WATER RESOURCES OF NORTHERN AFGHANISTAN AND THEIR FUTURE USE[1]

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Introduction

The Civil War in Afghanistan, that has been dragging for two decades already (it began in late 1978 after intrusion of the Soviet Union and then the anti-terrorist operation pursuing the target to do away with the "seat" of terrorism represented by the Taliban movement), has led, in addition to huge people losses, to devastation of the economy. Considerable areas of agricultural lands have been disused. Hundreds of thousands of rural population emigrated from the country. By UN estimates at present Afghanistan is the only country in the world with such great number of mines. In view of the finance deficit the peasants more often than before prefer growing not wheat, but opium poppy that is sold to intermediaries and then is exported to foreign countries.

General Characteristics

Afghanistan covers the southwestern part of Central Asia. In the north Afghanistan borders on Tajikistan, Uzbekistan and Turkmenistan, in the west – with Iran, in the south and east – on Pakistan, India (Jammu and Kashmir), China (Sinzyan). The territory of Afghanistan is 655 thousand square kilometers[3], about 80% of its territory are taken by mountains.

Afghanistan is a mountain arid subtropical country locating in the northeast of the Iranian Highland, where it joins the Central Asian mountain systems. For this country with complicated orography typical is a combination of high mountain ridges with plateau and

[1] This report is prepared on the basis of investigations and design made by such institutes as Sredazgyprovodhlopok, Soyuvodproject, Sredazgydroproject in the period 1965-1975.
[2] Baumanskaya str., 43/1, Moscow, Russia
[3] This area is approximate equal to the areas of France, Belgium, The Netherlands and Denmark taken together.

intermountain valleys. In the northeastern and central parts there are found grand sharply-topped highlands and more monotonous medium-high mountains rimmed on the north, west and south with desert plains and flatlands.

In spite of the fact that the country locates in subtropical latitudes, the mountains and general uplift of the territory make natural conditions of Afghanistan rather severe. Only in the southernmost part they can be called subtropical.

Afghanistan lies to the southwest of the border where Tajikistan, China, India and Pakistan meet in the neighborhood of the world's most difficultly accessible mountain area – here the world's highest mountains Himalaya, Karakoram, Kunlun and Pamirs meet Eastern Hindukush. From the Pamir Highland solid mountain ridges run like a fan: a giant system of Central Hindukush and Paropamsus Range attended on the south with ranges of the Middle-Afghan Hazarajat Highland extends to the west and ridges of Haibarsky and Suleiman mountain arches – to the southwest. Such fanning ridges cover the eastern margins of the Iranian Highlands where a greater part of Afghanistan lies.

The Iranian Highlands are the easternmost in Middle Asia. Middle Asian (east Mediterranean) features in the nature of Afghanistan are met and dominate both in flat-desert and mountain-steppe areas. But proximity to the tropical southern slopes of Himalaya imparts South-Asian features to the eastern regions of Afghanistan, while presence in the country of such areas of the "World's Roof" as Eastern Hindukush and Western Badakhshan indicates that Central-Asian landscapes are typical of this country as well. In the north the southern margins of Central Asia belong to Afghanistan – margins of the Turanian Lowland uplifted to 400 m, in fact, being a southeastern "bay" of the Karakum with their inherent Central-Asian nature of deserts belonging to the moderate belt. The surface does not drop below 250 m.

Present State of Agriculture and Irrigation in Afghanistan

Agriculture is the dominating sector of the Afghan economics. It gives approximately two-thirds of its national income. The country has about 17 mln ha of lands suitable for agricultural use, or approximately ¼ of the total territory of Afghanistan, of which 7.9 mln ha are considered arable lands, including 5.3 mln ha – suitable for irrigated farming. Before the

war 4.5 mln ha were cultivated, of which by the late 1970s crops were grown on 3829 thou ha, including 2863 thou ha or 74.8% of irrigated lands.

The war damaged the agriculture of Afghanistan enormously. By UN data, already in 1991 the cropped areas made up no more than 3.2 mln ha, i.e., 1% less than before the war, including 1.5 mln ha of irrigated lands. A military conflict with the Soviet Union led to destruction of many irrigation systems without which it is impossible to grow wheat and barley.

