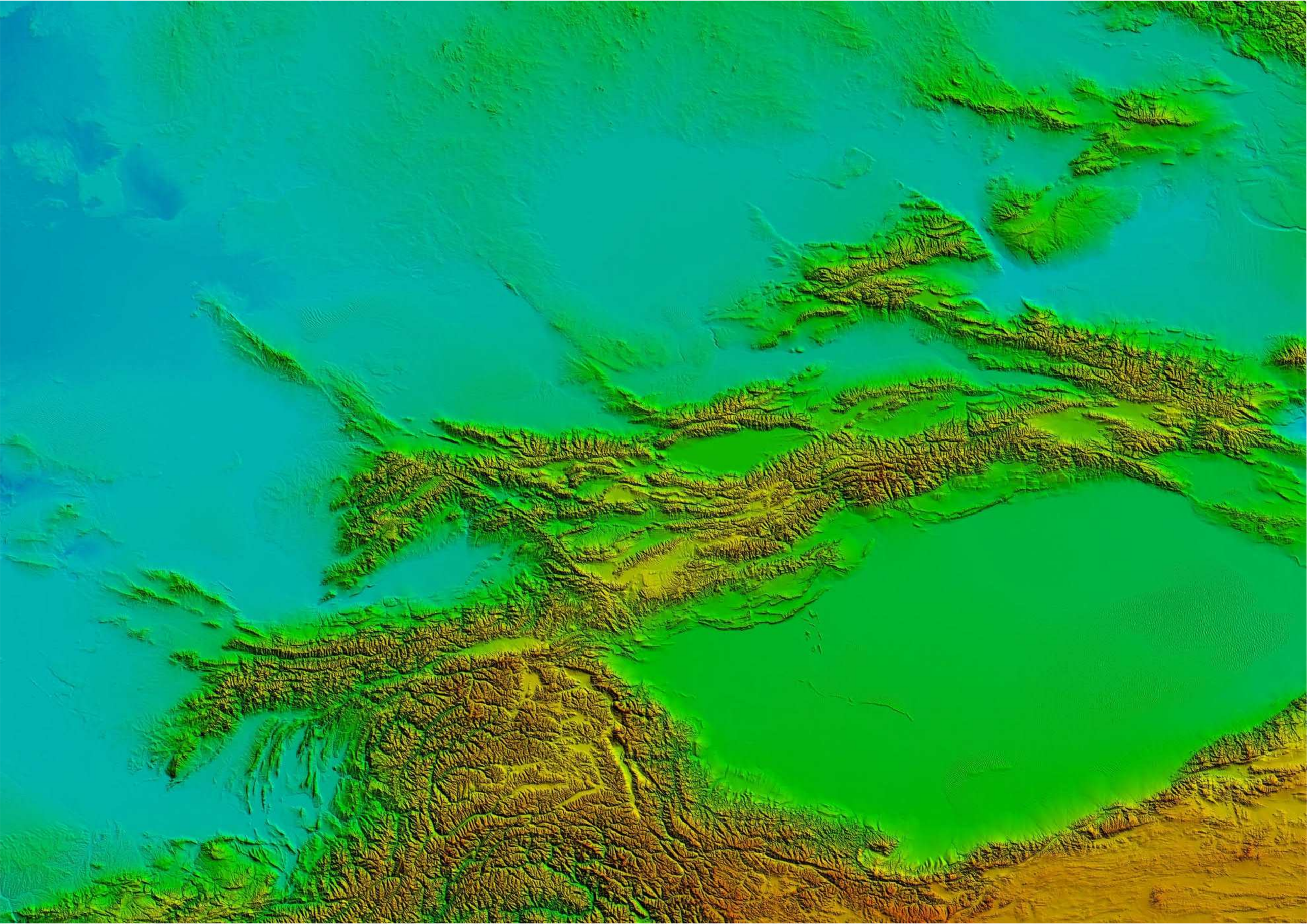
КЫРГЫЗ РЕСПУБЛИКАСЫ

ATLAS

OF MUDFLOW AND FLOOD HAZARDS IN THE TERRITORY OF THE KYRGYZ REPUBLIC



CABINET MINISTRY OF KYRGYZ REPUBLIC

Ministry of Emergency Situations
of the Kyrgyz Republic

Hazards Monitoring and Forecasting Department
under the MES KR

ATLAS

OF MUDFLOW AND FLOOD HAZARDS IN THE TERRITORY OF THE KYRGYZ REPUBLIC

The atlas was compiled with the support of the Country Office
of the United Nations World Food Programme in the Kyrgyz Republic (WFP UN)
and with financial support from the Swiss Agency for Development and Cooperation (SDC).

Schweizerische Eidgenossenschaft
Confédération suisse
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Swiss Confederation

WFP World Food Programme

BISHKEK
2025

UDC 351/354:614
LBC 68,9
A92

Approved for publication by the Scientific and Technical Council of the Ministry of Emergency Situations of the Kyrgyz Republic

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A92 "Atlas of mudflow and flood hazard on the territory of the Kyrgyz Republic", - B.: Ministry of Emergency Situations of the Kyrgyz Republic, 2025 – page 164.
ISBN 978-9967-9581-2-8

Official publication of reference and methodological nature. Atlas of mudflow and flood hazard in the territory of the Kyrgyz Republic is intended to facilitate the analysis and decision-making on risk management from mudflow and flood processes and phenomena in the Kyrgyz Republic. It presents basic data and maps on mudflow and flood hazard, exposure and risk at the level of the country and districts.
The publication analyzes the current state of territories subject to mudflows and floods, and outlines the applied aspects of forecasting mudflows and floods.

The materials presented in this Atlas will allow heads of state structures, local government bodies, employees of ministries and departments, scientists and specialists of scientific and production, design, insurance organizations to carry out socio-economic planning and management taking into account the dangers and risks of emergency situations associated with mudflows and floods.
The atlas is also recommended for use by teachers and students of higher education institutions, and will also be of interest to a wide range of readers for use in their daily work and studies, with the aim of implementing socio-economic planning and management, taking into account natural and man-made hazards and risks of emergency situations.

The atlas was developed with the support of the UN World Food Programme in the Kyrgyz Republic.

The conclusions presented in this publication are those of the authors and do not necessarily reflect the views of the United Nations World Food Program.

The United Nations World Food Program encourages the dissemination of the information contained in this publication, provided the source is acknowledged.

Thanks to: Mr. Kojiro Nakai , Ruslan Umaraliev , Zarangez Makhmudova, Uson Albanov and Kydyr Nazarkulov

ISBN 978-9967-9581-2-8

UDC 351/354:614
LBC 68,9

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Preface

The Kyrgyz Republic is a continental, mountainous country in Central Asia, exposed and vulnerable to a number of geological, hydrometeorological, biological and man-made hazards. Mudflows are one of the most destructive types of natural processes that have a significant impact on the environment, economic activity and safety of the population of the Kyrgyz Republic. During the period from 1990 to 2024, 1990 emergencies related to mudflows of various origins were registered in the territory of the Kyrgyz Republic, which is 42.5% of the total number of natural emergencies. In addition to the stable pattern of growth in the number of mudflows, their expanding geography is noted. In particular, due to climatic and socio-economic changes in the last decade, the country's exposure to mudflow processes and phenomena has increased significantly, with mudflow hazard affecting not only rural areas but also cities.

Mudflow processes in the Kyrgyz Republic are aggravated by the consequences of economic activity. The growth in the number and scale of mudflows is aggravated by increasing erosion and degradation of soil and vegetation on slopes caused by overgrazing , plowing of slopes and watersheds for agricultural crops with the construction of a network of irrigation ditches and excessive irrigation of agricultural lands; uncontrolled urbanization and the ever-increasing scale of construction (often illegal) of residential, tourist and recreational facilities in the foothill zone and in river basins; construction of local roads and other local infrastructure; extraction of soil and inert materials in the beds and floodplains of mudflow-prone rivers; cutting down of floodplain forests, burning of grass and bushes.

Like other natural phenomena, mudflows have written many dark pages in the history of man's struggle with nature. The loss of life, partially or completely destroyed settlements, destroyed bridges and roads, snow-covered fields and gardens, the costs of eliminating the consequences of the harmful effects of mudflows and protecting against mudflows - this is the price that humanity pays for oversight, incompetence, recklessness, for disregard for mudflows.

In the context of global climate change and active anthropogenic impact, the problem of mudflow hazard is becoming increasingly urgent, requiring scientific understanding and effective solutions. One of the key ways to reduce the risk of emergency situations is monitoring, forecasting and early warning systems.

Today, it is extremely important to develop technologies for monitoring, forecasting and early warning systems for natural and man-made disasters, including effective systems of space and ground observation. The basis of the mudflow monitoring system should be tracking stations that record the amount, intensity and duration of precipitation, air temperature, water flow in many places in the basins of mudflow-hazardous rivers, and also control the movement of the mudflow mass.

Addressing disaster risk reduction challenges in light of future threats should be comprehensive. It is necessary to develop methods for forecasting and preventing natural disasters, implement "green solutions" and restore landscape resilience as measures to adapt to climate change.

Improving monitoring systems is essential, with a focus on developing regional, national and local warning systems. Natural disasters can undo years of development efforts and investments by communities, governments and organizations. This is why disaster resilience is a central element of the Sustainable Development Goals set out in the 2030 Agenda. To achieve these goals, all new infrastructure must be able to withstand extreme natural events, which is especially important for disaster risk reduction. Resilience planning must be thorough and comprehensive. Early warning systems must reach all people at risk, and prompt access to food, water and shelter must be ensured, even in the most remote areas.

Policies and measures aimed at reducing vulnerability and exposure to external factors are therefore key to preventing or minimising disaster risks. This can be achieved through sustainable development, disaster risk reduction and climate change adaptation.

However, the main obstacle is the lack of information to conduct a comprehensive risk assessment at the local level, which makes it difficult to implement preventive measures.

This atlas is intended for a wide range of users, including specialists in the fields of geology, geography, urban planning, representatives of government bodies and local governments, as well as students and teachers of specialized universities.

We hope that it will become a valuable tool for planning sustainable development of territories and increasing the level of protection of the population from natural threats.

In recent years, Kyrgyzstan has seen a rapid increase in the number of climate-related disasters, among which mudflows have taken first place in terms of economic and environmental damage.

MINISTER OF EMERGENCY SITUATIONS
OF THE KYRGYZ REPUBLIC
MAJOR GENERAL AZHIKEEV BOOBEK ERGESHOVICH

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Introduction

Natural disasters, many of which are caused by the acceleration of global climate change, are becoming more frequent and intense, causing loss of life, significant material damage, and negatively impacting the population and economy, which significantly impedes progress towards sustainable development in the country.

Available evidence shows that the level of exposure of people and assets in all countries is increasing faster than vulnerability is decreasing, resulting in the emergence of new hazards and increasing levels of disaster losses with significant socio-economic impacts, particularly at the local and community level.

The Kyrgyz Republic has been repeatedly subjected to devastating disasters over its long history, which entailed enormous economic losses and, worst of all, loss of life. Among the dangerous exogenous processes, mudflows and floods that form mudflows occupy a special place in terms of frequency of formation, territorial distribution, and scale of damage caused. On average, about 70 emergency situations related to mudflows and floods occur in the republic annually, which is up to 31% of all emergency situations. Mudflow and flood damage affects populated areas (95% of all populated areas in the republic are located on the banks or cones of alluvial rivers or temporary watercourses), transport communications, agricultural lands, hydraulic engineering, irrigation structures and other objects. Mudflow activity is observed almost throughout the entire territory of the Kyrgyz Republic.

During the spring-summer rains of 2024, outstanding mudflows were observed on the rivers flowing down the slopes of the Kichi -Alai, Alai, Fergana, Chatkal , Kyrgyz, Kungey and Terskey Ala- Too ridges, causing great economic damage. During the passage of mudflows, houses were destroyed, agricultural fields were flooded, bridges and roads were destroyed, and there were also human casualties. In total, more than 300 mudflows were recorded during the spring-summer period of 2024.

In 2024, on the Zyndan River (Ton River basin), as a result of a breakthrough of a high-mountain lake, powerful mudflows were repeated, similar in power to the catastrophic mudflow of a break-through nature that descended along this valley in 2008.

In the first 9 months of 2024, 337 emergencies related to mudflows and flood processes and phenomena were registered. In the first half of June 2024, heavy rainfall occurred in various regions of the Osh, Jalal-Abad and Batken oblast. They caused numerous mudflows on the rivers of the mountainous frame of the southern and eastern parts of the Fergana Valley. The most powerful mudflows were observed in the following valleys: Aravan-Sai, Abshir -Sai. On the listed watercourses, mudflows had the features of exceptionally powerful, destructive flows, previously not observed. They were caused by a very localized downpour that passed in a very narrow strip along the foothills. This downpour caused a powerful surface runoff and mudflows. Active slope runoff was facilitated by favorable geological and geomorphological conditions - steep foothill slopes, large areas of Cenozoic deposits, practically devoid of vegetation and with very low infiltration capacity.

The mudflow that passed along the Ak- Buura River in July 2024 through Osh caused significant destruction, according to the Ministry of Emergency Situations of the Kyrgyz Republic, 5 people died, in the affected area 182 residential buildings, 2 social buildings, 1 kindergarten, 5 intra-farm bridges, 14 recreation areas of the population were damaged with varying degrees of damage. The main cause of the mudflow tragedy was a sudden, abnormally intense downpour of rainfall in the vicinity of the city of Osh and its agglomerations on July 14 from 14:00 hours, for a period of time long enough for downpour of rainfall, lasting up to 35-40 minutes.

Rational development of mountainous territories, as well as the development of protective preventive measures, require the use of modern methods of mudflow mapping from mudflow studies. Recent decades have been characterized by increased attention to the problems of assessing mudflow activity and risk, and the importance of assessing the role of climate in mudflow activity for building an adequate protection system has emerged.

Effective mudflow and flood risk management requires a clear understanding of where mudflows and floods have occurred or are likely to occur; which areas are potentially affected; an understanding of the main triggers and how to recognise them; and potential structural and non-structural solutions to reduce risk.

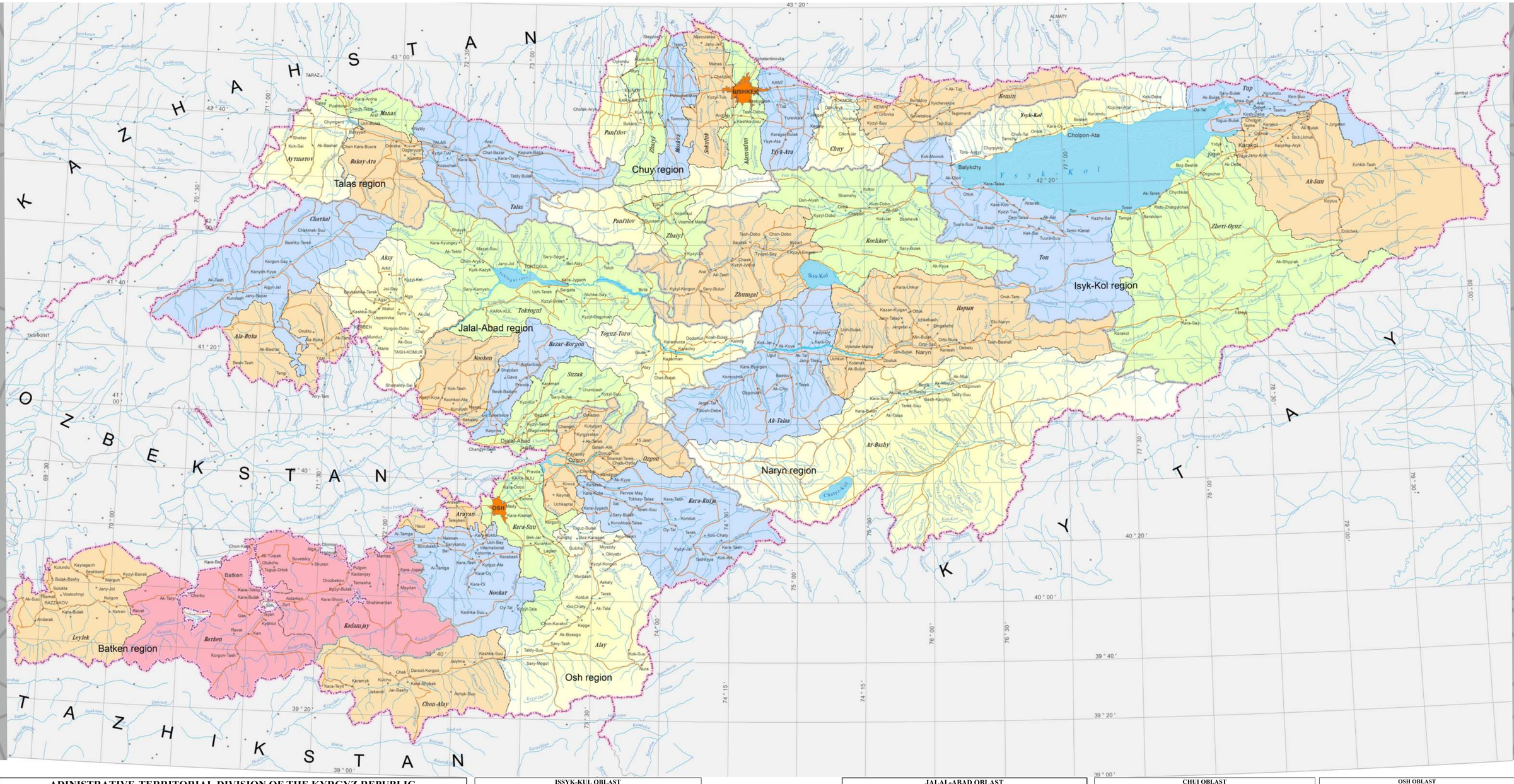
This Atlas of Mudflow Hazard contains fundamental long- and medium-term maps and diagrams for forecasting mudflow and flood processes and phenomena that negatively impact the population, infrastructure and territory of the Kyrgyz Republic.

The maps-schemes present both scientific and applied aspects of forecasting mudflow and flood processes. In the Atlas of Mudflow Hazard, based on the generalization of materials from scientists and specialists using modern geoinformation technologies, maps-schemes of the territory of the Kyrgyz Republic reflecting the natural conditions for the development of mudflow and flood processes are digitized and compiled.

Chapter 1 presents the history of the study of mudflow processes in the Kyrgyz Republic with a description of the main stages. Chapter 2 is devoted to the conditions of formation and distribution of mudflow processes on the territory of the Kyrgyz Republic, describes the physical and geographical conditions that determine the predisposition of valleys to the formation of mudflows, highlights the climate features and provides the main types of mudflows. Chapter 3 examines the factors of formation of mudflows in the Kyrgyz Republic. Chapter 4 provides the main characteristics of mudflows. Chapter 5 presents examples of the most catastrophic mudflows, glacial and torrential genesis that have occurred in the Kyrgyz Republic.

Forecasting mudflows and floods that form mudflows is a very complex process based on a thorough study of the processes taking place and an analysis of their interaction. It is necessary to apply scientifically based measures using modern technologies and methods.

