

## **Field research of glaciers and glacial lakes located in Karatag, Vakhsh and Zeravshan river basin.**

Since the fifteen-year break of the field researches, Agency on Hydrometeorology in collaboration with the Regional Centre of Hydrology and Executive Committee of International Fund for Saving the Aral Sea (IFSA) launched the field investigation of the glaciers GGP, Diakhandara and Fedchenko, as well as the observation of glacial lakes in Saritag and Karatag river basin.

**GGP glacier.** The GGP glacier is located in the north mountainside of the Hissar range in Saritag river basin. The GGP glacier gives rise to Zambar, right inflow of the river Saritag. Upper valley of the river Zambar involves range of kars, where a number of lakes were formed. The mountainside of the valley is concave with wide bottom and four visible ancient mountain ridges. Stream canal is greatly meandering. Zambar valley converges to V-form below with a longitudinal slope greatly rising. Stream canal of the river is rich with rocky ledges and waterfalls depicting here and there.

The subalpine belt occupies the zone with altitude from 2800 m to 3200 masl. The flora of the zone is mainly stepped. Particularly, in Sarihadang (middle stream of Zambar river) the valley is covered by fescue.

Alpine belt occupies the terrain from 3000 m – 3200 m accordingly, extending to eternal snow level. The local flora is mainly featured by rocky vegetation, rubble talus and moraines and vegetation of alpine meadows in moraine hollows, along river banks.

**Climate.** The region relates to the Mediterranean climatic zone with the north subarea of the subtropical region, where maximum precipitation in the winter period predominates. The climate is insufficiently humid. In the area of the lake Iskanderkul, summer is featured with warm temperature, whereas winter is relatively mild. In the belt zone, summer is temperate, winter snowy and severe.

Meteorological data of the Hydrometeorological station Iskanderkul (close to the Saritag stream, 2200 masl), and Anzob pass (close to the Hissar range on the 45 km height from GGP glacier, 3370 masl) were used to assess meteorological indicators and quantitative characteristic of the glacier region.

Therefore, one may surely note, that the relief strongly impacts on heavy precipitation and low air temperature in winter season on the upper basin of the river Zambar, which, certainly, form favorable conditions for glaciers. From the right side of the GGP glacier a small glacier is observed, which provides melting water into the right side of GGP glacier. Field researches made it rather clear that the top of the glacier is covered by 5-10 sm. melted snow.

Outcomes of the field research display, that for the latest 16 years (1990-2006) the left side of the glacier has been receded by 35-40 m, whereas its right side reduced by 50-55 m. Hence, average speed of the glaciers retreat comprises nearly 3 m per year.

**Diakhandara glacier.** Diakhandara glacier got its name from the river Diakhandara, which springs from the glacier situated on the south slope of the Hissar range (at the turn of the Kaldirga range) flowing into the river Karatag. Diakhandara glacier was first observed on 18 August, 1940. In 1958 the first investigation of the glacier was made, and constant reference points to observe the glacier terminus were set up.

By the moment of the current field research the glacier was in the process of retreating. The surface of the glacier terminus is hilly and covered by the 3-4 m moraine. There are no cracks

on the glacier surface. Final and side moraines of the glacier, located on the left side, rise above 10-15 m. The latest moraine partitions the valley and drops off from 150 masl.

Observations quite vividly prove that the Diakhandara glacier is completely covered by the moraines. The glacier is settled, particularly near its terminus, falling into pieces here and there. For instance, the right part of the glacier (zone of the glacier feeding) was totally separated. Currently, glacier is in the final stage of its degradation; therefore, no tachometric survey was executed.

**Fedchenko glacier.** The region with the Fedchenko glacier considers the largest glaciation knot in Central Asia. Since many years long this zone was the blank spot on the Pamir maps. This region occupies a large area and presents the extensive system of mountain ranges, partitioned by deep valleys of glaciers and rivers. There are highest mountain heights of Tajikistan. Fedchenko glacier basin is a part of Amu-Darya river basin, which flows into the Aral Sea.

The basic boundary of the relief within the Fedchenko glacier basin is caused by an active tectonic regime of the mountain zone and large glaciation formation. There are the highest ranges and peaks, including the range of Academia Nauk with its Peak Somoni, Yazgulem range with its Revolution Peak, etc.