During the last three years (1999 – 2001) Afghanistan suffered from the most severe drought that had not been registered in some regions in the last 50 – 100 years (by forecasts, it should end this year). Naturally, this will make a struggle for water more acute, especially in the northern provinces of Afghanistan where irrigation is based on water resources of Afghan rivers.

Agricultural produce and products of its processing take approximately three-fourths of the whole Afghan export. Technical equipment of agriculture is very poor. In villages manual labor prevails. Widely used are sickles, wooden plows, primitive harrows, etc. Tractors are used on less than 1% of the annually cultivated lands. Main agricultural crops grown here are cereals, cotton, sugar beet, rice, vegetables and fruits.

There are three largest river basins in the country:

- the Amudarya River basin – Panj, Kowkchen, Konduz, Khulm, Balkh, Sar-e Pol, Kaisar, Morghab, Harirud rivers;
- the Indus River basin – Kabul with Konar, Kurram and Gumal rivers;
- the Sistan Depression basin – Helmand with Arghandab, Harut, Farah and Hashrud rivers, their total average annual flow is equal to 420 cu. m/s.

The river flow that is formed on the territory of Afghanistan makes up 1600 to 1750 cu. m/s, or 50 to 55 cu.km a year.

In the climatic conditions of Afghanistan, that are characterized by low annual precipitations and dry climate, the irrigated farming makes the base of agricultural production here and a key factor for agriculture development. Only on slopes of some ridges where more than 300 to 500 mm of precipitations fall it is possible to practice rainfed farming.

Table 1 gives distribution of water and land resources by river basins in Afghanistan.

Table 1

Distribution of Water and Land Resources of Afghanistan by River Basins

River basin	Surface water resources, km^3	Mln thou ha		
		suitable for irrigation	irrigated in 1965	perspective irrigation
Amudarya	23.6	1580	460	1120
Helmand	13.0	500	290	210
Kabul (Indus)	24.0	146	56	90
TOTAL:	60.6	2226	806	1420

At present, by estimates of Afghan specialists, about 15 to 18 cu. km of water are used for irrigation. Remaining water goes out from the country because there are not regulating reservoirs. In the future only 35 to 37 cu. km of water a year will be used for irrigation and water supply. By rough estimations, the existing irrigated land stock in the country is 2.6 to 2.8 mln ha, out of which 1.65 mln ha are provided with irrigation water to some degree and 1.15 mln ha are intermittently irrigated lands, i.e., they have irrigation systems, but get water only during a flood period (Fig. 1).

Engineering and semi-engineering irrigation systems are constructed on an area approximately 0.33 mln ha (Helmand, Arghandab, Jalalabad, Sarde, Parvan, Gavargan, Kelagai and others). About 1.3 mln ha of lands are irrigated by traditional local non-engineering systems which are characterized by multi-head water intakes, a great extension of idle sections, great meandering, lack of regulation structures, low efficacy, etc.

As the rivers in the country are not regulated the greater part of the flood flow cannot be used for irrigation and runs out of the country destroying on its way hydraulic structures and flooding irrigated lands.

There are 12 water reservoirs in Afghanistan, they are Kadjaki on the Helmand River capable to store 1.7 mln cu. m of water, Arghandab on the Arghandab River – 0.34, Naglu on the Kabul River – 0.36, Darunta on the Kabul River – 0.04, Sarde on the Djelga River – 0.164 bill cu. m and some other reservoirs with a storage capacity from 1 to 19 mln cu. m built in the period from 1920 through 1940. Many of them need fundamental repair.

In open valleys and low piedmont areas, especially in the south and southeast of the county, about 15% of irrigated lands are provided with underground waters from kyariz, pits and springs.

Productivity of irrigated lands is much higher than that of rainfed lands. About 0.5 mln ha of irrigated lands in private ownership give two and in some places even three crops. The bulk of agricultural produce (99.9%) is grown in private low-commodity landholdings.

The irrigated farming is still on a very low level. The share of agriculture and irrigation in the state capital investments in 1986 was only 7.0%. By this index Afghanistan takes one of the last places in the region among developing countries.

The main reasons of such poor management of the available lands are inadequate development of irrigation and low efficacy of the existing irrigation systems. The greater part of irrigation systems is represented by primitive dams made of logs, fascines, bags with sand and pebble from which a network of simple aryks is constructed. In open valleys and low piedmont areas ground waters from galleries – kariz are used for irrigation. In many mountain areas the most primitive water intakes are constructed on springs, and this water is used for irrigation.