ADMINISTRATIVE-TERRITORIAL DIVISION OF THE KYRGYZ REPUBLIC



ADINISTRATIVE-TERRITORIAL DIVISION OF THE KYRGYZ REPUBLIC
Capital - Bishkek
Date of formation of the Kara-Kyrgyz Autonomous Oblast - October 14, 1924
Date of transformation into the Kirghiz ASSR - February 1, 1926 Date of transformation into the Union Republic and entry into the USSR - December 3, 1938 Date of transformation into an independent sovereign state - August 31, 1991 Territory in km² - 199,951 Population - 7,161,910 thousand people

BATKEN OBLAST
Center - Batken town
Population: 583,362 thousand people

Name of the region	Name of the regional center	Number of rural areas	Population density per 1 km²
Batken	Batken	9	17.2
Kadamjai	Kadamjai	8	34.0
Leilek	Razzakov	9	33.0

Cities of regional subordination: Batken, Kyzyl-Kiya, Sulukta Cities of district subordination: Aidarken , Kadamzhai , Razzakov

NARYN OBLAST
Center - Naryn town
Population – 312,068 thousand people

Name of the region	Name of the regional center	Number of rural areas	Population density per 1 km²
Ak-Tala	Baetovo	4	4.7
At-Bashy	At-Bashi	5	4.0
Jumgal	Chaek	6	10.2
Kochkor	Kochkor	5	12.0
Naryn	Naryn	7	5.1

City of regional subordination - Naryn

ISSYK-KUL OBLAST
Center - Karakol town
Population: 544,364 thousand people

Name of the region	Name of the regional center	Number of rural areas	Population density per 1 km²
Ak-Su	Ak- Suu	4	6.8
Jeti - Oguz	Kyzyl- Suu	5	7
Issyk-Kul	Cholpon-Ata	4	27.6
Tone	Bokonbaevo	4	7.8
Tyup	Tyup	5	34

Cities of regional subordination: Balykchy, Karakol, Cholpon-Ata

TALAS OBLAST
The center is the town of Talas
Population: 277,144 thousand people

Name of the region	Name of the regional center	Number of rural areas	Population density per 1 km²
Bakai-Ata	Bakai-Ata	4	19
Aitmatov	Kyzyl-Adyr	4	17.2
Manas	Pokrovka	3	30.2
Talas	Kok-Oy	5	14

City of regional subordination - Talas

JALAL-ABAD OBLAST
Center - Jalal-Abad city
Population – 1,335,841 thousand people

Name of the region	Name of the regional center	Number of rural areas	Population density per 1 km²
Aksy	Kerben	6	31.1
Ala-Buka	Ala-Buka	8	39.7
Bazaar - Korgon	Bazaar - Korgon	4	100.4
Nooken	Masy	5	65.0
Suzak	Suzak	8	110.1
Toguz -Toro	Kazarman	3	7.4
Toktogul	Toktogul	6	13.6
Chatkal	Kanysh-Kiya	2	6.6

Cities of regional subordination: Jalal-Abad, Kara-Kul, Kok- Zhangak , Maili -Sai, Tash-Kumyr
Cities of regional subordination: Kerben , Toktogul, Shamaldy -Sai, Kochkor-Ata, Bazar-Korgon

CHUI OBLAST
Center - Bishkek
Population – 1,086,842 thousand people

Name of the region	Name of the regional center	Number of rural areas	Population density per 1 km²
Alamudun	Lebedinovka	7	84.3
Zhayil	Kara-Balta	6	33.6
Kemin	Kemin	4	14.6
Moscow	Belovodskoe	5	50.6
Panfilov	Kaindy	4	19.3
Sokuluk	Sokuluk	9	102.3
Chuy	Tokmok	5	34.4
Issyk-Ata	Kant	9	53.2

City of regional subordination - Tokmok
City of regional subordination - Kant, Kara-Balta, Shopokov , Kaiyndy , Kemin, Orlovka

OSH OBLAST
Center - Osh city
Population – 1,490,054 thousand people

Name of the region	Name of the regional center	Number of rural areas	Population density per 1 km²
Alay	Gulcha	7	13.7
Aravan	Aravan	6	110,00
Kara- Kulzha	Kara- Kulja	7	17.5
Kara-Su	Kara- Suu	10	118.8
Nookat	Nookat	13	102.5
Uzgen	Uzgen	12	89.5
Chon-Alai	Daraut -Kurgan	3	7.7

Cities of district subordination: Kara- Suu , Uzgen , Nookat

BISHKEK
Territory in km² - 387
Population -1,165,497 thousand people

OSH
Territory in km² - 182.5
Population - 366,738 thousand people

CHAPTER I

HISTORY OF MUDFLOW STUDIES IN THE KYRGYZ REPUBLIC

History of mudflow studies in the Kyrgyz Republic

Some fragmentary information about the manifestations of dangerous natural processes in the past, especially slope processes, can be found in the geographical and geological literature of the nineteenth and early twentieth centuries. For example, in the works of P.P. Semenov -Tyan-Shansky (1948), K.I. Bogdanovich (1911), I.V. Mushketov (1890), N.A. Severtsev (1867).

In the later period of the twentieth century, starting from the 1920s, the study of dangerous natural processes becomes necessary due to the spread of economic activity in the mountainous zone. Mining enterprises appear in the mountains, new roads are built, power lines are laid. Valuable information on the development of dangerous natural processes is contained in engineering survey, geographical and geological works. The most famous authors of such works are N.N. Kuznetsov-Ugamsky (1931), B.A. Fedorovich (1931, 1934, 1935), V.V. Shumov (1932), S.S. Shults (1943, 1945, 1948), V.L. Shults (1949).

A great contribution to the study of dangerous natural processes in the Kyrgyz Republic was made by the staff of the Physical-Geographical Station of the Academy of Sciences of the Kyrgyz SSR G.A. Avsyuk (1952, 1953), L.G. Bondarev (1960, 1963), M.I. Iveronova (1952, 1953), R.D. Zabirov (1956), A.N. Dikikh (1966, 1971).

One of the first detailed works devoted to the study of mudflows is the mudflow engineering-geological survey of Northern Kyrgyzstan on a scale of 1:50,000 (Ivanenko, 1967) , conducted in 1965-1967. The mudflow process itself was studied the least in this survey, but much attention was paid to the description of the geological and engineering-geological conditions of the formation of mudflows.

Works specifically designed to study mudflow activity were carried out by specialists of the hydrographic party of the Directorate for Hydrometeorology and Environmental Monitoring of the Kirghiz SSR on an annual basis. One of the landmark works was "Compilation of a Cadastre and Map of Mudflows on the Territory of Kirghizia" in 1980 under the supervision of S.S. Kubrushko , in which special attention was paid to the study of mudflow centers (gullies, cuts, erosion gullies). Thus, it was established that high-density mudflows are formed only in certain places (mudflow centers), and not in the entire basin. In the works of the hydrographic party, a classification of mudflow centers is used, including: centers of local (rocky, cuts, ruts) and dispersed mudflow formation . The results of the conducted studies have shown that in mudflow centers such as mudflow cuts and ruts, under the influence of rain or breakthrough flow, the erosion-shear mudflow process prevails. In the centers of dispersed mudflow formation and rocky centers, the shear mudflow process occurs.

According to the data from the catalogue of mudflow basins and foci of the USSR , 26 mudflow regions were identified on the territory of the republic, in which there were 658 mudflow basins.

In 1975-1986, specialists from the Kyrgyz Complex Hydrogeological Expedition led by V.P. Gostev (1978, 1984, 1988) conducted a special engineering-geological survey of the physical-geological processes of northern Kyrgyzstan at a scale of 1:200,000. As a result, maps of the distribution of various types of hazardous natural processes were compiled, which provide valuable material for studying hazardous natural processes. A detailed study of hazardous types of hazardous natural processes and an assessment of their danger were not carried out. Therefore, there was a need for an in-depth study of hazardous natural processes to prevent their catastrophic manifestations and develop protective measures against their threat. For this purpose, monitoring the development of hazardous natural processes is necessary, the results of which are presented in this Atlas .

The study of mudflow hazard of mountain valleys in the last 25 years has been conducted together with the survey of outburst-hazardous lakes, since the mudflow hazard of mountain valleys largely depends on the presence of outburst-hazardous lakes in the valley. In the reports of S.A. Erokhin (1992, 2000, 2003, 2008, 2010, 2011, 2012) it is shown that the formation of mudflows in mountain valleys depends, first of all, on the development of mudflow centers in the mountain valley and the flow rate of the outburst flow.

In 2003, a large-scale work of a team of specialists from the Engineering and Geological Detachment of the Kyrgyz Complex Hydrogeological Expedition of the State Geological Agency of the Kyrgyz Republic was completed to compile a map of the development of hazardous natural processes in the territory of the Kyrgyz Republic (Erohin, 2003). Mapping of areas of development of hazardous natural processes was carried out on the basis of geological factors, since they determine the spatial boundaries of the areas. Meteorological factors have a greater influence on the time of activation of processes. The most important factor in the formation of hazardous natural processes is the stratigraphic -lithological factor. Each type of process is formed in rocks of a certain composition and age. Areas of development of a particular type of hazardous natural processes consist of a certain set of stratigraphic -lithological complexes. The work provides a concept of a stratigraphic -lithological complex - a set of heterogeneous , coeval mountain formations with similar engineering-geological properties that form, under appropriate morphological conditions, certain types of hazardous natural processes .

Since the establishment of the Department of Monitoring and Forecasting Emergencies under the Ministry of Emergency Situations of the Kyrgyz Republic in 2001, the Department has been conducting regular field surveys of mudflow-prone rivers and temporary watercourses in the event of floods passing through them, using unmanned aerial vehicles (UAVs). The Department also prepares short-term and long-term forecasts for the activation of mudflow processes along mudflow-prone rivers during the period of predicted anomalies in heavy rainfall. In recent years, the Department of Monitoring and Forecasting Emergencies under the Ministry of Emergency Situations of the Kyrgyz Republic has been conducting modeling in the RAMMS Debris program Flow for modeling mudflows of glacial genesis. For regional modeling of mudflows, the Flow -R program is used.

The Institute of Water Problems and Hydropower of the National Academy of Sciences of the Kyrgyz Republic, which includes the Laboratory of Dangerous Exogenous Hydrogeological Processes, under the supervision of candidate of geological and mineralogical sciences S.A. Erokhin , contributes to the study of mudflows. The laboratory focuses on the study of mudflows, breakthroughs of high-mountain lakes, and flooding by groundwater. The laboratory staff regularly publishes scientific articles devoted to the topic of mudflows.

Conditions of formation and distribution of mudflow processes on the territory of the Kyrgyz Republic

PHYSICAL AND GEOGRAPHICAL CONDITIONS

The territory of Kyrgyzstan occupies the southeastern part of Central Asia. Its borders run mainly along natural boundaries - the crests of high mountain ranges and rivers, with the exception of the outlying valleys (Chui, Talas and Fergana), where the border descends to the plain. In the north and northeast it borders on Kazakhstan, in the southeast - on China, in the southwest - on Uzbekistan and in the south - on Tajikistan. The area of the republic is 198.4 thousand km^2 , the main part of which is occupied by the powerful mountain system of Tien Shan, and in the south - by the Pamir-Alay ranges.

The Kyrgyz Republic is a mountainous country located within the Tien Shan mountain system. There are several dozen large and small ranges, mountains, spurs on the territory, which are separated by intermountain valleys, depressions and basins. The mountains of Kyrgyzstan belong to the Pamir and Tien Shan mountain systems. Tien Shan consists of a number of mountain chains, most of which have a latitudinal and sublatitudinal extension. The most powerful ridges extend up to 500 km in length and up to 60-70 km in width. These are Teskey Ala- Too , Kyrgyz, Talas, and the Kungey , Zhumgal-Too , Moldo-Too , Susamyr-Too , Fergana, Chatkal , Alay, Zhetym-Too and other ridges are somewhat smaller .

More than 60% of the country's territory is located at an altitude of 2,000 to 4,000 m above sea level [1]. The entire mountain system is extended in the latitudinal direction [2]. The Tien Shan system includes the following orographic regions: Northern, Eastern, Western, Southwestern and Inner. The Northern Tien Shan is a relatively young mountain system, including the following mountain ranges within Kyrgyzstan: Talas, Kyrgyz, Kungey and Teskey Ala- Too [3], created by block uplifts and folding on the site of an old, previously existing, but strongly leveled one. Later, the uplifts and folds were subjected to various relief changes, especially river erosion.

An important factor in the formation of the high-mountain relief of the Northern Tien Shan was ancient glacial activity, which left trough valleys and glacial cirques. The axial parts of the mountain ranges of the Northern Tien Shan are characterized by the alpine relief of the area of modern and late Pleistocene glaciation of the summit parts of the highest and high rocky ridges, dissected by cirques, cirques and troughs with an average slope steepness of 45-80° and a dissection depth of up to 3000 m. This relief is widespread above the modern snow line, at altitudes of 3500 - 4000 m.

The mid-mountain region is characterized by the wide development of erosional relief forms [7]. River valleys are V-shaped. The slopes are well turfed and in places covered with screes. Watersheds are convex and smoothly articulate with the slopes.

High mountain regions are characterized by alpine and alpine-type relief.

All the mountain ranges of the Tien Shan are highly dissected, with deep and steep gorges. The area of glaciation, according to the latest estimates, is 6,804.8 km^2 , with 9,957 glaciers in the area [8]. The main runoff basins of the Syr Darya, Chu, Talas, Tarim and Lake Issyk-Kul are formed in the mountains of the Kyrgyz Republic. There are about 36 thousand rivers, including 99% of the smallest rivers, small rivers (from 26 to 50 km) - 1%.

The soil and vegetation cover of the Tien Shan is very poor. There is no soil cover at all on rock outcrops in the axial parts of almost all ridges. There are very poor soils and vegetation on Holocene moraines. Soils are somewhat better developed on deluvial slope deposits in the zone with sufficient moisture, where there are forests. In total, about 3% of the area in the mountains of the republic is occupied by forest vegetation [1,2]. Soils and vegetation are better developed on sedimentary strata in the foothills and on the adyrs. But here, too, due to the fact that less precipitation falls than evaporates, the vegetation is predominantly ephemeral, which burns out after 2-3 months.

In addition, the mountain slopes are highly susceptible to pasture erosion, so there is no continuous vegetation cover on the slopes in some places. All this indicates that those few and not so large rainfalls are capable of forming slope runoff, which, concentrating in the thalweg network, channels and mudflow centers, causes mudflows.

The geological structure of the Tien Shan ranges is quite varied, the tectonics are complex. The northern arcs of the Tien Shan were formed in the Caledonian folding (the Terskey Ala - Too , Kungey Ala- Too , Zailiysky Ala- Too , Kyrgyz and Talas ranges, etc.). The remaining ranges are located to the south of those listed; they were formed by the Hercynian folding [1,2].

The northern arcs of the Tien Shan are composed mainly of metamorphic and igneous rocks of the Precambrian and Lower Paleozoic. The Archean and Proterozoic strata consist of various gneisses, crystalline schists, quartzites, marbles and other rocks. The Precambrian strata are sharply dislocated and broken through by intrusions granitoids . Most rocks yield coarse-grained weathering products [1,2].

The southern arcs of the Tien Shan are composed of various crystalline rocks that occur along the axial parts of the ridges. Limestones, shales, etc. predominate here.

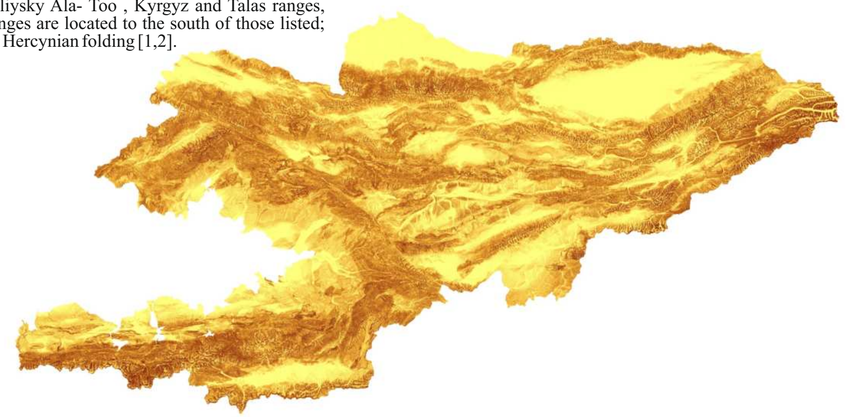
In addition, significant areas are occupied by Mesozoic and Quaternary sedimentary deposits. Among the Quaternary rocks, loess rocks are widely distributed.

The development of certain types of mudflow sources depends closely on geological conditions: the composition of rocks, faults, etc.

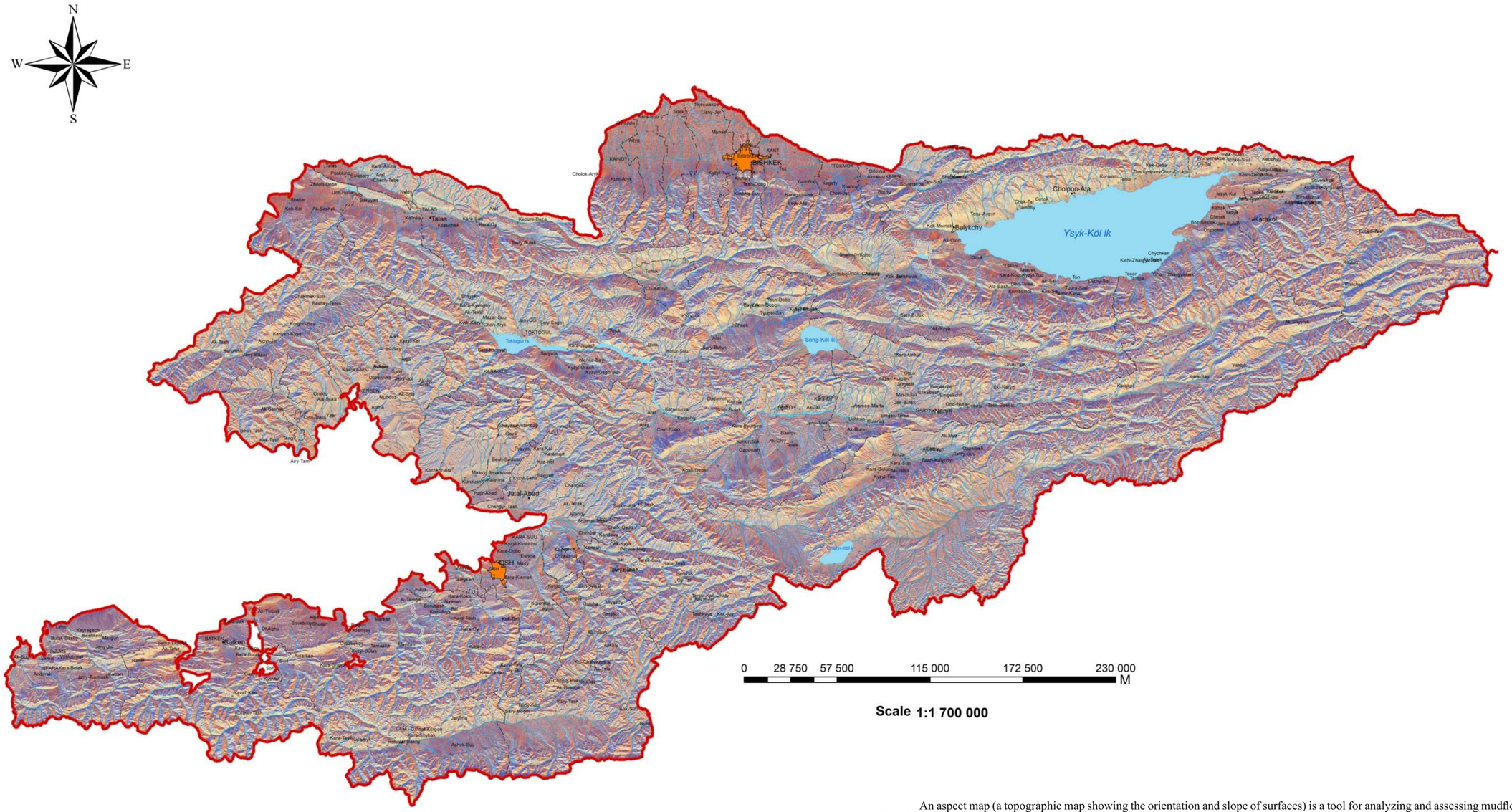
Mudflow incisions are distributed mainly on moraine deposits below the modern glaciation. They are distributed more or less evenly over the territory. Mudflow ruts are developed not only on the eluvial-deluvial substrate, but also on the colluvial (on screes). Moreover, in modern glacial and periglacial areas, ruts are confined mainly to screes. Cases of their development have been noted on the benches of moraines, where shear and erosion-shear mudflow processes can originate.

Other types of mudflow centers develop mainly on rocky sections of mountain ranges (rock mudflow centers). They can often be seen on tectonic faults at contacts. Therefore, rock mudflow centers are found in axial sections of mountain ranges. Gullies develop mainly on sedimentary strata, deluvial slopes, developed in the middle parts of ridges and in the foothills. To sedimentary strata and deluvial deposits are also associated with active runoff-forming surfaces.

Mudflows are associated not only with ancient moraines, but also with other powerful morphogenetic formations, such as landslides, avalanches, and rock glaciers.



MAP OF EXPOSITIONS OF THE KYRGYZ REPUBLIC



Code	Slope Direction	For Azimuth Angle of Exposure
-1	Flat	No slope
1	North	0° – 22.5°
2	Northeast	22.5° – 67.5°
3	East	67.5° – 112.5°
4	Southeast	112.5° – 157.5°
5	South	157.5° – 202.5°
6	Southwest	202.5° – 247.5°
7	West	247.5° – 292.5°
8	Northwest	292.5° – 337.5°
9	North	337.5° – 360°

Legend

Boundaries
- Republics
- Provinces
- Districts
- Roads
- Rivers
- Settlements
- Hydrography
- Glaciers

Slope aspect
- N
- NE
- E
- SE
- S
- SW
- W
- NW

An aspect map (a topographic map showing the orientation and slope of surfaces) is a tool for analyzing and assessing mudflow and flood hazard. It is used for various types of analysis and forecasting. In particular, an aspect map shows the orientation of slopes, which allows one to understand how water will flow off certain areas. For example, south-facing slopes may be more susceptible to snowmelt due to solar insolation, which increases the likelihood of spring floods. Steeply sloped surfaces may facilitate rapid water runoff, increasing the risk of erosion and localized flooding.

Using an aspect map, you can identify low spots or areas where slopes converge. These are the areas where water is most likely to accumulate during floods.

Combined with climate data (precipitation, temperature, snowmelt rate), the exposure map helps to predict flood risks.

