

The Aral Sea Basin is located in the centre of Eurasian continent and covers the territory of Tajikistan, Uzbekistan, major part of Turkmenistan, part of Kyrgyzstan, southern part of Kazakhstan and northern part of Afghanistan.

Water resources of the Aral Sea basin are formed in surface and underground sources and glaciers.

Surface waters are mainly concentrated in the basins of the two main rivers of the region Amudarya and Syrdarya. Independent hydrographic basins (gravitating towards the Amudarya and Syrdarya rivers) create Kashkadarya, Zaravshan, Murgab, Tedjen, Chu, Talas rivers that lost connection with the main rivers many centuries ago.

The territory can be divided to three main zones on the conditions of formation and transformation of the surface flow in the region:

- zone, where the flow is formed (area of feeding in mountainous regions);
- zone of transit and dispersion of flow;
- delta zones.

Numerous glaciers are concentrated in the mountain systems of the Central Asia, which give rise to practically all large rivers of the region, the water of which is intensively used in the national economy. The major part of glaciers is located in the territory of the Republic of Tajikistan and the Republic of Kyrgyzstan.

On the whole, water resources in the Aral Sea basin are not equally distributed. 55,4% of the flow in the basin are formed within the territory of Tajikistan, in Kyrgyzstan 25,3%, in Uzbekistan 7,6%, in Kazakhstan 3,9%, in Turkmenistan 2,4%, on the territory of Afghanistan and other countries, share of which is not significant (China, Pakistan) around 5,4% of the flow is formed.

Rivers

The main source of the rivers in Central Asia is made with melted snow and glacial waters. Glacier-derived feed of rivers is considerable only in headwaters of those rivers where the main watershed area is occupied with glaciers and snow fields (especially in the Pamir Mountains). When flowing down from the mountains, the portion of glacial waters usually do not exceed 25% of annual flow of the rivers; in total annual flow of all Central Asian rivers glacial waters make up a little over 6%. A significant role in feeding rivers is played by underground waters, especially in winter time; in most of the rivers they make 10-25% of annual flow, in some up to 50%.



Amudarya is the largest river in Central Asia. Its length from the headwater of the river Pyandzh is 2540 km and the area of basin is 309 thousand square km. After confluence of the rivers Pjandzh and Vakhsh the river is called Amu-Darya. In the middle course the Amudarya is joined by three large tributaries from the right (Kafirnigan, Surkhandarya and Sherbad) and one tributary from the left (Kunduz). The main flow of the Amudarya river is formed on the territory of Tajikistan and partly in Northern Afghanistan. Then the river flows along the borderline between Afghanistan and Uzbekistan, crosses Turkmenistan and flows back to Uzbekistan. Further along the length of 1 257 km the river does not have any tributaries.

Before the Amur river flew into the Aral sea, but in the eighties due to large-scale diversion for irrigation inflow to the sea completely ceased.

A feed of the river basically is made with melted snow and glacial waters, therefore the maximal charges are observed in the summer, and the least - in January - February.

Proceeding on plain, from Kerka up to Nukus, Amudarya loses the most part of the drain on evaporation, seepage and irrigation. On turbidity Amu Darya wins first place in the Central Asia and one of the first places in the world.

Syrdarya is the second on water content and the greatest on length river of Central Asia, it is formed by confluence of Naryn and Kara Darya in east part of Fergana valley.

The length of the river from the headstream of the Naryn is 3 019 km and the basin area is 219 thousand square km. The Syr-Darya flow is formed in the mountainous part in Kyrgyzstan (74%), small part of headstreams is located on the territory of China. Then Syrdarya crosses Uzbekistan and Tajikistan and inflows in the Aral Sea in Kazakhstan.

It is fed mainly by snow and to a lesser extent by glaciers and rain. High water which usually starts in April ,is typical for the water regime of the river in spring and summer. When flowing out of Fergan valley the river crosses the Farkhad mountains and then flows along the spacious partially swamped plain flood 10-15 km wide through Tashkentsko-Golodnostepskaya lowland.

In the middle course the Syr-Darya is joined by three rivers: the Ahangaran, Chirchiq and Keles.



In the low course the Syrdarya flows along east and north outskirts of Kyzylkum Desert; here the river bed is meandering and unstable, there is often high water in winter and spring time. The last tributary is the Arys river. In the lower reaches of the river from Turkestan to Dzhusaly there is a spacious plain flood (10-50 km wide) with a great number of delta branches. In the river mouth the Syrdarya forms delta (near Kazaklinsk city) with numerous delta branches, lakes and swampland.

Before the Syrdarya flew in the Aral Sea; at present due to catastrophic lowering of its level and division of

Thus, the main drainage basin of the rivers Amudarya and Syrdarya is located in mountainous area and highland.