During flooding periods these systems are practically completely destroyed. Investigations carried out by international organizations and Soviet specialists have shown that every year up to 10% of the crop are lost due to failure and interruptions in the use of canals, while up to 30% of lands in the lower reaches of these canals remain without water because of the absence of regulation structures on them.

Construction of modern engineering irrigation systems in Afghanistan began largely in the late 1940s to the early 1950s. But constructed were only large projects with a view to get in the future a considerable growth of irrigated lands. As we know, in the 1960s the US EXIM Bank granted credits for construction of irrigation structures in the valleys of the Helmand and Arghandab Rivers that was started still in 1946 by the Company “Morrison-Nadsen”. All in all the Americans constructed more than 250 km of main canals, several dams and hydropower plants.

Experience of development of new irrigated lands with the help of irrigation systems Sarde, Parvana, Kelagai and Helmanda has shown that such practice was not successful.

As there was no an integrated approach to design and construction of many large and regionally significant irrigation projects the basic structures in these projects were constructed, but bringing of thus prepared lands into agricultural production requires additional investments and time. The only finished integrated engineering project tat gives economic benefits is the Jalalabad irrigation complex that was built with technical support of the former Soviet Union. This complex was damaged seriously in the course of military actions in this region.

Water Resources and Irrigation in the Northern Regions of Afghanistan

Northern regions of Afghanistan are supposed to include the valley on the left bank of the Panj and Amudarya Rivers, beginning from the Kowkchen River valley in the east and ending with the Shirintagao River valley on the border with Turkmenistan in the west. On the north this territory is rimmed by the Panj and Amudarya Rivers, on the south – by outspurs of the Bandi-Torkestan (more correctly Tirbandi-Torkestan) and Hindukush Ridges[1].

Mountain glaciers are an important indicator of climatic changes in the region. Investigations that had been carried out recent by the Head Hydrometeorological Service ("Glavgidromet") of Uzbekistan revealed a steady degradation of mountain glaciation in the zones of flow formation of main rivers in the Aral Sea basin[2]. In the recent four decades the area of glaciation in mountains has become nearly 40% less. At the same time studies on mathematical models developed by specialists of "Glavgidromet" enabled evaluation of the effect of climatic changes on river basins and an integral evaluation of the runoff. The obtained results have indicated that none of the tried climatic scenarios reflecting climate warming contributes to the increase rivers flow of the Amudarya basin. At the same time an essential reduction of flow in a vegetation period may be expected. In this case the increased intensity of rainfall in combination with higher temperatures will lead to a greater number of floods and mudflows and their greater intensity.

Investigations on mathematical models for evaluation of the flow of major rivers in the Aral Sea basin for perspective taking into account changing climatic conditions have made it possible to formulate the following conclusions:

- with the increase of the mean annual air temperature by 1-2^{o}C the seasonal accumulation of snow in mountains will decrease and further shrinking of the area of mountain glaciation will be observed;
- the river flow in the Amudarya basin will become 20 to 30% less;
- rise of the mean annual air temperature by 3-4^{o}C will destroy mountain glaciation in the region and this will cause reduction of water availability in rivers by 30-40%.

Severe droughts in 2000 and 2001 can be viewed as an analog of a hydrological situation after climate warming in the future.

[1] The basins of Morghab and Tejen (Harirud) are not included in this territory. It should be said that their inclusion will make the irrigated areas in the foreign part of basins Panj and Amudarya up to 2,2 mln. ha.
[2] Chub V.E. (2002). The consequences of climate changes for water resources of the Aral Sea Basin. Report to International Conference "Aral Sea and Circum Aral Problems – Imperative for International Cooperation". Tashkent.

An area of lands suitable for irrigation in this region of the country exceeds 1.5 mln ha, of which 466 thou ha were irrigated (with various degree of water supply) beginning from 1965[1].

The sources for irrigation here are local rivers Kokcha, Konduz, Hulm, Balkh, Sar-e Pol and Shiritagao running over the northern slopes of the mentioned ridges and rivers on the border with Tajikistan and Uzbekistan – Panj and Amudarya.