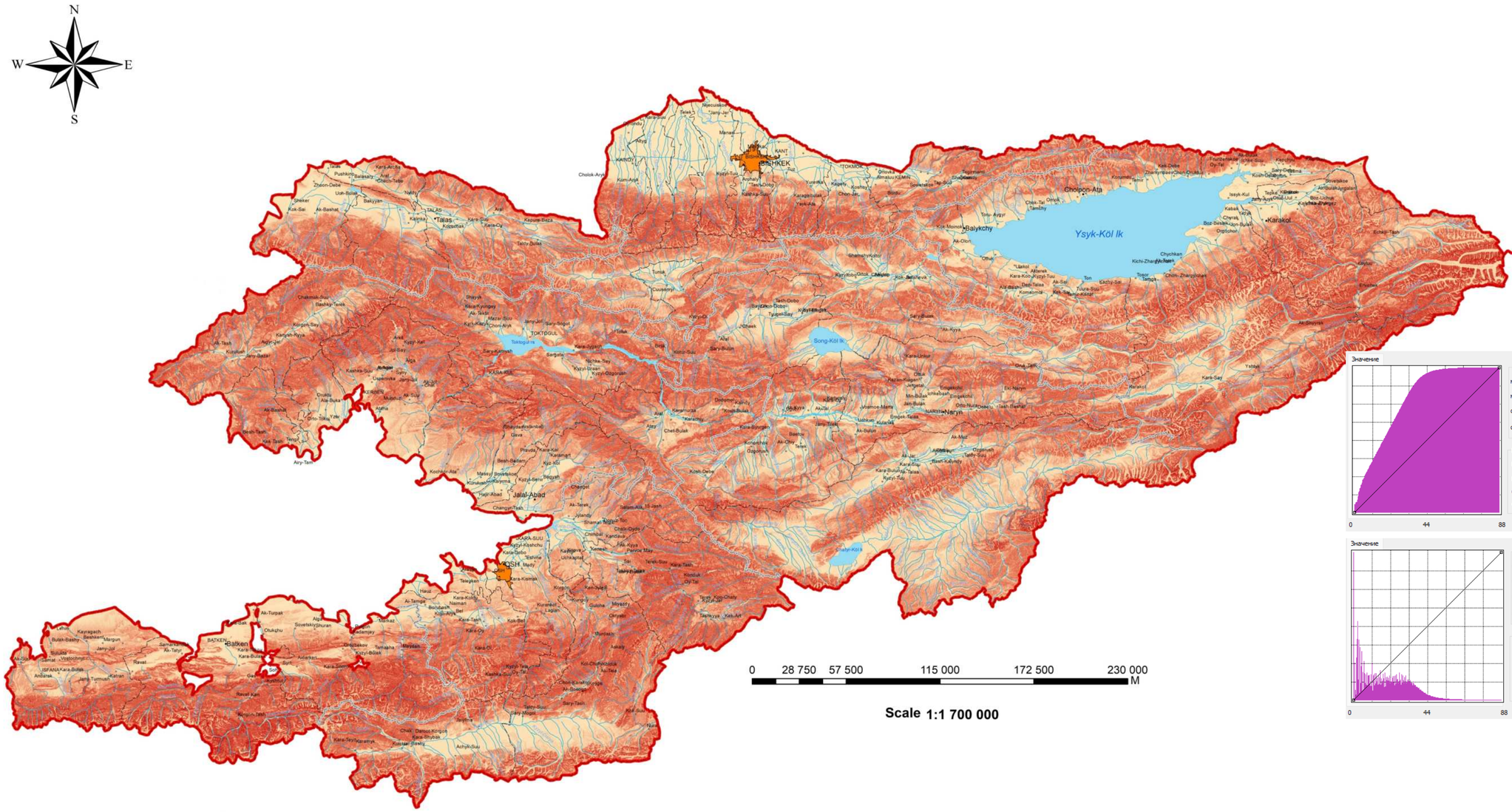
Areas with northern exposures will retain snow longer, which may delay flooding but lead to its intensification later.

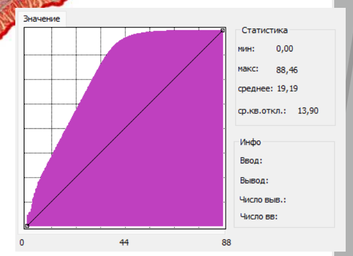
Based on terrain data, hydrological models can be created to estimate water distribution and calculate flood volumes.

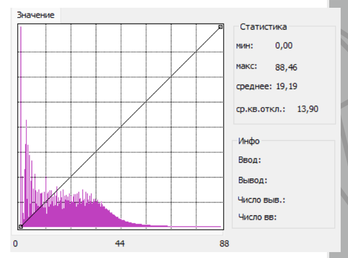
An aspect map can be used to identify areas where floods may cause severe soil erosion, especially on steep slopes.

Additional data for synthesis analysis such as: hydrographic network, soil types, etc., historical flood data, meteorological forecasts, as well as the use of combinations with GIS technologies significantly increases the accuracy of flood risk analysis.

MAP OF SLOPES OF THE KYRGYZ REPUBLIC







Legend

Boundaries
- Republics
- Provinces
- Districts
- Roads
- Rivers
- Settlements
- Hydrography
- Glaciers

Slope in degrees

88,5
80
70
60
50
40
30
20
10
0

The slope map is an important tool for studying mudflow and flood hazards; the slope of the terrain directly affects the rate of water runoff, sediment accumulation, slope stability and the likelihood of mudflows.

The slope map is used to estimate the rate of water runoff. Steep slopes increase the rate of water runoff, which contributes to the formation of mudflows and increases their destructive power.

Gentle slopes slow runoff but can allow water to accumulate, posing a risk to low-lying areas.

The slope map also allows us to identify areas with steep slopes where rapid water runoff and mudflow formation are most likely.

Critical slopes (usually more than 15–20°) are considered to be the most susceptible to the risk of destruction and mudflows. Slopes less than 10° can be dangerous in conditions of soil saturation with water, especially during prolonged precipitation.

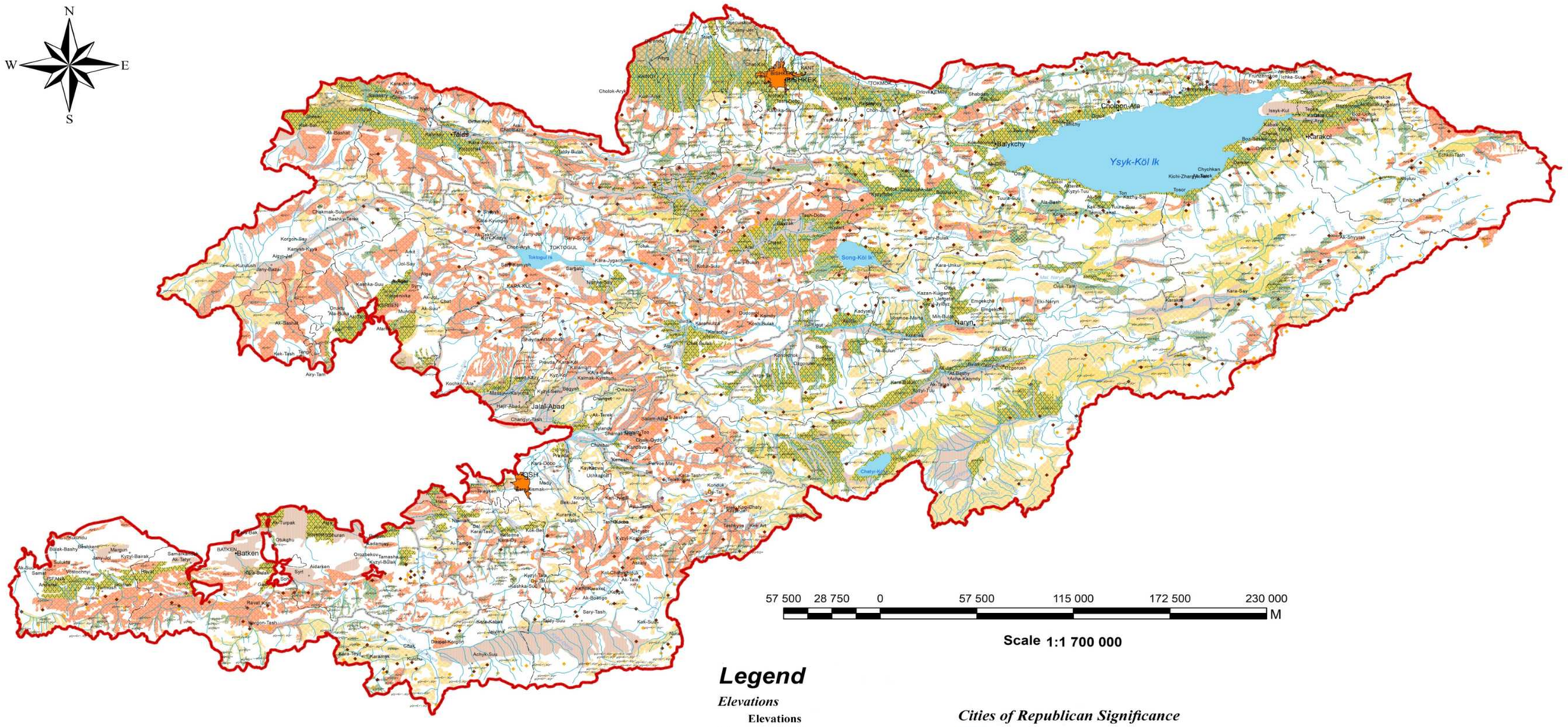
Using the slope map, it is possible to identify areas where slope monitoring and stabilization are required, as well as identify hazardous areas.

The data are synthesised with meteorological conditions and soil types to perform a risk assessment to identify areas with steep slopes and low permeability that are most susceptible to mudflows.

GIS allows you to combine slope maps with other data layers (precipitation, soil types, land cover), which improves the accuracy of analysis and forecasting.

The use of slope maps in combination with aspect maps, hydrological data and climate models allows for the effective assessment of mudflow and flood hazards and the development of measures to reduce them.

MAP OF MUDFLOW-FORMING DEPOSITS OF THE KYRGYZ REPUBLIC



Legend

Elevations
- Elevations

Types of mudflow
- Mudstone flow
- Debris-water flow

Boundaries
- State Boundaries
- Provincial Boundaries
- District Boundaries
- Other

Rivers
- Rivers

Contours
- Contours

Cities of Republican Significance
- Cities of Republican Significance

Lakes
- Lakes

Debris-flow-forming areas
- Boulder, sandy-pebble deposits with interlayers or lenses of sands, loams, gravelly-pebble, and gravelly-crushed stone deposits
- Pebble deposits with sandy-loamy fill, loamy-gravelly deposits
- Pebble, blocky-gravelly, gravelly-pebble, gravelly-crushed stone deposits
- Blocky-gravelly deposits
- Blocky-gravelly deposits with sandy-loamy and loamy fill
- Loamy-gravelly deposits
- Loams with boulder inclusions
- Loams with interlayers of sand and gravel

FEATURES OF MUDFLOW FORMATION IN THE KYRGYZ REPUBLIC

Almost the entire territory of the Kyrgyz Republic is mudflow-hazardous – there are 3103 mudflow rivers in total. The largest number of them are in the basins of the Chu River – 479, Talas – 254, Naryn – 789, Kara-Darya – 666, Lake Issyk-Kul – 375. The following main mudflow areas are distinguished: the Kyrgyz Ridge, the Talas Depression, the Issyk-Kul Basin, the south of the Kyrgyz Republic, and the regions of the inner Tien Shan. In recent years, the regions of greatest mudflow activity have been the south of the republic, namely the northern spurs of the Alay and Turkestan ridges. Among the mudflow-hazardous areas, the mudflow basins of the following ridge slopes stand out: the southern slope of Kungei Ala- Too , the northern slope of the Kyrgyz ridge, the southern slope of the Kyrgyz ridge, the northern slope of the Talas ridge, the basin of Lake Issyk-Kul, the southeastern slope of the Chatkal ridge , the southwestern slope of the Fergana ridge and the northern slope of the Alay ridge, the basins of the Naryn, Kurshab , Mail uu-Suu , Taldyk, Kugart, Akbura , Aravan, Abshirsay , Isfayramsay , Shakhimardan rivers, the Shakhimardan-Sokh interfluve, the Karadarya and Gulcha river basins.

In 2024, mudflows claimed the lives of 22 people. The total damage amounted to more than 1 billion soms . Figure 1 shows all registered emergencies related to mudflows and floods in the period from 1990 to 2024.

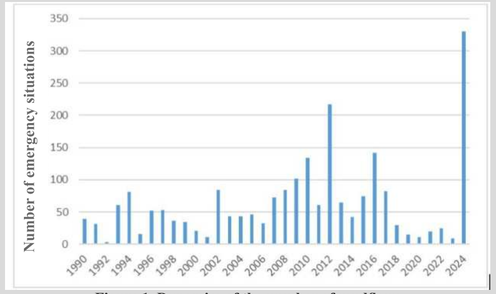


Figure 1. Dynamics of the number of mudflows and floods in the Kyrgyz Republic

By structural cohesion, according to lithological-geomorphological and regional features, the density of mudflows is taken as 8 times greater than that of water

Mudflow Type	*Mudflow Density, g/cm³*	*Structural Cohesion*
Water-Pebble	от 1.1 до 1.4	*A mixture of water and sandy-clayey material with the inclusion of larger debris fragments*
Debris	от 1.4 до 1.8	
Debris-Stony	от 1.8 до 2.5	

As a rule, the greatest mudflow activity usually occurs not on the main river of the basin, but on its tributaries, which have a greater drop (high slopes) and relatively small catchment areas, which can often be simultaneously covered by intense rain. In the mudflow regions of the Kyrgyz Republic, an average of 200 - 500 mm of precipitation falls during the warm period of the year. Rainfall is observed in April - August (mudflow-hazardous period). The average number of days with rainfall in April - July is 5-7. In recent years, due to climate change, in some areas the mudflow-hazardous period has been extended until September.

An analysis of the available materials showed that mudflows occurred with precipitation amounts of more than 30 mm per rainfall, while the intensity of downpours in the Fergana mountain range reached 1.44 mm/min, in the Issyk-Kul basin – 1 mm/min, on the Kyrgyz ridge – 0.7 mm/min, on the Talas ridge – up to 0.5 mm/min [6, 7].

The formation of a mudflow begins in the form of a flood, which, moving down the valley, enters a mudflow center, becomes saturated with loose debris and thereby transforms into a mudflow. A mudflow and a flood are different forms of mountain flows. One form can easily transform into another and back, depending on the structure of the mountain valley. Mudflows are closely related to floods and vice versa. Therefore, forecasting mudflow activity generally reflects an increase in the water content of mountain and foothill flows to catastrophic proportions. Mudflows differ from flood flows by a higher concentration of solid material and density. When a flood flow is saturated with coarse debris by more than 10%, its density increases to over 1.1 g/cm^3 . Such a flow is already qualitatively different from a flood flow [4].

The speed of mudflows is on average 2-4 m/s, sometimes 4-6 m/s, which causes their great destructive effect [5].

In addition to floods, mudflows are accompanied by sedimentation and erosion processes.

Based on structural similarity and the relationship between hydrodynamic and rheological properties, mudflows are grouped into the following types:

1) alluvial
2) mud
3) mud-stone.

Alluvial mudflows have a density of 1.1 to 1.4 g/cm^3 , consisting of a mixture of water and sand-clay material with the inclusion of coarser fragments, mudflows have a density of 1.4 to 1.8 g/cm^3 , mudstone flows from 1.8 to 2.5 g/ cm^3 .

Mudflows in the Kyrgyz Republic occur as a result of:

1) liquid precipitation;

2) breakthroughs of high-mountain lakes and intraglacial reservoirs

3) intensive snow melting.

The main cause of mudflows in Kyrgyzstan are heavy and prolonged rains, which account for about 96% of all cases registered in the republic; mudflows caused by active snowmelt account for about 3%, and about 1% are breakthrough flows.

Despite the fact that flows of glacial genesis make up only 1%, they are catastrophic in almost all registered cases. As a result of breakthroughs of high-mountain lakes, mudflows of high density are formed.

Alluvial flows are formed only by heavy rains. Floods are formed after the disintegration of mudflows and alluvial flows, which lose their loose debris mass, decrease in density and transform into an ordinary muddy water flow. The processes of flow formation are activated after a snowy winter, when intensive snowmelt saturates the soils that form mudflows with melt water.

It is also necessary to distinguish between three types of mudflow processes: transport, erosion-shear and strike-slip.

Climate change

Average annual temperatures in the Kyrgyz Republic have increased by about 1.1°C over the period 1960–2010. The rate of warming has accelerated over the period 1990–2010. Warming trends have been observed in all regions of the Kyrgyz Republic and at all altitudes [30]. Average annual precipitation has changed little at the national level. Some changes have been reported at the subnational level, including small increases in precipitation in the central and northwestern parts of the country and small decreases in the east, but there are insufficient data to distinguish these trends from typical natural variability in the region [33, 34].

The impact of climate change on mudflows and floods is less well understood and difficult to accurately predict due to their local nature. However, it is important to consider such risks in the Central Asian region, where the frequency and magnitude of mudflows have increased in recent decades. Heavy and prolonged rainfall is one of the main risk factors triggering mudflows and floods. More intense rainfall under climate change may increase this threat. Although further research is needed to better understand and map climate-induced risks, previous work has shown that significant areas of population and infrastructure are located in potentially vulnerable areas [35].

The Kyrgyz Republic is particularly vulnerable as it is a mountainous country with complex terrain. In 2024 alone, 335 flows were recorded, mudflows claimed the lives of 22 people and flooded 3,752 houses, 84 social facilities, 411 kilometers of roads and destroyed 29 kilometers of canals. 99 houses were declared unsafe. The total damage is estimated at 1 billion 255 million soms. Over the past 20 years, 2024 was a record year for the number of registered mudflows and floods.

Recent studies show that due to climate change, mudflows have begun to occur in places where there had been no flows for a long time.

CLIMATE FEATURES

There are 4 climatic regions in Kyrgyzstan, which have similar climatic conditions within the regions and significant climatic differences between them. I. Northern and Northwestern Kyrgyzstan. This region includes the Chui and Talas valleys and the surrounding mountain ranges, which are characterized by a moderately warm and fairly humid climate, with maximum precipitation in spring and early summer and moderate winter precipitation, due to the influence of the Siberian anticyclone. The second half of summer is dry in the lower zone. II . Southwestern Kyrgyzstan. This region includes the Fergana, Alay, and Chatkal valleys and the surrounding mountain ranges. This is the warmest and most humid territory, where, unlike other regions of Kyrgyzstan, significant amounts of precipitation fall during the cold season. Otherwise, the annual precipitation pattern is similar to that of climatic region I: the maximum falls in the spring in the lower zone and shifts to the beginning of summer in higher zones. The second half of summer is characterized by a small amount of precipitation, in the lower zone in August and September there is a drought. In the warm season, this climate zone is characterized by the highest air temperature. III. Northeastern Kyrgyzstan. This region includes the Issyk-Kul basin. This territory is characterized by maximum precipitation in the summer and an insignificant amount in the winter, since low winter clouds formed at altitudes below 3000 m are retained by mountain ranges and almost do not penetrate the Issyk-Kul basin. Due to the non-freezing Lake Issyk-Kul located in the lower part of the basin, this territory has features of a maritime climate. The water mass of Lake Issyk-Kul has a softening effect on the air temperature in winter, in summer this effect is almost imperceptible. IV. The inner Tien Shan is characterized by the coldest and insufficiently humid climate, a distinctive feature of which is low evaporation at low temperatures. In the high-mountain zone, where the amount of precipitation exceeds evaporation, significant areas are occupied by glaciers and snowfields. The annual course of precipitation is similar to the annual course in climatic region III, the maximum precipitation occurs in May, June, July.

The climate features include continentality, altitudinal zonality, dryness and insufficient moisture. In general, in terms of moisture, mountainous regions are classified as territories with insufficient moisture from 140 to 1000 mm per year. The southern position of the Tien Shan causes high evaporation. Most of the republic, especially the regions of the inner Tien Shan, receive about 300 mm of precipitation per year. Up to 800 mm per year falls on the western slopes of the Fergana Range and in the east of the Issyk-Kul basin; up to 1000 mm on the slopes of the Chatkal Range . Another feature is that a significant portion of the precipitation in the foothills up to altitudes of 2500-3000 m falls in the form of intense showers. Showers fall from one to 3-5 times a year. The greatest probability of showers is in April-May-June in the Western Tien Shan, in the Chui and Talas valleys the greatest probability of showers is in July, in the regions of the inner Tien Shan and the Issyk-Kul Lake basin the greatest probability of showers is in August. Sharp contrasts in air temperatures are very pronounced in the Tien Shan mountains. Summer air temperatures in the Fergana and Chui valleys reach 40°C. Winter air temperatures - up to - 50°C are noted in the Ak-Sai and Susamyr valleys . Temperature contrasts contribute to very strong weathering of rocks, i.e. their destruction [1, 18] .

The trends in precipitation changes are multidirectional and weakly expressed, which does not allow us to draw an unambiguous conclusion about an increase or decrease in annual precipitation for the entire territory of the Kyrgyz Republic. For the North-West climatic region, over the entire observation period, a fairly clearly expressed trend of increasing annual precipitation is manifested only for the city of Bishkek. For Talas, the amount of annual precipitation increases insignificantly. For the North-East climatic region, at all meteorological stations, there is a slight increase in the amount of annual precipitation with the greatest increase in the region of the town of Cholpon-Ata. For the South-West climatic region, the amount of precipitation has increased slightly. The total amount of precipitation has decreased slightly, but a fairly short observation period does not fully reflect the situation. For the Inner Tien Shan region, there is a slight increase in the amount of annual precipitation.