The dominating source for most of the rivers is melt water of seasonal snow cover and to a lesser extent glacial water and rain. Depending on the elevation of the drainage basin and the degree and period of precipitation, the share of different feeding sources for the rivers considerably varies, and this causes to a certain extent variation in flow regime.

According to hydrometric observation data, assessment of the average annual flow of the rivers is characterized with the following figures: for the rivers of the Syrdarya basin it makes 37 203 mln cubic meters per year; for the rivers of the Amudarya basin (including internal-drainage rivers in Afghanistan, Iran and Zarafshan) it makes 79 280 mln cubic meters per year.

Thus, total average annual resources of surface (river) water in the Aral sea basin make 116 483 mln cubic meters per year.

Due to fluctuation in water content, annual volume of water resources changes from 95% probability in years with low water to 5% probability in years with high water in the following range: the Amudarya from 58,6

cubic meters to 109,9 cubic meters, the Surdarya from 23,5 cubic meters to 51,1 cubic meters. River water is mainly used for economic needs, that is why the present-day flow quantity in lower reaches of the rivers has decreased by more than 10-15 times compared to a conditional natural period (before 1960).

Glaciers

The glacier deposits, located in the mountainous areas of Central Asia and Kazakhstan, are the most important sources and longstanding reserve of clean fresh water. Producing melted water in the hottest time of the year, when the supply of seasonal snow is nearly exhausted, they compensate the deficit of irrigation water in time of the highest demand.



Glaciers in Tajikistan and Kyrgyzstan play an important role in forming of Amudarya and Syrdarya rivers which are the largest water arteries of the Aral sea basin.

However the glacier deposits are not stable. At present researchers-glaciologists observe all-round glacial recession: small glaciers are disappearing while large glaciers are degrading.

Reduction of glaciers in the consequence of climate change (Regional Hydrology Center, 2009)

Future effect of climate change in the arid Central Asian region can have a direct influence on the volume of glaciers, feeding sources and water content of the rivers and, finally, availability of water for downstream regions and states. For example, glacier melting in Tajikistan annually contributes in average 10-20% to the flow of the large rivers, while in dry and hot years contribution of glaciers to the water resources of certain rivers in summer time can achieve 70%.

Impact assessment of global climate change on the Pamir-Alai glaciers shows that for the whole observation period starting from 1930 (the first instrumental measurements), the total glaciation area in Tajikistan reduced by about 20-30% and glaciers in Afghanistan (left bank of the Pjanzh river) reduced by 50-70%. Change in glaciation area is especially noticeable in the basins with extensive glacier surface (Bartang, Muksu, Fedchenko glacier system) in the center and in the south of the region.

In consequence of active melting of glacial deposits, flow of glacial water in the rivers Pjanzh, Vahsh and Amudarya river in general can increase in the beginning, however in the long-term perspective it will on the contrary decrease due to depletion of glacier deposits.

Unfavorable change in hydrologic regime of the rivers can have serious consequences both for separate vulnerable communities and for the whole region. If the current rate of degradation of glaciers stays the same, many smaller glaciers in Tajikistan will completely disappear in the nearest 30-40 years. Reduction in the amount of precipitation can result in reduction of surface water and, consequently, in the water-surface area of the lakes. Assessment of change in glaciation in the West Tyan-Shan allowed to define current rate of glaciation reduction. For 20 years glaciation of this area has reduced totally by 16,8%. Assessment of the respond of glaciers in Gissaro-Alai, located in Uzbekistan, to climate change showed that if the amount of precipitation is reduced by half 700 meters higher, the glacial surface will reduce by 86% and glacial water flow will decrease by 96%.

Underground waters

The third component of water resources in the Aral Sea basin is underground water. Approved regional deposits of underground water make 14,7 cubic kilometers. In as much as exploitation of underground water can have an impact on the surface water flow, the numeric estimation of underground water resources should be accurate in defining that part of deposits which can be used without sufficient reduction in surface water flow. Reserves approved for extraction, are estimated as 7,1 cubic km per year. Total volume of actual extraction of underground water in the basin is about 4,8 cubic km.

An important role in the hydrogeology of the Aral Sea basin is played by ground water, which saturates alluvial sediments in the valleys and which is adopted to channel, terrace and delta deposits. In the desert plain areas where salinized ground water prevails, filtration of alluvial water creates desalted zones which can be several kilometers wide.

An important role in ground water balance is played by artificial irrigation, and the slower is the motion speed of ground water under natural conditions, the more they change under the effect of irrigation. Underground water in desert plains is of great significance in national economy, providing possibilities for development of livestock breeding on pastures outside irrigated oasis lands.