Rivers of Northern Afghanistan, by the present-day use of their waters for irrigation, availability and location of free, suitable for irrigation lands in their basins, can be divided into ***three categories***:

- Hulm, Balkh, Sar-e Pol and Shirintagao Rivers;
- Panj, Kowkchen and Konduz Rivers;
- Amudarya River.

The land stock in the basins of rivers of the ***first category*** exceeds much their irrigation potential, thus, in the present-day conditions the flows of these rivers are used practically completely even in the years of high water availability. By the conditions of flow formation the floods on these rivers are observed early (April – May), so cereal crops (up to 70%) that are, in fact, considered conventionally irrigated are cultivated on irrigated lands here.

Low water supply of lands at present excludes a possibility, after flow regulation efforts and transfer to optimal irrigation, of maintaining areas of irrigated lands at their present level. While considerable shrinking of irrigated areas in conditions of private land use and availability of multiple small farms is unacceptable, because in this case the majority of these small farms will be left without sustenance. Some saving of water in these and other basins can be attained through refurbishment of the most primitive irrigation systems and improvement of their efficiency.

It follows from the above that regulation of the flow of rivers in this category and refurbishment of irrigation systems in their basins can be recommended only if these efforts are combined with additional supply of water from a nearby source – the Amudarya River. Then realization of the recommended measures in each system would lead to irrigation development, and not to shrinking of irrigated areas.

Irrigation of lands from rivers referred to the ***second category***, such as Panj, Kowkchen and Konduz, has attained at present a significant scale (especially as refers to Konduz). However, in the basins of these rivers there are found both water reserves and free lands suitable for irrigation. These

[1] According to Sredazgyprovodhlopok

lands haven't been irrigated so far only because this required construction of diversion dams, long and complicated canals, pumping stations and others.

The positive factor in the likely construction of hydraulic structures in the basins of these rivers is that this can be realized locally without involving a need in complex interrelated efforts.

And the source of the ***last category*** is the Amudarya River 1250 km long (in the Panj upper reaches). In spite of its ample flow the waters of this river are used in Afghanistan only for irrigation of a narrow land strip along the river itself sizing about 10 thou ha, net.

Water resources in the Aral Sea Basin formed by the Amudarya River are distributed as follows: Tajikistan – 62.9 cu. km/year, Kyrgyzstan – 1.9 cu. km/year, Uzbekistan – 4.7 cu. km/year, other countries (Iran, Afghanistan) – 8.9 cu. km/year. Thus, the total flow in the Amudarya upper reaches is equal to approximately 78.5 cu. km/year. The greater part of the surface flow of the Amudarya River basin, or 83% are formed on the territory of Tajikistan, about 8% - on the territory of Afghanistan, 6% - in Uzbekistan and less than 3% - in Turkmenistan and Iran.

Vast areas of lands suitable for irrigation are separated from the river by a strip of mobile barkhan sands up to 20-30 km wide. In the past difficulties with construction of the head water intake and a canal through sands made impossible progress in irrigation with waters from the Amudarya River in Afghanistan. Only with the help of uptodate construction technique it becomes possible to construct irrigation systems. However, such construction can be economically feasible only for rather large irrigated areas, and this will demand significant water intakes from the river.

Irrigation of the whole free land stock in Northern Afghanistan (more than 1.5 mln ha) is possible without construction of waterworks, it will be enough to construct a damless water intake with water pumping in three places:

- near the confluence of the Panj and Vakhsh Rivers;
- near the Geshtepe outpost (opposite the mouth of the Kafirnigan River);
- near the Kelif gap (Fig. 2,3).

In the remaining part of the border section the river is meandering, has not permanent riverbed and, hence, not suitable for construction of a damless water intake.

In all cases water should be pumped to a height no more than 20 to 30 m, power supply can be provided by the thermal power plant using local natural gas.

Kowkchen and Konduz Rivers are wholly internal sources of Afghanistan (similarly to rivers Vakhsh, Kafirnigan and Surkhandarya). Their free annual flow of 50%-probability used at present for irrigation water supply is evaluated at 9.9 cu. km, including Kowkchen – 6.2 cu. km and Konduz – 3.7 cu. km.

