Transboundary water management remains one of the key issues leading to conflict in the region today.

Though Azerbaijan is an extremely water-poor region (the water supply of the Azerbaijan Republic territory situated downstream of trans-boundary rivers makes up about 100,000 m^3/ km^2) there are often floods at mountain rivers that lead to huge damage to the economy of the country and human losses.

Rivers of the Big and Small Caucasus with average altitudes of the catchments area higher than 2500m main source of flood is melted snow (more than 70%). 80% of flood maximum is observed in June-July.

In the article results of studies on use of satellite information for flood management is also described.

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ИНТЕГРИРОВАННОЕ УПРАВЛЕНИЕ ВОДНИМ РЕСУРСАМИ КАК ОСНОВА ПРЕВЕНЦИИ НАВОДНЕНИЙ В БАССЕЙНЕ Р. КУРА./*Мамедов Р.М., Исматова Х.Р*/ Сб. Трудов Института Гидрометеорологии Грузинского Технического Университета Грузии. –2011. – т.117. – с. 19-23. – Анг .; Рез. Груз., Анг.,Рус

В статье дается обзор о частоте и причинах наводнений в различных регионах Азербайджанской Республики. Для управления наводнениями в бассейне р. Кура, в частности на территории Азербайджана, предлагается Интегрированный Метод Управления Водными Ресурсами. При этом отмечается отсутствие юридических и организационных баз для этого. Одним из основных моментов управления наводнениями является использование данных полученных с помощью искусственных спутников Земли. Успех предлагаемого метода зависит от заключения соответствующего соглашения и обмена информацией.

В конце статьи предлагается информационная модель для управления наводнениями и затоплениями в устье р. Кура.