The largest glaciation zones within the Fedchenko glacier system are dated for their highest massifs of peaks: Somoni peak, Garmo peak, Revolution peak, and to Severniy Tanimas range. The largest glaciers – Fedchenko, Bivachniy, and Nalivkina were originated from them.

More than 100 glaciers are included into the Fedchenko glaciation system, and 26 among them inflow into the main glacier, and generally represent a glaciation complex. Fedchenko glacier basin wins the first place for the amount of large glaciers in Pamir. Moreover, all glaciers of the basin are located in the range with 2900-7480 masl.

**Climatic conditions of the glacier region.** Due to high altitude of the Fedchenko glacier region, climatic conditions are mainly featured by open upper air impacts. Strong south-west air currents greatly contribute to the slackening of the underlying surface activity, forming smoothed motions of the air temperature. According to the long-term data provided by the hydrometeorological station named after Gorbunov (at Fedchenko glacier) annual mean temperature comprises  $-7.1^{\circ}\text{C}$ . Monthly mean temperature from June to September may comprise up to  $1.6^{\circ}\text{C}$ . The warmest months are July and August with monthly mean temperatures  $3.1^{\circ}\text{C}$  and  $3.6^{\circ}\text{C}$ . Absolute maximum of air temperature is  $15.5^{\circ}\text{C}$  and absolute minimum of air temperature is  $-31.4^{\circ}\text{C}$

The Fedchenko glacier is blown by south and south-west winds with 80% average reiteration. North winds are rare, whereas east winds are totally absent on the territory of the Fedchenko glacier. Average wind speed is 5.8 m/second. Maximum wind speed was observed during the winter season being 35-40 m/sec or 50 m/sec. South gravity wind dominates in the upper zone of the glacier.

Precipitation, usually in the form of the snow forms 99% at all. Precipitation in the form of the rain is mainly fixed in August, forming the rest 1% of all precipitation. Annual mean precipitation comprises up to 1192 mm. The driest months are August and September with precipitations 20 mm.

The seasonal blanket of snow in the center of the glacier is formed in the middle of October. Snowfall is mainly accompanied by snowstorms. The bulk of snow is blown off by the wind from surrounding ranges. Snowfalls may continue for several days.

## Field research of glacial lakes in Karatag and Saritag river basins

Main objective of the research is to assess conditions of the mountain lakes in Saritag and Karatag river basins in the light of climate warming.

**Lake Iskanderkul.** Lake Iskanderkul is located on 2190 masl. The area of the surface water is 3.4 sq. km. Mean width is 3.2 km. The lake has obstruction originate. The water is 172 million cub m.

Due to the research date the water level was 1 m lower than high-water level (HWL). The color of water is turquoise. The check dam state, consisted of large blocked fraction, was stable. The threat of debacle is absent. Water temperature of the lake Iskanderkul was approximately 13-14 °C

**Lake Pairon.** Lake Pairon is located in the middle stream of the Pairon river, on 2123 masl. The area of the water surface is 160 thou sq. m; the capacity volume of the water is 1790 thou cub. m. On the right side of the lake Pairon, by 20-30 m up of the dam mudflows were observed. The water level was by 50-60 sm. lower than HWL. The lake is on the silt stage. The flow-out of the lake is communicated due to the filtration through blockages. There are trees and bushes growing at the dam, and this is to prove the stability of the dam since long time. Temperature of the lake water was within 12-13°C.

**Lake Timurdara.** Lake Timurdara is located in the middle stream of the river Kaznock, the left inflow of the Karatag river. The area of the water surface is 80 thou sq. m, the volume capacity of the water is 720 thou cub. m. The height of the lake is 1986.3 masl. The flow of the lake is filtrating. Due to the research date the water level of the lake was 1 m lower of HWL. The dam stage is stable. No threats of the lake outburst are observed. Temperature of the lake water was 12-13°C.

## CONCLUSIONS

**GGP glacier.** First observations over the GGP glacier were held in 1968. The GGP glacier owned its name due to the field expedition team of the Main Administration of Hydrometeorology of the Tajik SSR, which worked every summer within the period from 1971 to 1974.