The Panj River, having the ice-snow recharge, is running along the southern border of Tajikistan for 921 km and is formed from confluence of the Vakhandarya and Pamir Rivers. Its waters can be used both by Tajikistan and Afghanistan. A watershed area of these rivers is 107 thou sq. km, the total surface inflow from the mountain part of the basin is equal to 1100 cu. m/s (56% of the Amudarya flow at the site of Kerki City). Its annual flow without Kowkchen makes up 28.5 cu. km.

If for irrigation development Afghanistan uses completely water resources of its own rivers Kowkchen and Konduz, then its claims to the Panj flow will be 3.3 cu. km a year or only 11.6% of the annual flow of this river, which can be considered not excessive.

Irrigation development on the territory of Uzbekistan and Turkmenistan in the middle and lower reaches of the Amudarya will face certain difficulties, if Afghanistan arranges damless water intake, i.e., uncontrolled water intake. It is possible to avoid such situation if water is taken from the upstream face of waterworks in accordance with the respective agreement, and water releases in the required amounts are guaranteed to main water intakes on the territories of the mentioned countries.

After normalization of the situation in Afghanistan and its transfer to peaceful development it may become possible to withdraw water in the amount of 10 cu. km from the Amudarya for agricultural needs on a lawful basis (pursuant to the norms of the international basin law. As a result, the fresh water supply in Uzbekistan, that now satisfies only 70 to 80% of the actual needs, will sustain a nearly two-fold reduction. A similar tendency is observed in Kazakhstan and Turkmenistan.

By rough estimates, still in 1975 it was determined that the area of irrigated lands in Northern Afghanistan can be increased to 1.5 mln ha, then water intake for agricultural needs will be 15.0 cu. km a year, and adding here the needs of industrial and urban development the water consumption will be as large as 16.5 cu. km a year.

If by 2020 all lands suitable for irrigation in the river basins of Afghanistan are put to agricultural use, then their total area will reach 2.2 mln ha, and water consumption will increase to 21-22 cu. km/year.

Tables 2 and 3 give the planned irrigation development in the Amudarya River basin and in general for Afghanistan.

Table 2

Predicted Development and Irrigation Water Intake in the Amudarya River Basin

River basin	Existing		Perspective areas, thou ha			Planned water intake, km^3/yr		
	area, thou ha, 1965	water intakem cu.km	1990	2000	2020	1990	2000	2020
Harirud (Tedjen)	54	0.65	98	140	140	1.2	1.4	1.4
Local drainless rivers	264	2.0	300*	400*	600*	8.0	4.0	5.0
Konduz	104	1.2	145	220	245	1.5	2.2	2.5
Kowkchen	28	0.3	40	70	70	0.4	0.7	0.7
Panj	34	0.4	50	70	70	0.5	0.6	0.7
Amudarya	16	4.75	723	1250	1580	7.6	12.4	16.0

* Growth of irrigated lands in the basins of drainless rivers is possible due to water resources of the Amudarya.

Table 3

Predicted Development of Irrigated Farming and Assumed Water Intake in the River Basins of Afghanistan

Basin	Predicted development of irrigated farming, thou ha			Assumed water intake, cu. km		
	1990	2000	2020	1990	2000	2020
Amudarya	723	12.50	1580	7.6	12.4	16.0
Helmand	800	400	500	3.0	4.0	5.0
Kabul (Indus)	110	146	146	1.1	1.5	1.5
TOTAL:	1143	1806	2226	11.7	179	22.5

Nowadays the Amudarya is an international, transborder river between Tajikistan, Uzbekistan and Turkmenistan. In the post-Taliban time Afghanistan was added to these three states as a rightful "member of the basin".

So, the water problems acquire international dimension turning into a serious factor of international policy in the region and alikely a cause of disputes among these countries. In this context the most vital are the following issues:

- assessment of the condition of agriculture and water resources on the basis of aerial and space photographs of the territory of Afghanistan;
- plans for development of irrigation and water resources use in the country;

- plans for regulation of water resources and division of Amudarya water among the basin countries;
- to arrange a water use system in the Amudarya Basin to develop relevant inter state legal and regulatory acts;
- sequence of restoration and reconstruction of the existing water intake structures and irrigation systems;
- identification of priority actions in relation to water resources use for attraction of financial support from international organizations and donor countries.

Non-conflict management of transboarder waters and the fates of people living in the Amudarya Basin will depend to a great extent on successful solution of there issues.