The general elevation of the territory determines vertical climatic zonality and the presence of winter air temperature inversions. In summer, for every 100 m of elevation, the temperature decreases by approximately 0.6°C.

Snow cover in the lower zone of the Osh, Jalal-Abad, and Batken regions is established in late November - early December and remains until mid-March. Its height fluctuates between 5 and 25 cm. On the slopes of the Fergana ridge, snow cover, the height of which can reach 40-60 cm, can lie from mid-November to mid-April. The Chatkal Valley is one of the snowiest regions of Kyrgyzstan - stable snow cover of 60-100 cm lies for 4-5 months. The maximum height of snow cover on the flat part of the Chui Valley varies from 8 to 30 cm, in the western part of the Issyk-Kul basin, snow cover is practically absent, and in the eastern part, its height reaches 35 - 65 cm [18] .

The distribution of snow cover over the territory, the duration of its occurrence, the water reserves in the snow at the beginning of melting are extremely uneven and are determined by the influence of climatic and orographic factors. In the mountains, special conditions are created for abundant snowfall, long-term preservation and accumulation of snow, which has a huge impact on the dynamics of exogenous hydrogeological processes.

Depending on the orographic conditions and the nature of the distribution of snow cover in the area of mountain basins, four zones are distinguished:

1. The zone of permanent snow cover is located within the high-mountain (nival) zone at altitudes from 3200 to 4800 m and higher. The area of the zone is relatively small.

2. The zone of stable snow cover is located below the snow line (from 3000-3200 to 1500 m) and occupies a significant area. The duration of occurrence is from 3 to 6 months, decreasing with decreasing altitude.

3. The zone of unstable snow cover – occupies heights from 600 to 1000-1500 m in the foothills and adjacent valleys.

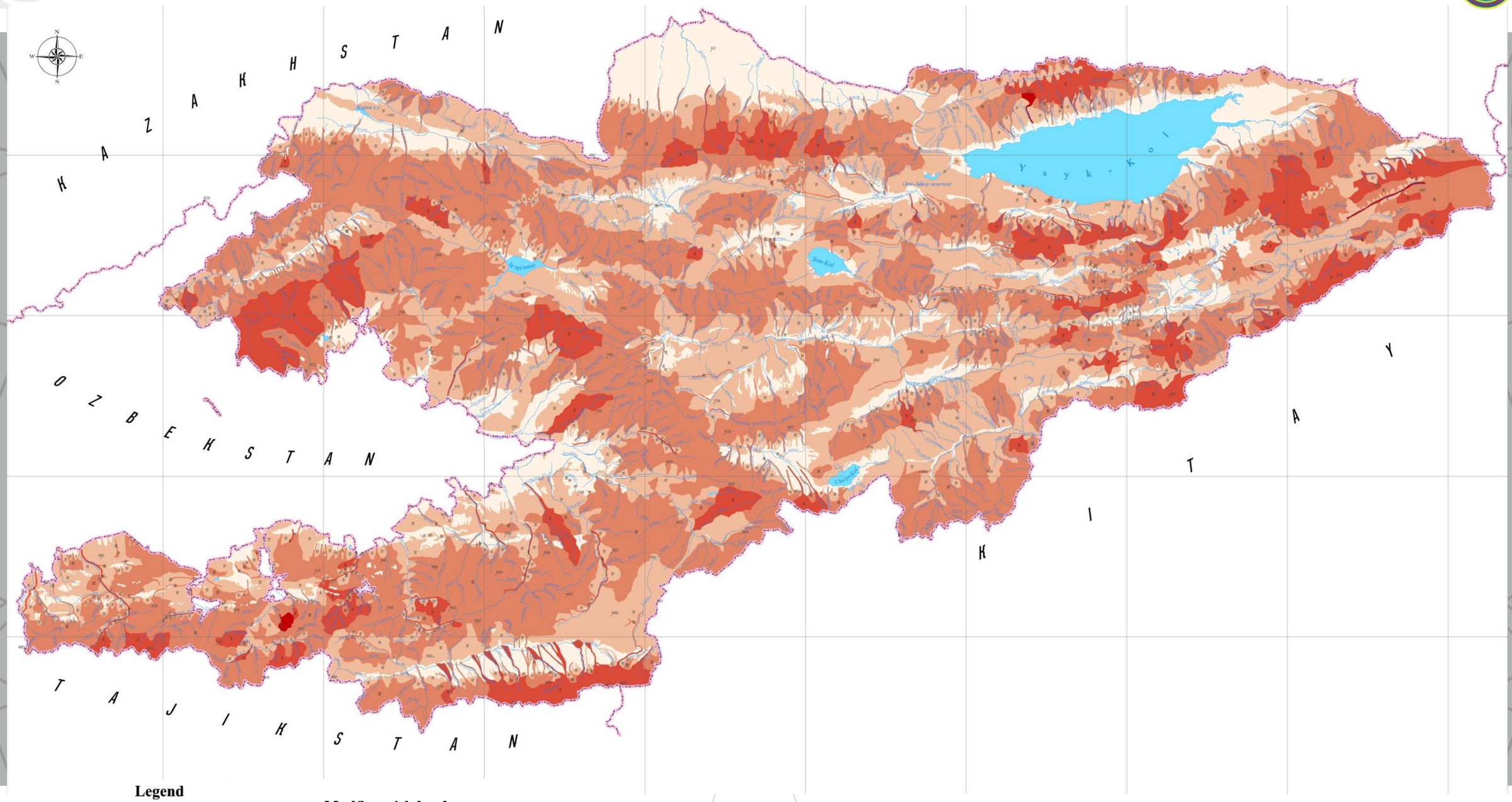
4. A zone with no snow cover, a zone where snow rarely falls and does not persist.

The thickness of the snow cover is distributed depending on the altitude, the exposure of the slopes (windward and leeward, northern or southern), as well as the degree of shading or openness of valleys, gorges, and basins.

In open valleys, due to the low amount of precipitation and unstable winters, the depth of snow cover is insignificant and does not last long.

Atmospheric circulation plays an important role in climate formation. In the cold period of the year, most of Kyrgyzstan is under the influence of the Siberian anticyclone. Cloudy, frosty weather with sharply expressed inversions of air temperature prevails. Precipitation is associated with the passage of cold atmospheric fronts of western, northwestern, northern invasions, as well as the exits of southern cyclones, which have the greatest impact on southwestern Kyrgyzstan (Osh, Jalal-Abad and Batken oblast). In the warm period of the year, Kyrgyzstan is located away from the main air currents, due to which a low-gradient field of low pressure prevails, in June-August a thermal depression can be established, replaced by western, northwestern or northern invasions, proceeding as dry and slightly cloudy in the valley regions and accompanied by thunderstorms and precipitation in the mountains. The underlying surface has a great influence on the formation of the climate. The mountainous nature of the relief determines the vertical zonality of the climatic zones. Ascending from the foothills to the peaks, the same change in climatic zones is observed as moving from the subtropics to the Arctic coast. The vertical climatic zonality is complicated by the orographic structure: heavily indented mountain ranges and intermountain basins have a significant impact on the formation of climatic conditions. Large altitude amplitudes create significant contrasts in temperature conditions and the degree of humidity. Characteristic features of the mountain climate are a decrease in atmospheric pressure and air temperature with altitude (on average by 0.6 ° C / 100 m), a decrease in daily and annual temperature fluctuations, and an increase in precipitation up to a certain altitude. Particularly unique climatic conditions develop in the Issyk-Kul basin, the lower part of which is occupied by an unfrozen lake. Here, in a relatively small area, all types of climate are represented - from sharply continental to maritime [19] .

MUDFLOW HAZARD MAP



Legend

- Major rivers
- Boundaries
- Elevations
- Lakes

Mudflow risk levels

- Areas of the 1st degree of debris flow hazard with potential for catastrophic debris flows and floods
- Areas of the 2nd degree of debris flow hazard with potential for debris flows ranging from 100 to 1000 m³/s
- Areas of the 3rd degree of debris flow hazard with potential for debris flows ranging from 10 to 100 m³/s
- Areas of the 4th degree of debris flow hazard with potential for debris flows up to 10 m³/s
- No debris flow activity observed

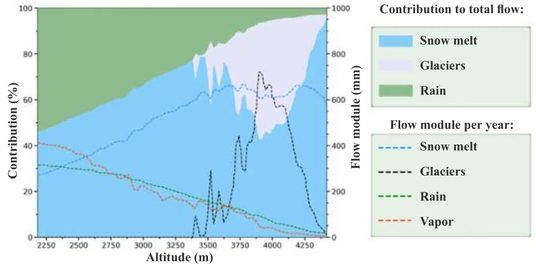
The mudflow hazard map was compiled based on the cartographic material of the Department of Monitoring and Forecasting of Emergencies under the Ministry of Emergency Situations of the Kyrgyz Republic. It is based on the mudflow hazard forecast map and possible breakthrough of high-mountain lakes, the Ministry of Emergency Situations of the Kyrgyz Republic and the mudflow hazard map on a scale of 1:500,000, S.S. Kubrushko , 1982). The map distinguishes four degrees of mudflow hazard: Level I - zones with high mudflow hazard, where catastrophic mudflows and floods with flows exceeding 1000 m³/s are possible. Level II - zones where mudflows with flows from 100 to 1000 m³/s are possible. Level III - territories with possible mudflows with flows from 10 to 100 m³/s. Level IV - zones with low mudflow hazard, where mudflows with flows up to 10 m³/s are possible. In the territory of the highest category of mudflow danger (first), there may be mudflow manifestations of lower categories (second, third, fourth), the second category of mudflow danger includes all subsequent ones, and so on. The boundaries of the mudflow danger zones were clarified taking into account data on past mudflows. The map is a dynamic system that can change over time depending on changes in natural conditions, climate change, and the level of mudflow activity.

HYDROLOGICAL FEATURES OF RUNOFF FORMATION IN MOUNTAINOUS REGIONS AND POTENTIAL IMPACT OF CLIMATE CHANGE

Accurate quantification of river runoff sources and understanding of hydrological processes in glacier-river basins of mountainous regions is vital for effective water management and mudflow hazard assessment in the context of climate change. The most optimal quantitative method for assessing runoff formation in mountainous regions is an integrated approach combining modeling of the earth's surface, glacier energy balance and river runoff.

The key hydrological factors underlying runoff formation are glacier melt, snow melt and liquid precipitation. Glaciers contribute significantly to total river runoff in the inner Tien Shan, reaching 54% in the summer months and averaging 19% of annual runoff in the studied basins [37]. Seasonal snow cover also plays an important role, providing an average of 58% of annual runoff, while rainfall contributes an average of 23% of annual runoff, with its contribution decreasing with increasing altitude. In contrast, evaporation decreases with increasing altitude, ranging from 400 mm at 2100–2200 m to near zero values above 4400 m, due to decreasing temperatures and reduced availability of atmospheric water vapor.

Figure 2. Altitude formation of runoff using the example of a river basin Chon-Kyzyl- Suu (average annual values, glaciated area - 11%).



The spatiotemporal dynamics of these hydrological components depend on many factors, including the extent of glaciation in the basin, the spatiotemporal distribution of precipitation, the influence of relief on the distribution of solar radiation, and cloudiness. A higher percentage of glaciation results in a greater contribution of glacial meltwater to runoff, while differences in the amount and seasonality of precipitation in adjacent basins determine the contribution of snowmelt and rainfall runoff. Topographic characteristics such as slope steepness, aspect, and shading have a significant impact on the spatial distribution of solar radiation and, consequently, on the processes of glacier and snow melt, while cloudiness significantly reduces the influx of solar radiation, which must be taken into account for accurate modeling of these processes [38].

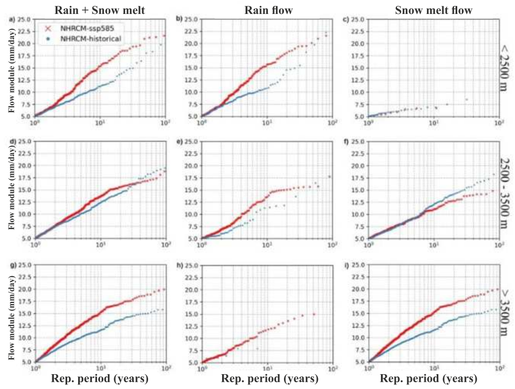
These hydrological factors are undergoing significant changes under the influence of climate change in the region. Climate warming leads to accelerated melting of glaciers, which affects the seasonality and magnitude of runoff, and there are also trends towards changes in the spatial and temporal distribution of liquid and solid precipitation, which affects the dynamics of snowmelt and rain runoff [39]. In addition, more frequent extreme precipitation, sudden thaws and glacial lake outbursts increase the risk of mudflows, floods and other dangerous processes.

An analysis of changes in temperature and precipitation regimes in the mountainous regions of Central Asia, performed using a high-resolution regional climate model, indicates a significant increase in average annual temperature (more than 6°C by 2090, 0.6°C/10 years) and an increase in precipitation, especially in the spring-winter period [40, 41]. This is expected to lead to significant changes in the hydrological regime and an increase in extreme events such as floods and droughts.

As for extreme events (Figure 3), in the lower regions of the Naryn basin (below 2500 m) there is a tendency for rainfall runoff intensity to increase. In the transition zone (2500-3500 m), snow cover will play a smaller role, and rainfall runoff will become more intense. In high-mountain regions (above 3500 m), on the contrary, an increase in extreme runoff is expected due to more intense snow melting [42].

Below 2500 m, rainfall is the main source of extreme runoff, while snowmelt has a minimal impact due to limited snow accumulation at these altitudes. For the climate change scenario, the impact of snowmelt will be even less significant. For rainfall runoff, runoff intensity is projected to increase, especially for the 5, 10 and 20 year return periods, with increases of 27%, 44% and 24%, respectively. In addition, 10-year maximum flood events calculated from the baseline estimates are expected to occur every 3–4 years by the end of the 21st century.

Figure 3. Change in the recurrence period of maximum daily runoff values depending on the altitude (NHRCM- historical (blue) – base historical period 1980-2000, NHRCM-ssp585 (red) – future scenario SSP5-8.5 2077-2096), average values for the area of the Naryn River basin are indicated.



Of particular interest are changes in the distribution of seasonal snow cover and meltwater. According to the modeling results, the maximum snow water content (SWE), using the Naryn River basin as an example, will decrease by 17%, and the peak of its melting will shift one month earlier (Figure 4) [43]. This will lead to earlier formation of runoff due to intensive snowmelt , which can potentially increase the percentage of snow-rain mudflows.

Assessing the contribution of various hydrological components to total river flow is key to effective water management under changing climate conditions. However, accurate quantification of these components faces a number of challenges related to the lack of observational data in high mountain regions, the difficulty of taking into account the influence of relief, and the limitations of physical models that require large amounts of input data.

An integrated approach combining modeling of hydrological processes, glacier energy balance and river runoff shows great potential for more accurate assessment of the contribution of various hydrological components to the mudflow formation process. However, to improve the reliability of such complex models, further development of observation networks and improvement of methods for spatiotemporal disaggregation of meteorological data in high-mountain conditions are necessary.

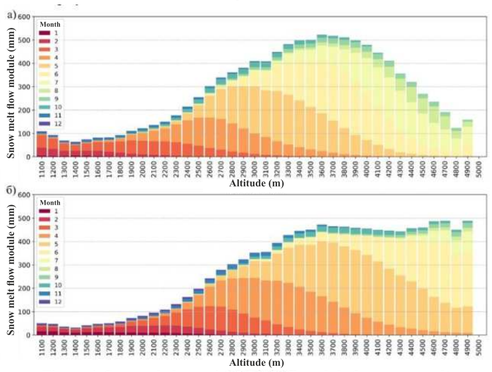


Figure 4. Seasonal change in the runoff module from snowmelt depending on altitudinal zonality in comparison with a) the base historical period (1980-2000), b) the future scenario SSP5-8.5 (2077-2096), average values for the area of the Naryn River basin are indicated.

MAIN TYPES OF MUDFLOWS

1. Glacial mudflows with a flow rate of several hundred and thousands of cubic meters per second are formed in valleys where modern glaciation has been preserved, where a powerful layer of glacial deposits has accumulated. The cause of such powerful mudflows is the breakthrough of mountain lakes or intraglacial reservoirs. The period of probability of their occurrence will begin for the southern regions of Kyrgyzstan in mid-May, for the northern regions in early June, and will end in mid-September. The highest probability of glacial mudflows is from July 20 to August 10. Such flows are capable of blocking the river bed in the main valley. The subsequent breakthrough of the temporary dam will lead to the formation of a powerful catastrophic flood in the main valley.

Mudflows formed during breakthroughs of avalanche-landfall and avalanche-landslide lakes can be no less powerful than glacial ones. For example, the flow rate during the breakthrough of Lake Yashilkel in the Isfayramsay River valley in 1966 reached several thousand cubic meters per second. However, the density of such flows usually does not exceed 1.4 kg/dm3 , i.e. they are more related to alluvial flows or floods. However, it is possible that a mudflow of high density can form during the breakthrough of a avalanche lake. If such a fact is established, then it is necessary to distinguish another type of mudflow - avalanche.

2. Mudflows of periglacial type with a flow rate of several tens and hundreds of cubic meters per second are formed in valleys in the altitude range from 2500 to 3200 m with a significant amount of potential mudflow material, including glacial deposits. Modern glaciation in these valleys is either absent or very insignificant, expressed either in the form of small slope glaciers or in the form of buried ice. The mudflow process begins here with the avalanche of moraine or slope deposits. This occurs when the process of active snowmelt is superimposed by torrential rain. The period of probability of manifestation of flows of this type begins in mid-April and ends in mid-September. The highest probability of periglacial mudflows is in May-June. When moving down the valley, the mudflow saturated with water, breaks through all the snow-avalanche blockages on the bottom of the valley, is enriched with potential mudflow material and is transformed into a mudflow. When entering the main valley, the mudflow can block the riverbed of the main valley with a temporary dam, the breakthrough of which is dangerous with catastrophic consequences.

3. Rain-type mudflows with a flow rate from several cubic meters to the first tens of cubic meters per second are formed in valleys in the altitude range of 1000-2500 m, where there is no modern glaciation and significant accumulations of potential mudflow material. Above this interval, glacial and periglacial mudflows are formed during periods of active melting of snow and ice in the high-mountain zone. Below 1000 meters, there are no mountain valleys capable of forming mudflows. Rain mudflows are a fairly common phenomenon for mountain valleys. Their power is insufficient to block the riverbed of the main valley, but they are capable of causing a major flood. They are formed after heavy rainfalls of outstanding intensity (30-80 mm per day, according to the Hydrometeorological Service) falling on mountain slopes. The period of their probability of occurrence begins in April and ends in September. The probability of torrential mudflows is highest in May-July.

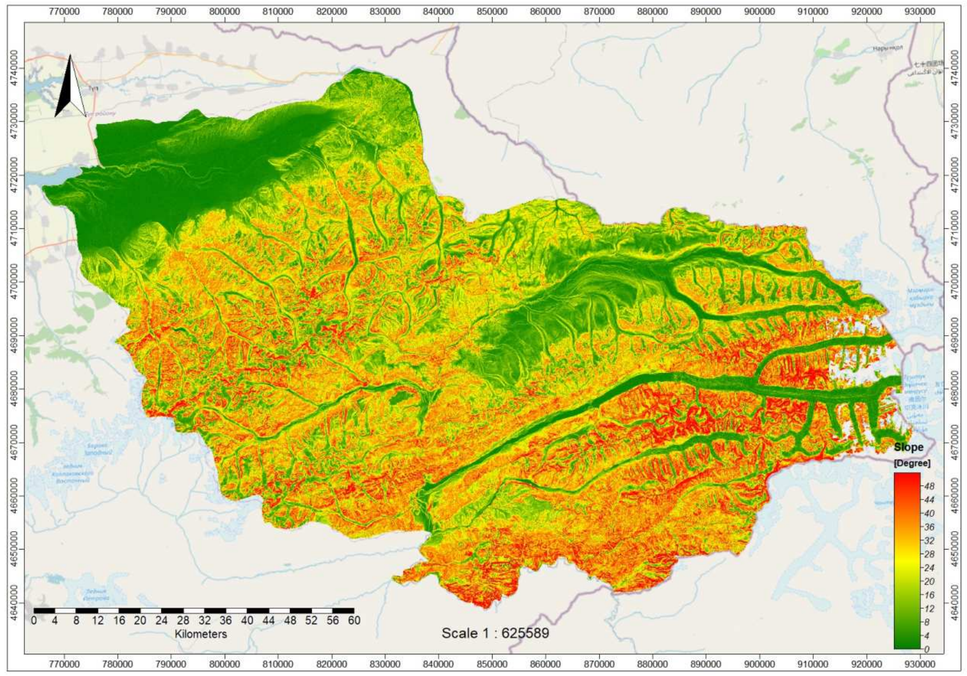
4. Flood flows are a continuation of mudflows on flat sections of mountain valleys and on foothill plains. Here, mudflows lose their energy, deposit debris, and then a muddy water flow rushes down the channel. In addition, floods can form without the formation of mudflows in cases where the flow rate of the water flow does not reach a critical value and the flow is not saturated with solid material. The flow rate of flood flows can vary widely from several cubic meters to several thousand cubic meters. The period of probability of their occurrence begins in April and ends in September. The probability of floods is highest in the second half of May and the second half of July.