Currently, the glacier is intensively retreating. Within 1968-1976, it had been receded by 18 m with average speed 2.2 m per year. At the same time the glacier lost 3100 sq. m of the total area, its surface reduced by 3,6-4,0 m. After 1976 the speed of retreating decreased: from 1982 to 1990 the glacier receded by 63.1 m with average speed 7.9 m per year.

Field investigations over the glacier (due to 2006) showed that for the latest 16 years (1990-2006) the glacier's left bank side has been receded by 35-40 m, whereas the right side bank receded by 50-55 m. Hence, the GGP glacier recedes with average speed 3 m per year and starting from 1980-s the trend of the retreating was considerably reduced.

**Diakhandara glacier.** Field observations showed that the Diakhandara glacier, in comparison with the other main glaciers of the Hissar range (Yakarcha and GGP glaciers), is on its final stage of degradation. It's greatly settled, broken into pieces, whereas the greater part of the glacier is covered by the moraine. Obviously, this is to explain that Diakhandara glacier is located on the southern slope of the Hissar range, whereas other main glaciers are situated in the northern zone.

**Fedchenko glacier.** In 1910-1913 the Fedchenko glacier expanded and moved forward by 800-1000 m. In 1914 the glacier blocked up the Balyandlik river and sank into its right rocky slope; as a result the river was running under 50 m ice. Then, the glacier had been significantly receded and continued to recede until now. Within 1928-1960 the glacier lost nearly all right

inflows, including Kosinenko, Ulugbeck, Alert and others, which lately considered independent glaciers. However, presently, they possess final moraines and grottos with heavy streams washing up the main glacier.

Within 1928-1958 the glacier had been receded by 460 m, and lost 8 sq. km of the area;  
Within 1955-1978 the glacier had been receded by 247 m and lost 0.91 sq. km of the area;  
Within 1979-1991 the glacier had been receded by 240 m and lost 2.3 sq. km. As a result, for the latest 63 years the glacier had been receded by 947 m and lost 11.2 sq. km of the area.

The surface of the Fedchenko glacier was rather settled: within 1976-1991 it was settled by 15 m in the bottom of the glacier; within 1976-1980 it had been shrunk by 2.3 m per year. Then, reduction trend was decreased to 0.5 m per year.

In 1979 the thickness of the Fedchenko glacier terminus comprised 40-50 m, whereas in 1988 – 20-25 m only. It reduced (by 9 km!) in Bivachniy inflow, its largest right inflow, which is located 20 km further.

Research showed that within 1991-2006 the Fedchenko glacier as well as the GGP glacier had been retreated with the average speed 8-10 m per year; i.e. speed of retreating was half reduced in comparison with 1980s.

For the latest 15 years in the cross profile (7 km from glacier's terminus) glacier had been shrunk by 1.7 m per year in its left part and by 1.3 m per year in its right part; in overall – 1,5 m per year.

Within 1978-1988 the glacier had been settled by 2.0-2.5 m per year. Hence, retreating of the glacier decreased as well.

Currently, terminus of the glacier is strongly cracked for 6-8 km long, and covered with the glacial lakes. This is to confirm that the biggest glacier in Tajikistan is on its increasing stage of the retreating and degradation.

Field researches of Tajikistani glaciers made it possible to reveal modern and important data with regard to glaciology (trends of their changes) and climatic conditions (in the light of global warming).

Intensive retreating of Tajikistani glaciers was occurred from the end of 1970s to the beginning of 1980s. This was obviously caused with changes of the ordinary warm and cold mass flows, wind speed and directions, climatic fluctuations, evaporation, therefore, leading to precipitation amount increasing.

The recede speed of the GGP glacier along with the Fedchenko glacier (the smallest and the biggest glaciers) decreased by 2.0-2.5. The speed of the retreating decreased insignificantly.

Survey of the main glaciers, like Fedchenko and GGP as well as glacial lakes of Tajikistan is necessary for receiving accurate and reliable data (glaciological). Their intensive retreating with changes in snow and ice stock is regarded as result of climate warming. Data received will be meant to assess the current state and conditions of the Tajikistani glaciers, glacial lakes with regard to the development of the national economy with accent to agriculture and energy, its core branches.

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