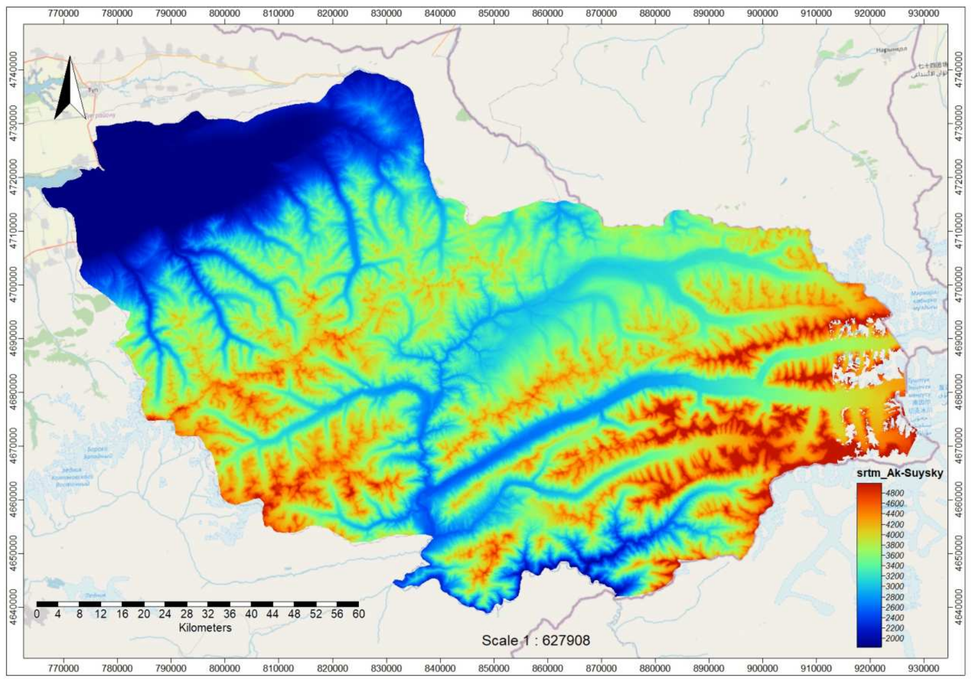
Table of characteristics of the largest rivers of Kyrgyzstan

No.	Name of the river	Hydropost	Catchment area, km2	River feed type	Dangerous periods		Maximum flow rate, m3 / sec date	The beginning of the flood
					Flood maximum flow	Ice formations		
1	Naryn	Naryn	58370	glacial-snow	May-July	November-March	772 May 1936	
Rivers of the Fergana Range								
2	Donguz- Too	Donguz- Too	166	snowy	April-June May		637 April 1958	March
3	Zerger	Tosoy	216	snow and rain	March-May April		97.9 April 1952	March
4	Yasi (Jazi)	Salamalik	1180	snowy	April-June May		410 May 1966	March
5	Tentek -Sai	Charbak	1300	snowy	May-June		315 May 1960	March
6	Koegart	Mikhaylovka	1010	snowy	April-June May		236 May 1959	March
7	Changet	Changet	381	snow and rain	March-May April		58 March 1956	March
Rivers of the Alai and Turkestan ranges								
8	Kara- Kulja	Aktash	907	snow-glacial	May-July May-June	November-February	160 July 1956	March
9	Tar	Turban	3840	snow-glacial	May-July June		377 June 1953	
10	Kurshab	Gulcha	2010	snow-glacial	May-July June		109 June 1966	
11	Aravan-Sai	Kara-Kol	1680	snow-glacial	May-July June-July		86.7 April 1941	April
12	Isfayram -Sai	Uchkorgon	2220	glacial-snow	June-August July-August		162 July 1945	May
13	Shakhimardan	Gidelik	1180	glacial-snow	June-August July-August		172 July 1977	
Rivers of the Chatkal ridge								
14	Padysha-Ata	Toast	366	snow-glacial	May-July June-July	November-February	44.5 June 1928	April
Rivers of the Issyk-Kul Lake basin								
15	Ak- Suu	Teploklyuchenka	301	glacial-snow	June-August July-August	December-March	61.4 June 1966	May
16	Karakol	Kashka- Suu	325	glacial-snow	June-August July-August	December-March	56.4 June 1980	May
17	Jyrgalan	Soviet	250	snow-glacial	May-July June-July	December-March	78.6 June 1981	April
18	Chon Kyzyl- Suu	Lesnoy Kordon	307	glacial-snow	June-August July-August	November-March	50.6 July 1956	
19	Chon Ak- Suu	Grigorievka	309	glacial-snow	June-August July-August	November-March	65.6 July 1986	May
Rivers of the Kyrgyz Range								
20	Alamedin	Chon -Kurchak	317	glacial-snow	June-August July-August	December-February	58.2 July 1958	May
21	Chon-Kemin	Mouth	1890	glacial-snow	June-August July-August	December-February	189 July 1958	
22	Ala-Archa	Kashka- Suu	233	glacial-snow	June-August July-August	December-February	50 June 1953	May
23	Ak- Suu	Chon-Aryk	426	glacial-snow	June-August July-August	December-February	35.7 August 1946	
24	Sokuluk	Belogorka	353	glacial-snow	June-August July-August	December-February	45.8 July 1958	
25	Kara-Balta	Sosnovka	577	glacial-snow	June-August July-August	December-February	65.7 June 1988	May
26	Talas	the Uch-Koshoy River	1210	glacial-snow	June-August July-August	December-February	153 June 1934	May
Rivers of the Talas Ala- Too ridge								
27	Besh-Tash	Aryk-Saz	286	glacial-snow	June-August July-August	December-February	55.4 June 1945	May
28	Ur-Maral	Oktiabrskoe	1120	glacial-snow	June-August July-August	December-February	102 July 1991	May
29	Kumush-Too	Dzhany -Aryk	393	glacial-snow	June-August July-August	December-February	July 28, 1935	May
30	Kurkureo-Suu	Chon -Kurchak	454	glacial-snow	June-August July-August	December-February	40.2 July 1953	May

CHAPTER II

FACTORS OF FORMATION AND ASSESSMENT OF MUDFLOW AND FLOOD HAZARD FACTORS OF MUDFLOW FORMATION IN KYRGYZSTAN





Factors of formation and assessment of mudflow and flood hazard Factors of mudflow formation in Kyrgyzstan

The formation and development of mudflow processes occurs under certain conditions that develop in a mountain valley under the influence of a number of factors that are divided into hydrological and geological. The former determine the formation of the water component of the mudflow, the latter determine the saturation of the water flow with coarse debris and its transformation into a mudflow.

A mudflow is formed by the transformation of a water flow by saturating the latter with loose debris. Observations in mountain valleys show that loose debris of various genetic types of quaternary deposits take part in the formation of mudflows. At the same time, the contribution of each type to the mudflow formation process is far from the same. Thus, it has been noted that glacial (moraines), colluvial, proluvial deposits are active in the formation of mudflows. Alluvial and fluvioglacial deposits, as well as deposits of rock glaciers, are much more inert. The reason for this lies in the composition of the deposits that form mudflows.

Mudflows are characterized by their short duration, high speed and destructive force, saturation with solid material, creating characteristic deposits. Mudflows also have a high erosive capacity, causing deepening of riverbeds and destruction of banks, and can lead to the formation of floods on rivers. Mudflows are formed both on temporary and permanent watercourses, while the flow rate of flows increases sharply and exceeds flood discharges several times. Mudflows are characterized by movement in the form of successive waves (rolls) with the formation of jams of debris, snow-glacial mass, trees, bushes with their subsequent breakthrough. Mudflows are formed by the interaction of geological-geomorphological and hydrometeorological factors. Geological-geomorphological factors include the steepness of slopes and riverbeds, the presence of a large number of easily eroded rocks, mudflow centers and riverbeds.

GEOLOGICAL FACTORS

The source of solid materials may be landslides and avalanches. Mudflow centers, which are sections of mountain valleys with a large slope and accumulation of debris, play an important role in the formation of mudflows. If they are powerful enough, powerful mudflows may form here, not only during breakthroughs of high-mountain lakes, but also during heavy rainfall.

The main danger of mudflows is as follows:

1) They transform a water flow into a mudflow, thereby significantly increasing its destructive power;

2) They increase the flow rate many times over and thus dramatically expand the boundaries of the affected area.

Under the influence of geological factors in a mountain valley, conditions are formed for the transformation of a water flow into a mudflow. Of the variety of geological factors, the main ones are: 1) morphological; 2) lithological; 3) genetic; 4) moraine formation 5) stratigraphic; 6) tectonic. This series can be continued, but the purpose of this work is not to list all the variety of geological factors, but to reveal the mechanism of action of the main ones. It is important to evaluate the role of each factor in the process of mudflow formation.

1. The morphological factor reflects the influence of the longitudinal and transverse profile of the bottom of the mountain valley in which the mudflow is formed on this process. It has been established, including by our studies, that the degree of saturation of the water flow with debris depends on the slope of the mudflow bed: the greater the slope, the higher the weight concentration of debris in the mudflow mixture, provided that it contains a sufficient amount of this debris, the so-called potential mudflow material.

2. The lithological factor determines the influence of the composition of loose debris deposits on the possibility of their participation in the formation of mudflows.

As it moves down the valley, the water of the breakthrough flow penetrates the loose debris rocks that make up the sides and bottom of the valley, saturates them and involves them in movement. In this case, the concentration of solid debris in the flow increases, and the density of the flow increases. As the breakthrough flow is saturated with debris, its density increases, which determines the structure and dynamics of the flow. At the first stage of mudflow formation, the saturation is still insignificant, its density increases only to 1.4 kg/dm3 . Such a flow, by its properties, is classified as alluvial . At the second stage of saturation, the density increases to 1.8 kg/dm^3 and the flow becomes a mud flow. At the third stage, the density can increase to 2.5 kg/dm^3 and the flow becomes a mud-rock flow, which has enormous destructive power. In such a flow, blocks up to 5-6 m in diameter float like light pieces of wood.

With a significant content of clay particles, the density of the mudflow does not exceed 1.4 kg / dm^3 . Therefore, the flow retains its fluid properties and is called water-mud. Such flows are typical for the foothills and small intermountain depressions composed of Paleogene-Neogene deposits. Mud-rock mudflows of high density (2.2-2.4 kg / dm^3) are formed in the mountain zone . They have the properties of a viscous-flowing liquid with great destructive force. Their movement is wave-like. Each wave is an active phase in the dynamics of the mudflow. The gaps between the waves are the passive phase. It is associated with the suspension of the movement of the mudflow due to its oversaturation with detrital material. In this phase, the density of the mudflow mass reaches the density of a solid - 2.5-2.6 kg / dm^3 . It is necessary to liquefy this mass, reduce its density with new portions of water. Then it will be able to move again. If water comes in, the mudflow continues to move as a new wave. If new portions of water from the upper parts of the valley stop coming in, the mudflow stops.

The dependence of the mudflow-forming activity of loose-clastic deposits on the content of silt and clay particles in them has certain limits. As observations of mudflows in the mountain valleys of the Tien Shan show, the mudflow-forming activity of deposits increases to a certain limit as the content of silt and clay particles in them increases, beyond which it begins to decrease. With a significant (possibly more than 30%, see Fig. 2) content of clay and silt particles in the fine earth, deposits cannot form mudflows. The most striking example of this property of loose-clastic deposits is the absence of mudflows in areas of development of Paleogene-Neogene rocks. During weathering and destruction of these rocks, loose-clastic deposits with a significant content of clay and silt particles are formed, which form only alluvial flows with a density of up to 1.4 g/cm^3 . The section of Paleogene-Neogene rocks is crowned by coarse-grained deposits, the so-called Sharpyldak suite, of the Upper Pliocene of the Lower Pleistocene. The content of dusty and clay particles in the fine earth of the deposits of this suite is within the boundaries of mudflow formation, therefore, in the area of development of the Sharpyldak deposits, traces of typical mudflows, mud and mud-rock, are observed.

3. The genetic factor characterizes the predisposition of loose debris deposits of various genesis to the formation of mudflows. Thus, during field tests it was found that genetically different deposits saturate the water flow with debris material differently: the highest degree of saturation is observed in mudflows eroding glacial moraine deposits. On the contrary, the degree of saturation of mudflows eroding alluvial deposits is significantly lower and corresponds to the concentration and density of mudflows. High-density mudflows can form from glacial or proluvial deposits, but not from alluvial ones.

The reason for the different predisposition of genetically different deposits to the formation of mudflows is their lithological composition. Glacial or proluvial deposits contain more dust and clay particles than alluvial deposits, from which these particles are washed out by constantly acting river flows.

4. Factor of modern moraine formation Mudflow activity of a mountain valley largely depends on the process of modern moraine formation . If moraine-glacial complexes represented by terminal moraine tongues or "rock glaciers" are formed during the process of glacier degradation, then mudflow activity in a mountain valley is suppressed (Figure 5 A). This is due to the fact that terminal moraine tongues and "rock glaciers" dose the flow of meltwater flows, preventing, firstly, the formation of breakthrough flows, and secondly, almost eliminating the supply of debris to mudflows. In the middle part of the valley (Figure 5 B), traces of only very ancient mudflows are observed. Currently, the valley is non-selective.

On the contrary, if the modern moraine complex is washed away by flows of melted glacial waters, then mudflow processes in the valley are activated, as they receive a large amount of debris (Figure 6 A). This factor causes high mudflow activity in the Aksai River valley, as evidenced by the extensive alluvial fan (Figure 6 B).

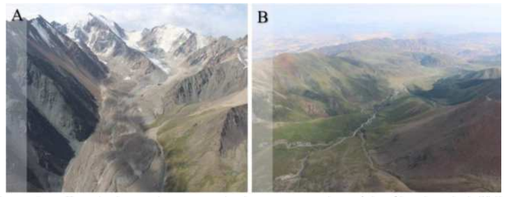


Figure 5. A. Terminal moraine tongue in the upper reaches of the Chunkurchak Valley B. middle part of the Chunkurchak River valley (photo by S.A. Erokhin)

5. Stratigraphic factor. Mudflow -forming activity of loose clastic deposits depends, to some extent, on their age. Research data [9] show that modern alluvial and glacial deposits are less prone to mudflow formation than Pleistocene deposits of the same genesis. The reason for this slight passivity of modern deposits in mudflow formation is their composition. More ancient deposits contain more sand and clay particles in the fine earth

6. The tectonic factor influences the process of mudflow formation in three directions: it causes the formation of tectonic steps and thus forms the slope of the valley; it promotes the destruction of rocks in the fracture zones of tectonic faults and the transformation of rocks into loose clastic rocks; it promotes the flooding of loose clastic rocks by underground waters of tectonic fault zones.

The tectonic factor determines the formation zone of each type of mudflow: 1) mudflows develop in the mountain zone; 2) alluvial flows form in the foothill zone; 3) mudflows most often form in the mid-mountain and low-mountain zones and less often in the foothill zone.

The tectonic factor is decisive in the formation of mudflow centers. A mudflow center is a section of a mountain valley in which conditions favorable for the formation of mudflows have developed, an example of such a mudflow center is an erosional cut on the slope of the ledge of the moraine-glacial complex of the Chon-Aksu River valley, on the southern slope of the Kungey -Alatau ridge

. Under the influence of tectonic movements, the slope increases in a certain section of a mountain valley. If it exceeds a critical value, then under the influence of other geological factors, conditions are created under which a water flow can transform into a mudflow.

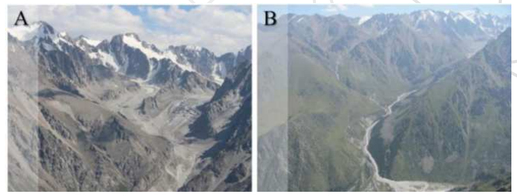


Figure 6. A. Moraine-glacial complex of the Aksai glacier B. Mudflow cone of the Aksai River (photo by S.A. Erokhin)

There is no clearly defined morphological, lithological, engineering-geological boundary between mudflow and erosion centers. The type of mudflow center is revealed by the results of the impact of water flow on it: if the water flow, saturated with debris, turns into a mudflow, it is a mudflow center, if it remains a water flow, although saturated with sediments, then it is an erosion center.

Figure 7. Mudflow source Kyzyljar , southern slope of the Kungei -Alatau ridge (photo by S.A. Erokhin)

HYDROLOGICAL FACTOR

The hydrological factor determines the formation of the water or liquid component of the mudflow. Showers as a factor of mudflow formation play the main role in the formation of mudflows - 70-80% of mudflows are of shower origin. Their recurrence depends on the frequency of showers and ranges from 1 in 2 years for the Kochkor , Jumgal and Toguz -Toro depressions, to more than 1 time per year for the foothills of the Kyrgyz, Talas, Teskey and Kungey Ala- Too ranges , framing the Fergana depression. Snowmelt, often in combination with rains, causes the occurrence of up to 15% of cases from 1 time in 3-10 years to 1 time in 6-10 years. Mudflows from the melting of seasonal snow and glaciers in combination with rains in the glacial zone, as well as those arising from the breakthrough of high-mountain lakes, make up 10-13%

There are three known variants of the formation of a potential mudflow flood:

1) intense rainfall; 2) breakthroughs of mountain lakes and intraglacial reservoirs; 3) active melting of snow accumulations and glaciers.

1. Heavy rainfall. The occurrence of mudflow floods in mountainous and foothill regions is significantly influenced by synoptic processes and meteorological conditions, which are also partially caused by these processes. Mudflows of rainfall origin are preceded by fairly uniform synoptic processes that promote intensive heat removal, changing the invasion of cold air masses into mudflow-prone areas. Cold invasions are observed on average 3-5 times a month, however, not all of them are accompanied by mudflow phenomena.

In the annual cycle, the maximum precipitation falls in the spring months - March and April. While in winter and the first half of spring, continuous precipitation associated with the development of cyclones and cold invasions predominates, in March and April, rainfall precipitation predominates. Summer precipitation is almost exclusively thunderstorm-like and is associated with highly developed convection during powerful cold invasions. The beginning of autumn is poor in precipitation, and only in its second half does precipitation begin again, associated with cold invasions.

The passage of the South Caspian and Murghab cyclones is usually accompanied by heavy precipitation and increased winds, often reaching storm force. Early spring floods on rivers are associated with breakthroughs of the South Caspian cyclones. If a cyclonic breakthrough is immediately followed by a cold invasion (mainly western and northwestern), then precipitation can be significant [18, 19].

1. During years of high floods, an increase in the rate of western, northwestern and northern intrusions is observed.

2. A mandatory condition for the formation of outstanding floods is an increased amount of precipitation during the cold period. Air temperature in the spring-summer period deviates little from the norm, excesses do not exceed 20%.

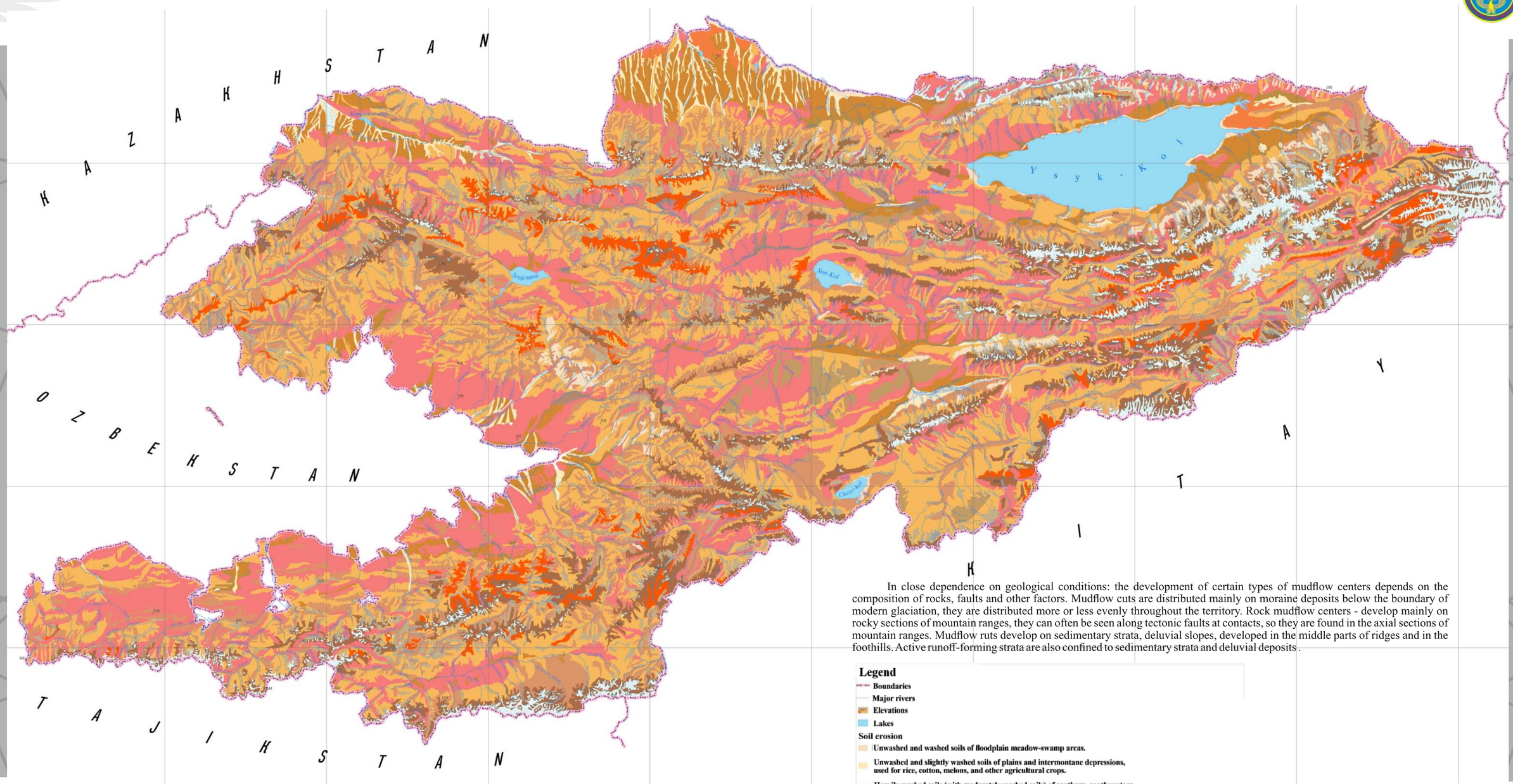
3. The cause of torrential flows are rains of high intensity and duration. In the mudflow regions of Kyrgyzstan, an average of 200-500 mm of precipitation usually falls during the warm period of the year. Precipitation of a torrential nature is observed in April-August (mudflow-hazardous period). The average number of days with showers in April-July is 5-7. Analysis of the available materials showed that mudflows occurred with precipitation of more than 30 mm per rain, while the intensity of showers in the Fergana mountainous framework reached 1.44 mm/min, in the Issyk-Kul basin - 1 mm/min, in the Kyrgyz ridge - 0.7 mm/min, in the Talas ridge - up to 0.5 mm/min [24].

2. Outbursts of mountain lakes and intraglacial reservoirs. Of the several thousand mountain lakes in Kyrgyzstan, 368 lakes have been identified at present, which at different periods of their development were classified as outburst-hazardous and included in the catalog of outburst-hazardous lakes in Kyrgyzstan. They are located across the territory of the republic as follows: in the Jalal-Abad oblast – 26; in Issyk- Kul oblast – 168; Naryn oblast - 18; in Osh and Batken oblast - 65; Talas oblast - 21 ; in Chui oblast – 70.

3. Active melting of snow accumulations and glaciers. When analyzing floods from breakthrough of lakes and reservoirs, it was found that the time of their occurrence is most often timed to coincide with the period of the most intensive melting of glaciers, and especially with the combined action of melt and rain waters. According to the Ministry of Emergency Situations of the Kyrgyz Republic, snowmelt, often in combination with rain , causes the occurrence of up to 15% of cases from once every 3-10 years to once every 6-10 years.

Glacial mudflow formation areas are territories associated with modern glaciation and moraines, common above 3000-3500 m. Due to conditions that promote accumulation of large volumes of melt water (in glacial and moraine lakes, intraglacial and intramoraine reservoirs, etc.), the presence of waterlogged moraine layers, significant slopes. Here, the most powerful and long-lasting flows can form. According to the Ministry of Emergency Situations of the Kyrgyz Republic, snowmelt, often combined with rain, causes up to 15% of mudflows.

MAP OF EROSION PROCESSES



On the territory of the Kyrgyz Republic there are several dozen large and small ranges, mountains, spurs, which are divided by intermountain valleys, basins and depressions. The most powerful mountain ranges extend up to 500 km in length and 60-70 km in width. These are Terskey Ala- Too , Kyrgyz, Talas, slightly smaller are the ranges Kungey , Fergana, Chatkal , Alay, Jetym-Too and others. All mountain ranges of the Tien Shan without exception have a large dissection, deep and steep gorges. Most of them have mountain glaciation. The soil and vegetation cover of the Tien Shan is very poor. Soil cover is completely absent on rocky outcrops in the axial parts of almost all ranges. Very poor soils and vegetation on Holocene moraines. Somewhat better developed soils on deluvial slope deposits in the zone with sufficient moisture, where there are forest areas. In total, 3% of the area in the mountains of Kyrgyzstan is occupied by forest vegetation. Better developed soils and vegetation on sedimentary strata of the foothills and on the adyrs. But here, due to the fact that less precipitation falls than evaporates, the vegetation grows mainly ephemeral, the vegetation burns out in two or three months. In addition, the mountain slopes are subject to pasture erosion, so there is no continuous vegetation cover on the slopes anywhere. All this indicates that those few and not so large in layer showers are capable of forming a slope runoff, which, concentrating on the thalweg network, channels and mudflow centers, causes mudflows. Significant areas are occupied by quaternary sedimentary rocks, among the quaternary rocks, loess rocks are widespread. Erosion processes exert an influence in particular in the flow transformation zone, where it is saturated with debris and passes into the mudflow phase. They are usually represented by cuts and ruts, usually they are considered to be the centers of local mudflow formation . In mudflow centers of this type (cuts and ruts), the erosion-shear process prevails. Mudflow cuts are distributed mainly on moraine deposits below the modern glaciation. They are distributed more or less evenly over the territory. Mudflow ruts are developed not only on the eluvial-deluvial substrate, but also on the colluvial (on screes). Moreover, in modern glacial and periglacial areas, ruts are confined mainly to screes. Cases of their development have been noted on the benches of moraines, where shear and erosion-shear mudflow processes can originate.

In close dependence on geological conditions: the development of certain types of mudflow centers depends on the composition of rocks, faults and other factors. Mudflow cuts are distributed mainly on moraine deposits below the boundary of modern glaciation, they are distributed more or less evenly throughout the territory. Rock mudflow centers - develop mainly on rocky sections of mountain ranges, they can often be seen along tectonic faults at contacts, so they are found in the axial sections of mountain ranges. Mudflow ruts develop on sedimentary strata, deluvial slopes, developed in the middle parts of ridges and in the foothills. Active runoff-forming strata are also confined to sedimentary strata and deluvial deposits .

Legend

- Boundaries
- Major rivers
- Elevations
- Lakes

Soil erosion

- Unwashed and washed soils of floodplain meadow-swamp areas.
- Unwashed and slightly washed soils of plains and intermontane depressions, used for rice, cotton, melons, and other agricultural crops.
- Heavily washed soils (with moderately washed soils) of southern, southwestern, and southeastern mountain slopes, intermontane depressions, and foothills. Vegetation less than 50%.
- Heavily washed soils of piedmont plains used for grain, industrial, and other agricultural crops.
- Heavily washed areas among rocks, screes, and inconvenient lands, rarely used as low-productivity pastures.
- Slightly washed soils of flat watersheds in combination with unwashed soils and gentle foothill areas used for grain.
- Slightly washed soils of northern, northwestern, and northeastern mountain slopes, intermontane depressions, and syrty plateaus. Vegetation 70-90%.
- Slightly washed areas among rocks, screes, and inconvenient lands, used as low-productivity pastures.
- Moderately and heavily washed soils of upper slope areas used for...
- Moderately washed soils (in combination with slightly washed soils) of western and eastern mountain slopes, intermontane depressions, and foothills. Vegetation 50-70%.
- Moderately washed soils of piedmont plains used for orchards, cotton, fodder, and other agricultural crops.
- Badlands, heavily eroded Tertiary deposits.
- Gravels, sands, moraines.
- Snow-covered areas and glaciers.
- Rocks.

GENERAL PATTERNS OF MUDFLOW FORMATION

Mudflows form in mountain and foothill valleys. As they move, they begin to disintegrate, deposit the debris they bring, and transform into flood flows that rush down to the foothill plains. Thus, the mudflow zone covers not only the mountains and foothills, but also the foothill plains, i.e., a significant part of the republic's territory.

Against the general background of the widespread distribution of mudflows across the territory of Kyrgyzstan, some of their features can be traced:

1. Mudflows of the torrential type are formed in the foothill and mountain zones up to an altitude of 3200-3300 m. Above this level, the intensity of showers decreases sharply, their water content is not enough to generate flows that form mudflows. The state of high-mountain slopes covered with scree coarse-grained material, which prevents the surface runoff of rainwater, and ice, which prevents the shedding of debris, also does not contribute to the formation of mudflows. In the history of mudflow formation, there is a case when an intense rainfall that fell on the Golubina Glacier (Ala-Archa River basin, altitude 3400 m) on August 7, 1962, caused a mudflow that formed a mudflow. However, in this case, the rain only contributed to the activation of the glacier melting, which led to the discharge of a large volume of melt water from the glacier.

The area of formation of mudflows is foothills, adyrs and low mountains, dissected by river valleys and dry riverbeds. The main conditions are heavy rains, the presence of a large amount of loose sediments devoid of vegetation, and large surface slopes. Here, predominantly alluvial mudflows can form during heavy rainfall throughout the warm period of the year, as well as the melting of seasonal snow in the spring. The area of dispersion and accumulation of mudflows are foothill trains of intermountain depressions and piedmont plains. The most powerful mudflows can pass through this area in transit, reaching areas that are not subject to mudflow activity. Mudflow and flood processes can be activated during intensive snowmelt in certain areas, large amounts of heavy rainfall in the spring and summer, and in the event of breakthroughs of high-mountain lakes.

Mudflows of the snow-ice-melt type are formed and developed in the glacial and rarely in the periglacial zones, at an altitude of over 3200-3300 m.

2. Mudflows of the breakthrough type [10] most often form in the glacial zone at altitudes above 3500 m. They occur much less frequently in the mid-mountain zone in the altitude range of 2000-3000 m during the breakthrough of dammed lakes. The action of breakthrough mudflows covers the entire lower part of the mountain valley, including the flat part.

The most dangerous regions where mudslides and floods may occur are: in the Chui oblast- the valleys of Dzhardy -Kaindy, Tuyuk, Issyk- Ata , Shamshy -northern, Kyzyl- Suu , Sokuluk , Zhylamysh , Kurumdy , Ala-Archa, Nooruz , Isykata , Kegets ; - to Issyk- Kul oblast valleys Ak-Terek, Chetyndy-Tossor , Barskoon , Kumtor , Choktal , Zyndan -Ton, Kurumdu -Ton, Jer - Uy - Ak-Sai, Ak-Terek, Konur-Olen -Ak-Terek, Karakol, Sary-Jaz, Enilchek , Chon- Koisu ; in Talas oblast- the valleys of Chichirkanak , Urmaral and Kara- Buura ; in the Osh oblastof the Kichik -Alai-Ak- Buura valley ; in the Batken oblast- the valleys of Ak- Suu -Shakhimardan, Isfayram -Sai; in the Naryn oblast- the valleys of Shamsi-southern (Lake Buzulgansu), Anyrty , Ukek , Karakum -Kel- Ukek , Kara- Kungey - Ukek -east. The most likely period for floods to occur as a result of the breakthrough of high-mountain lakes is July-August, and depending on the conditions of the year, it can last until mid-September.

3. Mud and rock mudflows are formed in mountainous areas composed of fractured, heavily eroded rocks of the Proterozoic, Paleozoic and Mesozoic eras, as well as in areas of mountainous areas filled with coarse-grained, weakly cemented Pliocene-Lower Pleistocene and Pleistocene-Holocene deposits. Rocks of the above-mentioned age contain a sufficient amount of clayey, dusty and coarse-grained particles necessary to saturate the water flow with debris and transform it into a mudflow.

4. Mud and rock mudflows do not form in mountainous areas where Mesozoic and Paleogene-Neogene semi-rocky rocks develop, since they do not contain a sufficient amount of dust and sand particles to transform a water flow into a mudflow.

5. Mudflows are formed on mountain slopes covered with a loess-like loam cover. The cover thickness is from one to several meters. Mudflows of this type are usually formed in the foothill and low-mountain zones, less often in the mid-mountain zones at an altitude of 1000 to 2000 m.

6. Alluvial mudflows are formed in mountain and foothill zones based on rocks of any composition and age.

7. In the southern regions of Kyrgyzstan, the activity of mudflow processes is significantly higher than in the northern regions and the inner Tien Shan (Naryn oblast). Therefore, in the southern regions, the number of emergency situations caused by mudflows and floods is 6-8 times greater than in the northern regions, over many years.

Such a large disproportion in mudflow activity between the southern and northern regions of Kyrgyzstan is due to two main reasons:

1) In the southern regions there is more precipitation, especially in the northern mountainous rim of the Fergana depression, in the Jalal-Abad oblast mountains, for example, their amount exceeds 1000 m., and in the Chui oblast mountains only 600-800 mm., in Naryn oblast 400-600 mm;

2) The area of the foothill zone (adyr zone) in the Osh and Jalal-Abad oblast occupies up to 30% of their territory and significantly exceeds the area of the foothills in other regions, for example, in the Chui oblast (up to 10% of the territory). But it is in the foothill zones that alluvial and mud flows are formed, which predominate in the total number of mudflows. In the southern regions of Kyrgyzstan, alluvial flows predominate (up to 70%), which are formed in the foothill zone. Only 30% are mud and mud-rock flows. In the northern regions of Kyrgyzstan, the foothill zone stretches as a narrow (3-5 km) strip along the foothills of the ridges framing the Chui, Issyk-Kul and Talas depressions . Their influence on the formation of mudflows is not as significant as in the southern regions, where the foothill zone occupies vast areas of the bottom of the Fergana Depression;

3) In the southern regions, the rocks are looser, less resistant to weathering and erosion, and more prone to mudflow formation than the rocks of the northern regions of Kyrgyzstan. Limestones, argillites, siltstones, sandstones with marl interlayers, and conglomerates of the Jurassic and Cretaceous periods are especially active in the formation of mudflows of alluvial flows. Clayey-sandy molasses with interlayers of conglomerates, gravel-pebbles, gypsum, and limestones of the Paleogene and Neogene are no less active .

The area of formation of snow and rain mudflows (periglacial) is the territory of mid-mountain areas (2600-3500 m) without modern glaciation. The main conditions for mudflow formation are intensive snowmelt and showers, as well as accumulation of mudflow-forming sediments, mudflow centers, the presence of remnants of ancient moraines, solifluction on slopes. In the valleys of this zone, the formation of mud and alluvial mudflows is possible. The cause of the formation of mudflows are heavy rains and moistening of sediments with melted snow water, significant surface slopes. Snow and rain mudflows can have high flow rates and cause floods caused by the action of mudflows, which are most likely in the Jalal-Abad oblast in the valleys of Kasan-Sai, Mailuu-Suu , Kara - Unkyur , Kek -Art; in the Osh oblast in the valleys of the rivers Yassy, Kara -Kuldzha , Tar, Gulcha- Kurshab , Ak- Buura , Batken (Isfayramsay , Shakhimardan, Karavshin -Isfara, Leilek , Aksuu) and Talas (Kurkyureo-Suu , Sulu - Bakaiyr , Kyumyushtak , Kolba) regions. The periods of passage of mudflows are often associated with the period of snowmelt in the mountain zone and heavy rainfall - this is April–June.

The differences in the activity and regime of mudflow processes are so significant that they necessitate the construction of separate mudflow forecasts for the northern and southern regions of Kyrgyzstan, based on specific criteria characteristic of each region.

№	Criteria for assessing mudflow activity of mudflow basins:			
1	Presence of mudflow sources	Presence of a mudflow source in the valley	Each additional source is considered as a mudflow hazard (maximum size of debris in unloading zones)	
2	Presence of moraine -glacial complexes	Icefall	Extensive glacier	Small slope glacier
3	Existence of high-mountain outburst-prone lakes	Category 1 outburst -prone lakes	Category 2 outburst-prone lakes	Category 3 outburst-prone lakes
4	Area of the mudflow basin	Large mudflow basin	Medium mudflow basin	Small mudflow basin
5	Occurrence of historical mudflow events	More than 3 times in history	2-3 times	1 time

MAIN CHARACTERISTICS OF MUDFLOWS

A breakthrough flow moving down a valley covers either the entire width of its modern bottom or a part of it depending on the morphology of the valley (slope, width, presence of floodplain terraces), its geological structure (composition of rocks and sediments forming the sides and bottom), and the hydrological nature of the flow (flood or mudflow). Consequently, in order to determine the width of the flow, and thus the boundaries of the affected area, it is necessary to take into account the morphological, lithological and hydrological factors of the formation of the breakthrough flow in each specific section of the mountain valley. In this case, the role of each factor in the overall process is assessed by the corresponding parameters: morphological - by the width of the modern bottom of the valley and its slope; lithological - by the density of the breakthrough flow; hydrological - by the flow rate.

One of the most important characteristics of a mudflow is its flow rate. This parameter is necessary for determining the boundaries of the mudflow zone, for designing mudflow channels and mudflow-directing dams.

For a flood to turn into a mudflow, its flow rate must exceed the critical value characteristic of a given riverbed. Only then does the process of "reworking" the riverbed begin, during which the flow captures a significant amount of loose debris. However, not every flood reaches a flow rate exceeding the critical level.

If, during field work, markers of a high mudflow that has passed are installed in a certain section, the cross-sectional profile of the river bed in this section is determined, the longitudinal slope of the mudflow surface (according to the mudflow tracks) or the slope of the valley bottom are known, and the volumetric weight of the mudflow mass is also known, then the maximum flow rate of rain mudflow (m3/s), according to [11], should be determined using the formula:

$$Q = F \times v_c \quad (1)$$

where F is the cross-sectional area of the channel, m² ; is v_cthe average flow velocity, determined by formulas (2) or (3); according to [12], the following formulas are recommended for determining the velocities:

$$V_c = 4.83 \times h^{0.5} sin\ \alpha^{0.25} \quad (2)$$

where h is the average depth of the flow, m; α is the average angle of inclination of the mudflow channel in the area.

Empirical formulas are often used to determine the main characteristics of mudflows. Formula (2) was proposed by I.I. Kherkheulidze and is used to determine the boundaries of the mudflow damage zone adopted in the Kyrgyz Republic [12, 13].

Also, Golubtsov V.V. [14] proposed formulas for calculating the speed of mud and mud-rock flows:

$$v_c = 3.75 \times h^{0.5} i^{0.17} \quad (3)$$

The formula (Stepanov, 1984) can also be used to determine the speed of mudflows of torrential genesis:

$$v_c = \frac{2{,}1\Phi\sqrt{Rsin\ \alpha}}{\chi} \quad (4)$$

where Φ is the coefficient of the channel cross-section shape;

R – hydraulic radius, m.

At H ≥ B/2 (where H is the depth of the flow, B is its width, approximately equal to the bottom of the valley) F ≈ 2, R = H/2. At H ≤ B/2, F ≈ 1, R ≈ H.

χ is the Karman parameter, reflecting the saturation of the flow with loose debris material and its viscosity during movement;

$$X = 0.4 \times \frac{1+C_T(\frac{\rho_T}{\rho_0}-1)}{1+2.5C_T} \quad (5)$$

In the formula p o i p t - density of water and solid component of the flow;

C T – concentration of debris material in the mudflow.

The degree of saturation of the water flow with loose debris material depending on the slope of the bottom of the valley forming the mudflow was characterized and quantitatively assessed by famous scientists T. Takahashi , R. Bagnold [17] and Yu.B. Vinogradov [15, 16]. Based on the results of their research, they derived a formula called the Takahashi-Bagnold equation [17]. Transformed relative to the parameter C m , where C m is the weight concentration of debris material in the mudflow mixture, this equation looks like this:

$$C_T = \frac{\rho_{0\times}tg\alpha}{(\rho_T-\rho_0)(tg\varphi-tg\alpha)} \quad (6)$$

- where: ρ 0 and ρ T are the density of water and the solid component of the mudflow mass; for practical calculations, it can be assumed that ρ 0 = 1.0 g/cm 3 ; T = 2.65 g/cm 3 ;
- φ is the angle of internal friction of loose debris deposits under water;
- ά - the angle of inclination of the valley bottom or mudflow source.

Takahashi-Bagnold formula (6), the mudflow-forming activity of sediments is characterized by the parameter C T , which depends on the value of the angle of internal friction φ. The greater the value of φ, the greater the possibility of saturation of the water flow with debris. The angle φ, in turn, depends on the composition of the mudflow-forming sediments.

Volume. This parameter is necessary when assessing the mudflow hazard of each mountain valley, and especially when constructing mudflow storage facilities . The volume of mudflow deposits varies widely, from fractions of a cubic meter (micro mudflows) to several million cubic meters.

Several methods are used to determine the volume, of which two are the most common: 1) the product of the mudflow area Sm2 by the average mudflow capacity mcp , i.e. V= Smcp ; 2) the product of the average mudflow discharge Qcp , m³ / s, by the time it takes to pass - t, sec, i.e. V=Q*t. Each of these methods has significant drawbacks, primarily related to the complexity and inaccuracy of determining the average values, i.e. mcp and Qcp . However, the determination of the mudflow area is also very approximate, since debris, especially fine material, is carried by water flows far down the valley and cannot be taken into account.

To predict the volume of possible mudflows in a particular mountain valley, another mudflow parameter is used – the specific volume of mudflow removals, q, m³ / km² . It shows the volume of debris that can be involved in a mudflow from 1 km² of mudflow catchment area .

MUDFLOW HAZARD ASSESSMENT

To solve the problem of assessing the danger of mudflow sources, simple models by Yu.B. Vinogradov [36] and T.S. Stepanova [37] are used in practice. The main task is to assess the power of a mudflow source, for this purpose the parameter S is introduced - which can be considered the coefficient of the power of a mudflow source. The analytical formulas that reveal the essence of these models mainly include morphological parameters, and lithological parameters that reflect the composition and structure of the soils that form mudflows are taken conditionally as average values that reflect the huge spread of parameter values.

According to Yu.B. Vinogradov $$S = 1 + k \cdot L(1+\xi) \cdot \frac{tg\alpha}{tg\varphi} sin\alpha \quad (7)$$

According to T.S.Stepanova $$S = 1 + \frac{C_T}{1-(1+\xi)C_T} \quad (8)$$

In formulas (7) and (8) the following notations are used:

L– length of the mudflow source;

k – is a coefficient reflecting the increase in solid matter as the mudflow moves along the mudflow source;

ξ — relative humidity; $\xi = \frac{Q}{1-\varepsilon}$; Q – volumetric humidity;

$\boldsymbol{\varepsilon}$ - porosity of mudflow-forming soils.

ά - is the angle of inclination of the sediments that form the mudflows, on average equal to the angle of inclination of the valley bottom;

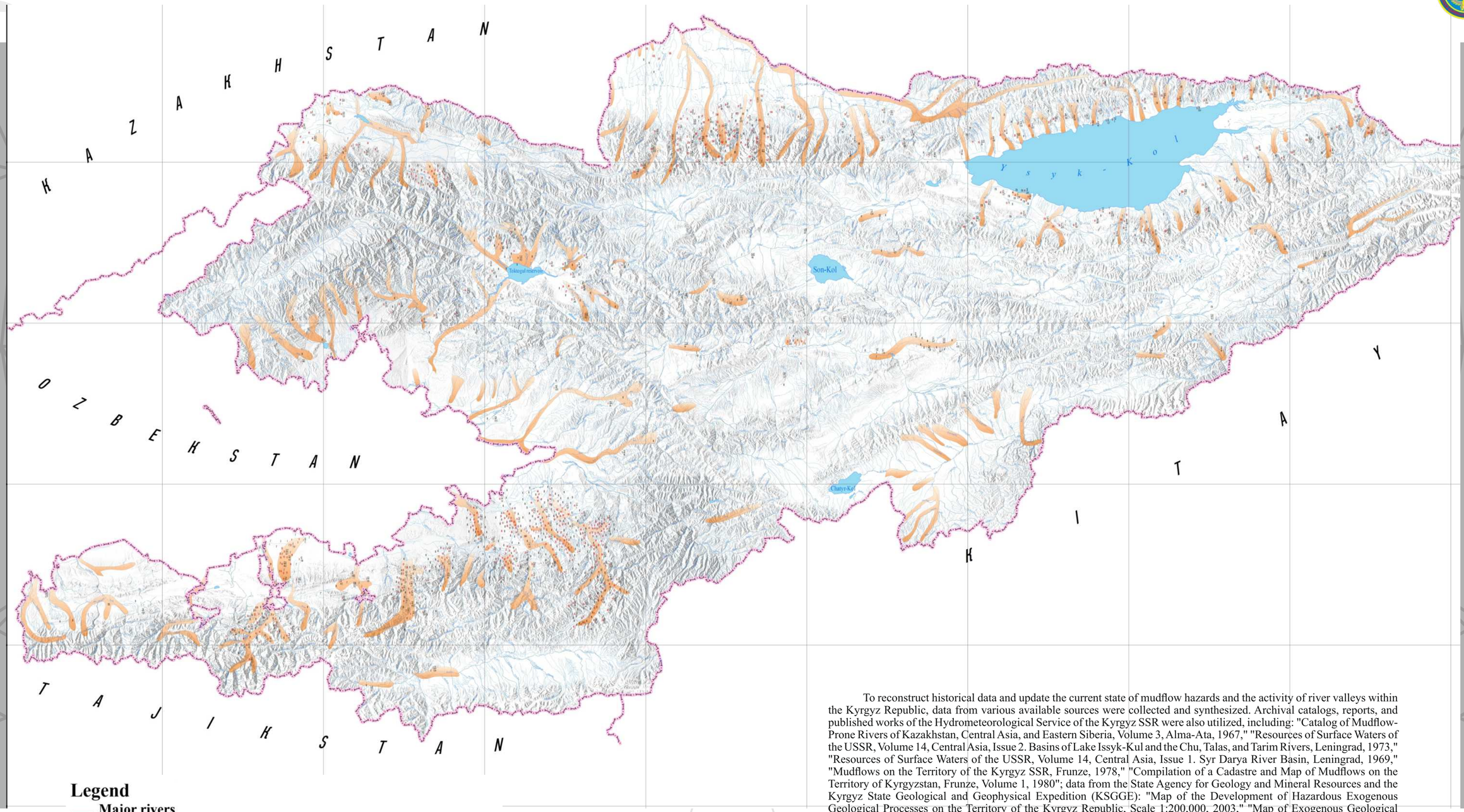
φ - is the angle of internal friction of mudflow-forming deposits;

According to formulas (7) and (8), the mudflow source capacity is estimated by two parameters: its length and slope (the value of C T is calculated using the slope). The length determines the influx of debris into the mudflow. However, such influxes are almost absent on the rocky sections of the sides and bottom of the mudflow source, so the rocky sections should be excluded from the mudflow process. Otherwise, the value of S will be overestimated. To take into account the influence of rocky sections, the mudflow source rockiness coefficient is introduced . Its value is determined by the formula $n = \frac{L_{ск}}{l_{общ}}$:l ск is the length of rocky sections in the mudflow source, m; l общ is the total length of the mudflow source.

The value S is a relative characteristic of a mudflow source. It reflects its geological properties: morphology, lithology, composition and structure of sediments. It shows the mudflow source's ability to form mudflows. However, it does not yet reflect the mudflow itself, since it is formed by two components: geological and hydrological. If the geological part of the mudflow is formed in mudflow sources, then the hydrological part is formed on the territory of the entire mudflow catchment area and depends on the climatic conditions of the entire mountain region. To understand how a water flow is formed, which, moving down the valley, can transform into a mudflow, or may remain a flood, it is necessary to study the entire mountain valley.

Density and concentration of debris material of mudflow mixture determine the structure, composition and rheological properties of the mudflow . As the amount of debris in the mudflow mixture increases, its density increases. It is the main criterion for the structural and rheological typification of mudflows. When the water flow is saturated with debris to a density above 1.1 g/cm³, it begins to exhibit mudflow properties. At a density above 1.4 g/cm³, the rheological properties of the flow begin to prevail over the hydrodynamic ones. Alluvial mudflows have a density of 1.1 to 1.4 g/cm³, mudflows from 1.4 to 1.8 g/cm³ , mud-rock flows from 1.8 to 2.5 g/ cm³ .

MAP TO THE CATALOG OF MUDFLOW-PRONE RIVERS



Legend

- Major rivers
- Boundar
- Elevations
- Lakes
- Mudflows prone area
- 30 10/25.6 Catalog number, length of the watercourse in km, area (numerator) of the catchment basin in m² (denominator)
- Mudstone flow
- Debris-water flow

To reconstruct historical data and update the current state of mudflow hazards and the activity of river valleys within the Kyrgyz Republic, data from various available sources were collected and synthesized. Archival catalogs, reports, and published works of the Hydrometeorological Service of the Kyrgyz SSR were also utilized, including: "Catalog of Mudflow-Prone Rivers of Kazakhstan, Central Asia, and Eastern Siberia, Volume 3, Alma-Ata, 1967," "Resources of Surface Waters of the USSR, Volume 14, Central Asia, Issue 2. Basins of Lake Issyk-Kul and the Chu, Talas, and Tarim Rivers, Leningrad, 1973," "Resources of Surface Waters of the USSR, Volume 14, Central Asia, Issue 1. Syr Darya River Basin, Leningrad, 1969," "Mudflows on the Territory of the Kyrgyz SSR, Frunze, 1978," "Compilation of a Cadastre and Map of Mudflows on the Territory of Kyrgyzstan, Frunze, Volume 1, 1980"; data from the State Agency for Geology and Mineral Resources and the Kyrgyz State Geological and Geophysical Expedition (KSGGE): "Map of the Development of Hazardous Exogenous Geological Processes on the Territory of the Kyrgyz Republic, Scale 1:200,000, 2003," "Map of Exogenous Geological Processes of Central Asia and Southern Kazakhstan, Scale 1:1,000,000, 1983"; reports, monographs, and published articles from the Institute of Water Problems and Hydropower of the National Academy of Sciences of the Kyrgyz Republic; and factual data from long-term monitoring of mudflow and flood processes by the Department of Monitoring and Forecasting of Emergencies under the Ministry of Emergency Situations of the Kyrgyz Republic (DMFE MES KR), including maps of mudflow process development, from which data on the location of sites were obtained, statistical data on the dates of mudflow occurrences recorded in the DMFE database as emergencies, and books titled "Monitoring and Forecasting of Hazardous Processes and Phenomena on the Territory of the Kyrgyz Republic, Bishkek: MES KR" from various publication years. The map includes all mudflow-prone rivers listed in the catalog, with numbers on the map corresponding to those in the catalog table. For most rivers, additional characteristics are provided on the map for convenience: the area of the mudflow catchment basin and the length of the watercourse.

The catalog numbers correspond to the table of mudflow-prone rivers on the territory of the Kyrgyz Republic, pages 141–161.

The most catastrophic mudflows of the Kyrgyz Republic

MUDFLOWS OF GLACIAL ORIGIN

In the Northern Tien Shan Mountains, thousands of lakes of various genesis were formed during their formation, hundreds of which had unstable dams and burst. The consequences of many bursts were catastrophic for the inhabitants of mountain valleys and foothill plains. In the process of moving down the valley, a breakthrough flow can transform into a mudflow, and its destructive energy increases dozens of times. Accordingly, the area of the mudflow damage zone and the degree of destructiveness of the mudflow increase sharply. Due to the fact that a breakthrough flow often transforms into a mudflow, breakthrough-hazardous lakes began to be called mudflow-hazardous. Catastrophic breakthroughs of mountain lakes are included in the group of natural emergencies.

BREAKTHROUGHS OF INTRAGLACIAL RESERVOIRS FROM THE AKSAI GLACIER (ALA-ARCHA RIVER BASIN)

The Ala-Archa River basin is located in the central, highest part of the northern slope of the Kyrgyz Range, the valley is densely populated . The Ala-Archa Valley is a national nature park and is a popular destination for tourists, climbers and vacationers from Bishkek, which makes mudflows even more dangerous.

The Aksai River Valley (the right tributary of the Ala-Archa River) is one of the most mudflow-prone areas on the northern slope of the Kyrgyz Range. Over the course of 11 years (from 1960 to 1970), more than ten powerful mudflows formed in the valley, repeatedly blocking the bed of the Ala-Archa River. Mudflows were recorded here on July 5, 1960, July 29, 1961, August 21, 1965, June 18, 1966, July 13, 24 and 25, 1968, July 24, 1969, July 18 and August 2, 1970, July 18 and August 3, 1980. One of the mudflows claimed the lives of three student interns who were in the valley during their summer internship. As a result of repeated passage of mudflows, a powerful mudflow cone was formed (Figure 8). The Aksai alluvial fan was formed over several thousand years. Periods of increased mudflow activity were followed by periods of calm, when most of the alluvial fan territory was overgrown with spruce forest. Then new powerful mudflows passed through these forest areas, uprooting trees and covering them with a cover of coarse debris up to 10 meters thick. In terms of the volume of debris removed, it is the largest in the northern Tien Shan. Its volume is about 12x10 6 m 3 [22]

Figure 8. Mudflow cone of the Aksai alluvial fan, August 2024. (photo by V.V. Zaginaev)

Five age generations can be traced in the structure of the Aksai cone. One of them, the largest, blocked the bed of the Ala-Archa River. Figure 9 shows the dynamics of mudflow development on the alluvial fan from 1960 to 2015. The main changes on the cone occurred during the period of increased mudflow activity associated with the glacier. The mudflow discharge calculated by formulas (1) and (2) on July 13, 1968 was 1000 m^3 / sec, the volume of mudflow removal was 0.2 million m^3. For comparison, the maximum discharge during the breakthrough of Lake Tez-Tor on June 20, 1953 was 500 m^3 / sec and the volume of removal was 1.2 million m^3.

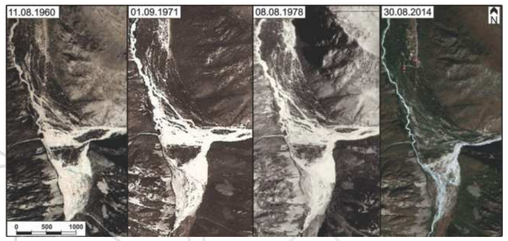


Figure 9. Dynamics of mudflow processes on the Aksai alluvial fan

Until now, the Aksai mudflows were formed after the breakthrough of water accumulated in the intraglacial reservoirs of the Ak-Sai glacier. At present, the glacier has shrunk, the power of its icefall, which is associated with the formation of intraglacial reservoirs, has decreased (Figure 10).

A powerful mudflow source formed on the slope of the advanced ledge of the moraine-glacial complex played a major role in the formation of mudflows. This is the so-called mudflow cut with deep steep sides with a V-shaped transverse profile. The length of the mudflow source is from several kilometers, the height of the sides up to several tens of meters. The average slope of the valley is 0.27, which is a very favorable factor for the formation of mudflows.

Figure 10. Aksai Glacier, August 2023. (Photo: archive of the Department of Monitoring and Forecasting of Emergencies)

The Aksai mudflows originated after the breakthrough of water accumulated in the intraglacial reservoirs of the Aksai glacier. The flow rates of the water flows forming the mudflows were 20-50 m^3 / sec, while the flow rates of the corresponding mudflows reached 900-1000 m^3 / sec. In the 1970s, due to the shortening of its end part and the decrease in the power of its famous icefall, the conditions for the formation of intraglacial reservoirs became less favorable [21, 23].

Therefore, in recent years, the Aksai mudflow center has remained relatively passive, but a large amount of mudflow-forming material has accumulated here, the discharge of which may occur in the coming years.

Currently, the moraine-glacial lake Aksai (Ch-40) is developing under the Uchitel glacier at an altitude of 3450 m. The lake has intra - moraine drainage channels and in recent years an increase in its size has been observed following the retreating glacier (Figure 11). In 2023, due to a sharp increase in the volume of water in the lake, this lake was transferred to the first category (the highest) of outburst hazard , however, due to climatic reasons and a cold snap, the filling stopped on August 1 and the lake entered a stable mode, lowering its level to a safe one.

Figure 11. Lake under the Uchitel glacier (photo: archive of the Department of Monitoring and Forecasting of Emergencies)

LAKE OUTBURST IN THE UPPER REACHES OF THE SHAKHIMARDAN RIVER VALLEY (NORTHERN SLOPE OF THE ALAI RIDGE)

The breakthrough of Lake Allaudin , located in the upper part of the Shakhimardan River basin, was the most catastrophic event in Kyrgyzstan and Central Asia in the 20th century.

A powerful mudflow and then flood flow formed in July 1998 as a result of a breakthrough of a non-stationary lake, a moraine-glacial type. In early July 1998, a strong increase in air temperature was noted throughout the upper part of the Alai Range. An increase in temperature from 7º to 12º C was recorded at the glaciological station on the Abramov Glacier. At the moment of the breakthrough, the temperature at an altitude of 4000 m reached 15º C. As a result of the increase in temperature, more intensive melting of glaciers and snow cover began, including the rapid filling of lakes with melt water.

The Archabashi glacier retreated from the lake back in the 80s of the twentieth century. Before the breakthrough, the lake was in a calm development mode. Nevertheless, it filled up. Its volume increased until the moment when the drainage channel opened. An underground breakthrough of the lake occurred through the thermokarst funnel and drainage channel (Figure 12).

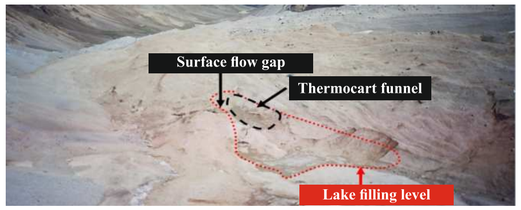


Figure 12.The Allaudin lake basin in the Shakhimardan River valley on the northern slope of the Alay ridge has not been filled with water since the breakthrough in 1998. (diagram by S.A. Erokhin)

When the breakthrough occurred, the roof of the drainage channel sank. A gap formed in the body of the lake dam, through which the breakthrough of the lake continued already by the surface route, which increased the flow rate of the breakthrough flow many times over.

The flood flow was 150-200 m^3 when the water reached the village of Shakhimardan [26].

The lake burst at night, and the mudflow took the residents of Shakhimardan by surprise. A flood wave up to 5 meters high passed through the entire village before midnight. The Shakhimardan seismological station was working at the time, and a local seismologist registered some strange recording of the instrument, not similar to an earthquake. Realizing that it could be a mudflow, he tried to warn people in the city, but it was too late (according to the Ministry of Emergency Situations of the Kyrgyz Republic). The valley above the village of Shakhimardan is deep and narrow with rocky walls on the left side, powerful alluvial deposits on the right side and a gravel surface at the bottom. The valley widens at the top of the outskirts of the village, so the flood wave spreads to both sides and spills over a large part of the plain. The powerful flood wave immediately destroyed houses, bridges and all infrastructure. The fatal circumstance was that people had developed the habit of resting and spending the night on the river bank in the open air during the hot summer season. People who were close to the river had no chance of survival. Information about the number of victims varies greatly. Officially, there were about 100 dead, but many bodies remained under the rubble. In the Kyrgyz territory below the Uzbek enclave, the disaster was not as serious, although the losses were also high. The wave was not as high and powerful, and in some cases, people had already been warned. Also, the morphology of the valley allows for the construction of houses on the higher parts of the terraces and slopes, and the river bank is used to a lesser extent. Bridges and roads were damaged and houses in the village of Kara-Bulak were destroyed (the wave height reached 4 meters), gardens and houses were flooded, a small hydroelectric power station was destroyed and bridges were demolished in the village of Zhidelik (the wave height reached 3-4 meters), bridges and roads in the city of Kadamzhai were damaged (the wave height reached 1-2 meters). After the Shakhimardan disaster, two monitoring flights were carried out in the southwestern part of Kyrgyzstan (Erohin 1998, 1999), the last major expedition led by S.S. Chernomorets was conducted in 2014, based on the results, a detailed work was published dedicated to this breakthrough [20].

LAKE ZYNDAN BREAKTHROUGHS

The catastrophic breakthrough of Lake Zyndan (N 41.945968°; E 77.023804°), located in the upper reaches of the river of the same name at an altitude of 3770 m, one of the left tributaries of the Ton River, occurred on 24.07.2008. Lake Zyndan is western (I-167), is a slope intramoraine depression. The lake belongs to the group of non-stationary high-mountain breakthrough-hazardous lakes (Figure 13 A).

As a result of the breakthrough, a powerful mudflow and rock flow was formed in the Zyndan River valley, the flow rate of which reached 60-70 m^3 /s in the lower part of the valley, the maximum flow rate, according to field studies conducted after the flow passed, was about 300 m^3 / s, the initial flow rate was estimated to be 25 m^3 / s. The mudflow passed along the Ton River valley, causing great destruction and human casualties. Particularly great destruction occurred along the Ton canal, due to the fact that most of the flow passed along the canal bed, the sides of the canal were washed away, which led to flooding of the adjacent territories. Lake Zyndan -zapadnoye broke through an underground drainage channel (Figure 13 B). The volume of the lake before the breakthrough was estimated to be 450 103 m^3 .

Figure 13. A. Prisklonovaya intramoraine depression partially filled with water from Zyndan -zapadnoe Lake (I-167) after its breakthrough on 24.07.08 (photo by S.A. Erokhin) V. Underground drainage channel to Zyndan Lake after the lake breakthrough

When the breakthrough flow passed along the Ton River valley, the following were hit by the following: a car with people inside (4 killed); a sheepfold was destroyed; the Bokonbaevo -Temir-Kanat highway from the village of Tuura-Suu to the Kara - Tumshuk section (road turn) for 4.5 km; two on-farm bridges were destroyed; hydraulic distributors and chutes were destroyed. The flow destroyed the drinking water supply pipeline of the fish factory, destroyed canals, power lines, and covered gardens, vegetable gardens, and pastures with debris and sediment. At the mouth of the Ton River, significant damage was caused to the fish factory: two ponds in which trout fry were raised were destroyed. The fry, prepared for release into Lake Issyk-Kul to replenish the fish stock, died.

After the breakthrough in 2008, the water in the depression did not accumulate for a long time or reached the level shown in Figure 9, which indicated that the drainage channels were developed and the water was drained down through them. In 2024, as a result of the analysis of space images , it became clear that the water was accumulating and in mid-July, according to estimates, the maximum volume reached 500 10 3 m^3.

Lake Zyndan - West erupted again on August 22, 2024. Figure 14 A shows a comparison of the lake area before and after the rupture: blue shows the lake area on August 9, 2024, and red shows the lake area after the rupture in the image on August 28, 2024. Due to cloudiness and the impossibility of assessing whether the lake ruptured in full or in part, Sentinel-1 images from the GEE platform were analyzed (Figure 14 B), which made it possible to assess that the lake ruptured according to the same scenario as in 2008, and with approximately the same volume.

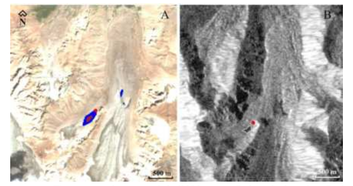


Figure 14.
A. Lake Zyndan -west on Sentinel -2 image.

B. Verification of breakthrough on Sentinel -1 image.

Due to the rapid filling of the lake in July 2024, recommendations were made to upgrade the lake to a high hazard category. Following aerial photography from a UAV, a decision was made to upgrade the lake to a very high rupture hazard category. When analyzing satellite images in the system four days before the rupture, a decrease in the lake height was noted. The lake surface area decreased from 410×10^3 m^2 to 350×10^3 m^2, indicating the appearance of underground flow channels and the beginning of drainage. Until this point, the lake had shown an increase in volume. According to previous bathymetric measurements, the lake volume at maximum capacity was approximately 400×10^3 m^3. Due to the opening of the drainage channels, it was predicted that the lake would burst within the next 10 days. Equipment was prepared in advance and work began to deepen the river bed. On the day of the rupture, more than 450 people were evacuated from the village of Turasu to a safe place. After analyzing satellite images and determining that the lake had almost completely burst (in two days), it was decided to bring people back. The Ton River Valley is the most mudflow and flood-prone. There fore, it is very important to know the flood and mudflow zone of the lower part of this valley, as the most densely populated.

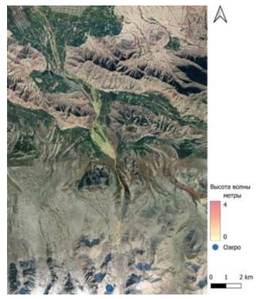


Figure 15. Potential damage zone in case of a breakthrough of Lake Zyndan - western

Modeling was carried out in advance in the RAMMS program on DEM, with a resolution of 8 m, to calculate the possible damage zone in the event of a breakthrough of Lake Zyndan -zapadnoye (Figure 15). The modeled zone coincides with the zone that was flooded during the event of 2024.

MUDFLOWS OF STORM GENESIS

Mudflows of torrential genesis are one of the main natural hazards in the mountainous and foothill regions of the Kyrgyz Republic. A high-density flow saturated with debris as it moves down the valley can cause destruction in populated areas. This natural process is associated with intense, anomalous concentrated torrential rainfall. It is expected that in the near future, the spread of these events will increase due to climate change in the region.

MUDFLOWS IN THE TYUP REGION, 2023

The mudflows that occurred from July 31 to August 12, 2023, caused extensive flooding and damage to agricultural fields, residential areas, social facilities and infrastructure in the villages of Taldy-Suu , Kuochi , Korumdu , Kainar, San- Tash , Ken- Suu and Balbay (Figure 16). The massive mudflows were preceded by intense concentrated rainfall. In particular, the mudflows damaged more than 150 houses in six settlements, more than 95 hectares of agricultural land were flooded, and on-farm bridges and roads were destroyed. Mudflows occurred in small catchment areas ranging from 0.09 to 3.7 km^2 , while the flow rate in settlements reached 20 m^3 /s. The heterogeneity of meteorological data and the lack of a significant increase in precipitation during the occurrence of mudflows in the Tyup region indicate other possible factors contributing to the occurrence of these flows, such as lithology and geomorphology, which became decisive in the formation of mudflows.

Figure 16. Mudflow location in Kainar village.
(A) Bottom erosion depth reached 1.5 m;

(B) Diameter of transported debris reached 1 m;

(C) Mudflow fan at the base of the slope.

MUDFLOWS AND FLOODS IN THE SUZAK REGION

Mudflows Alluvial flows passed in May 2022, as a result of abnormal heavy rainfall, alluvial flows of low density are formed. The geological structure and lithological composition of the rocks create favorable conditions for the formation of mudflows in this valley. Clays and loams, which are part of the rocks, poorly absorb moisture and during prolonged rainfall, water flows down all the lateral dry channels, without lingering on the slopes. Sandy loams that make up the sides of the temporary watercourse are also involved in the flow, the deep incision of the river in some areas indicates that alluvial flows have repeatedly passed along this sai. The alluvial flow, meeting obstacles in the form of bridges, slows down, accumulates and, not fitting into the cross-section, spills over the obstacles (bridges, dams, dams). The situation is also aggravated by the involvement of dry trees located near the channel in the flow. Trees involved in the mudflow get stuck under bridges, reducing the channel capacity and forming jams, which leads to the formation of mudflow shafts with subsequent breakthroughs and flooding of adjacent territories. When the flow enters a leveled section of the channel, its speed of movement is dampened, and it deposits sediment in the form of a mudflow mixture (sand, clay, loam). The height of the flow in some areas exceeded more than 1 meter.

At the same time, the meteorological conditions preceding the mudflow were favorable for its formation. According to the Hydrometeorological Service of the Ministry of Emergency Situations of the Kyrgyz Republic, on May 4, starting from 21:30 to 00:30, in the Suzak district in the villages of Changet , Barpy, there were intense rainfalls lasting about 3 hours, during this period 26.7 mm of liquid precipitation fell. Abnormal, prolonged precipitation caused mudflows.

The deposits are represented by loams, clays with sand crushed stone filler.

Figure 17. The territory of the village of Kara- Zhygach, the zone with the greatest flooding is marked in yellow (photo: archive of the Department of Monitoring and Forecasting of Emergencies)

Zhygach village , Atabekov rural district.
In this section, 75 residential buildings were flooded. The bridges in this section provided the capacity designed for normal flow rates. As a result of prolonged intense rainfall, a mudflow with flow rates of 30-40 m^3/s was formed , and the flow overflowed the banks in the narrowing sections of the channel. Meeting obstacles in the form of bridges and bridge crossings, the flow, by inertia, was reflected in the opposite direction, spilling and flooding the adjacent territories in areas located in a natural depression in the relief (the confluence of the mudflow channel " Ataika ").

Figure 18. Flooded houses and plots in the village of Kara- Zhygach (photo: archive of the Department of Monitoring and Forecasting Emergencies)

Bagysh village , Atabekov rural district.
In this area, 51 residential buildings, as well as outbuildings, courtyards and agricultural fields, were flooded.

Oryuk village , Barpy rural district.
In this area, as a result of mudflows from the temporary Shor- Suu watercourse , 89 residential buildings, one school and a mosque, as well as outbuildings, courtyards and agricultural fields were flooded . The automobile bridge across the Atayka Canal is in a state of emergency.

Village Tashtak , rural district of Barpy.
In this area, as a result of mudflows from the temporary Shor- Suu watercourse , 60 residential buildings, a first aid post and 2 kindergartens, a sports club, as well as outbuildings, courtyards and agricultural fields were flooded.

The village of Zhany- Ayil , rural district of Barpy.
In this area, as a result of mudflows from the temporary Shor- Suu watercourse , 30 residential buildings, a secondary school building, as well as outbuildings, courtyards and agricultural fields were flooded.

Village B. Osmonov , rural district of Barpa.
As a result of the overflow of the Changet River in the area of the railway bridge, 15 residential buildings, outbuildings, courtyard plots and agricultural fields were flooded. The main reason for the flooding of this area is the limited capacity of the railway bridge, with large flows of flood mudflows along the Changet River .

Komsomol village, Barpy rural district.
Kempir-Abad irrigation canal by mudflows , 35 residential buildings, a medical station, a kindergarten, outbuildings, courtyards and agricultural fields were flooded.

Chokmor village , Barpy rural district .
Due to the overflow of the Changet River , 23 residential buildings, outbuildings, courtyards and agricultural fields were flooded.

Figure 19. Automobile bridge in the village of Chokmor (photo: archive of the Department of Monitoring and Forecasting of Emergencies)

Village Choko-Dobo , rural Barpa district.
Kempir-Abad irrigation canal by mudflows , 16 residential buildings, outbuildings, courtyards and agricultural fields were flooded.

FORECASTING MUDFLOW ACTIVITY

Forecasting mudflow activity is a complex process that helps prevent or minimize potential destructive consequences. The main goal is to determine two key factors: location and time of activation.

1. It is necessary to determine precisely in which specific location there is a risk of mudflow occurrence. This may be a certain section of a mountain slope, valley or river bed. Taking into account the geological, hydrological and climatic features of the territory helps to increase the accuracy of the forecast. Assessing the mudflow hazard of territories and determining the boundaries of mudflow formation areas allows us to determine where mudflows can occur and develop.

2. It is important to predict the time period in which the mudflow process may become more active. This could be either a specific date or a wider time range, such as a season or a week.

When forecasting the characteristics of a mudflow, it is important to predict the time it takes for the mudflow to travel from its origin or a certain section to life-sustaining objects. This type of forecast answers a very important question about the amount of time available to people to carry out protective measures.

The basis for spatial mudflow forecasting is the compilation of maps: overview, medium-scale and large-scale. With the help of overview maps, it is possible to identify the general distribution of mudflow-prone areas, the area of mudflow-prone areas and identify the most mudflow-prone areas.

The purpose of medium-scale maps (from 1:100000 to 1:500000) of mudflow-prone areas is to identify and record general patterns and conditions for the formation of mudflows and to assess the degree of mudflow hazard in mountainous areas, which is necessary for drawing up general plans.

Depending on how detailed these questions can be answered, forecasts are divided into several types (Figure 20). Each of them has its own purpose and is applied depending on the available data, the objectives of the analysis and the urgency of the measures that need to be taken.

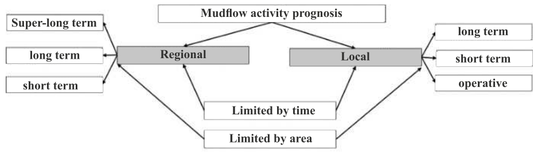


Figure 20. Types of mudflow forecasts

Mudflow hazard forecasts are divided into ultra-long-term (several years), long-term (season, several weeks), short-term (several days), and operational, which are determined by the time it takes for the mudflow wave to reach objects (Figure 20).

Mudflow forecast criteria are divided into two groups:

1) criteria for the location of the mudflow process, based on geological factors of mudflow formation - this is the category of mountain valley and the type of mudflow collection .

2) criteria for the time of manifestation of the mudflow process, based on hydrological factors of mudflow formation are: a) dangerous accumulation of winter precipitation; b) dangerous amount of expected precipitation in the spring-summer months; c) dangerous invasion of air masses; d) dangerous accumulation of daily atmospheric precipitation; d) dangerous increase in air temperature.

When compiling short-term and long-term mudflow forecasts, the variables will be the criteria of the time of manifestation of the mudflow process. The criteria of the place of manifestation remain constant for many years, since the geological processes that influence the formation of mudflows develop very slowly over centuries and millennia. Therefore, the mudflow hazard in mountain valleys remains for a long time. However, this does not mean that the maps of mountain valley categories by mudflow activity will not change. On the contrary, it is necessary to carry out constant work with such maps, since the geological situation in each mountain valley, although slowly, is constantly changing. In most valleys, these changes are almost unnoticeable due to their insignificance. But in some valleys, these changes can become so large that a change in the category of their mudflow activity will be required.

LONG-TERM MUDFLOW FORECASTS

A long-term mudflow forecast is made for a season of one year. The determining criteria for it are: 1) accumulation of winter precipitation; 2) the amount of expected precipitation in the spring-summer months. Table 1 shows the maximum values of these criteria for different regions of Kyrgyzstan. The probability of mudflow activation in the spring-summer season will be high in valleys of those categories where the maximum values of these criteria are exceeded.

Short-term mudflow forecasts

Short-term forecasts are made 2-5 days in advance and are the main means of warning the population of mountain valleys about the threat of mudflows. The main criteria of a short-term forecast are the following: 1) accumulation of winter precipitation; 2) amount of spring-summer precipitation; 3) invasion; 4) accumulation of daily atmospheric precipitation; 5) increase in air temperature.

Table 1. Sources of information for determining the values of long-term forecast criteria

Long-term forecast criterion	Region of Kyrgyzstan	Criterion value	Source of information
Dangerous accumulation of winter precipitation, kg/ m^2	Northern regions	600	Podrezov (2000)
		700	
		500	
	Southern regions	150	Handbook of the USSR. Climate, Issue 32, Cloudiness and Atmospheric Phenomena, 1970.
		1000	
		1100	
		800	
		300	
	Naryn oblast	350	
		400	
		300	
		100	
Dangerous amount of precipitation expected in spring and summer months	Northern regions	more than 300mm	Catalogue of mudflow-prone rivers of Kazakhstan, Central Asia and Eastern Siberia. Volume 3, 1967
		more than 350mm	
		more than 300mm	
		more than 250mm	
	Southern regions	more than 400mm	
		more than 450mm	
		more than 400mm	
		more than 350mm	
	Naryn oblast	more than 300mm	
		more than 350mm	
		more than 300mm	
		more than 250mm	

Operational mudflow forecasts

Operational mudflow forecasts are made in the event of a dangerous situation forming in a mountain valley, sharply increasing the degree of mudflow threat. The reasons for such situations may be the following:

1) rapid growth of the volume of the outburst-prone lake;

2) the emergence of a new outburst-prone lake and a rapid increase in its volume;

3) a sharp decrease in the flow of a mountain stream due to its blockage by a rockfall or landslide higher up the valley;

4) the overflow of water through the lake dam due to its overflow;

5) heavy rainfall of high intensity.

Operational forecasts are made to warn the population about the danger and to take urgent measures to protect against the mudflow threat. The form of the operational forecast should reflect the dangerous situation, therefore it should indicate a number of parameters necessary for assessing the threat and developing recommendations for eliminating the danger or minimizing it, examples of forecasts are given in Tables 2 and 3.

Table 2. Operational mudflow forecasts for mountain lake outbursts

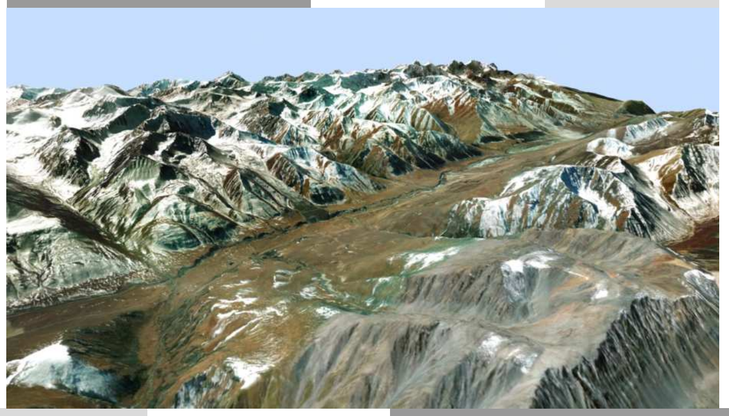
Place of manifestation				Time of manifestation		
mountain valley	mudflow , size	glacier	type of lake	A sharp increase in the volume of water in the lake	Dangerous accumulation of daily precipitatio	Dangerous rise in air temperature
Name	square km	Simple valley	moraine-glacial	Not really	more than 25mm	Average daily temperature more than 15 °C

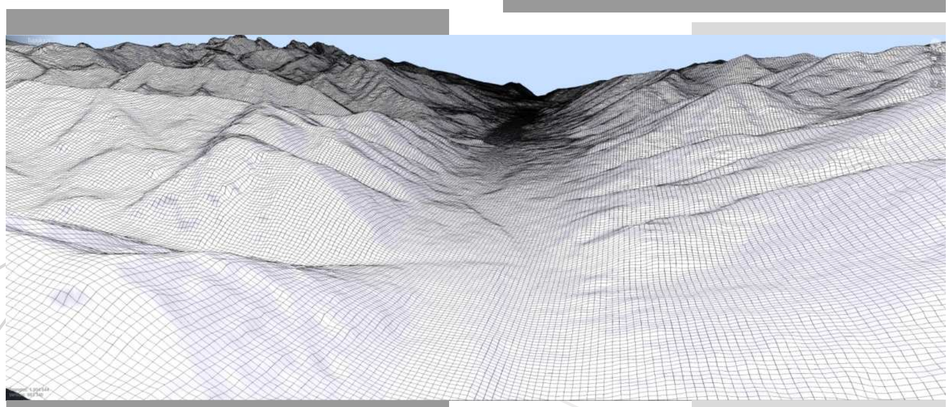
Table 3. Operational mudflow forecasts for downpours of dangerous intensity

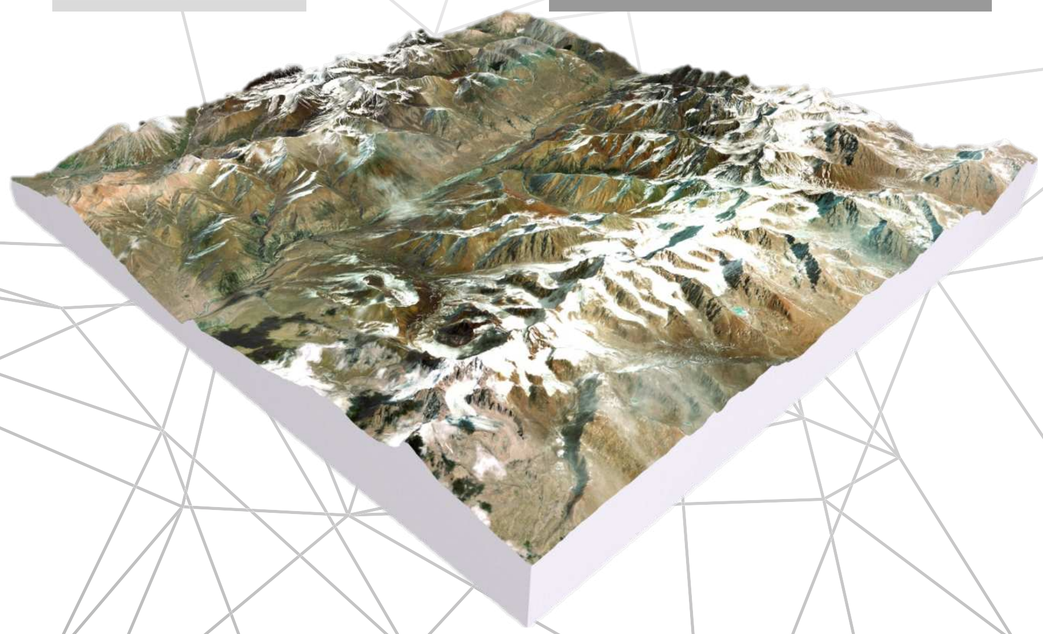
Place of manifestation		Time of manifestation	
mountain valley	mudflow collection	Dangerous accumulation of precipitation, for a downpour	Dangerous intensity of rainfall
Name	square km	30 mm/rainfall	1 mm/min

Local mudflow forecasts

Local mudflow forecasts are necessary for mudflow hazard assessment. The assessment should result in an answer to the question: "Will this section of the valley be affected by a mudflow or not?" The main resulting document of the local forecast for each mountain valley is a mudflow damage map.







CHAPTER III

MODERN APPROACHES TO MODELING AND FORECASTING MUDFLOWS

Modeling of mudflows and floods of torrential genesis along the Toguz-Bulak River (Cholpon - Ata)

Alos Digital Elevation Model was used as input parameters. Palsar and data from the meteorological station for local monitoring of mudflows and floods of the Department of Monitoring and Forecasting of Emergencies under the Ministry of Emergency Situations of the Kyrgyz Republic, located in the upper reaches of the Toguz-Bulak valley . The total area of the mudflow is 14.4 km^2 .

Figure 16 shows an example of the sub-basin breakdown required for modeling. The hydrograph is based on 10-minute data obtained from an automatic precipitation gauge , the data are presented in tabular form in Figure 21.

Figure 21. Toguz-Bulak drainage basin

The data shown in Figure 22 were obtained using the HYDRAS program for an automatic weather station.

HYDRAS 3 - Evaluation 16.08.2024

From	11.08.2024 20:00:00	Station	Cholpon-Ata
To	11.08.2024 23:59:59	Sensor	Precip. Accu NRT
		Unit	mm

10 Meas. values

Max.	13,59	11.08.2024 21:10:00	Mean	3,63
Min.	0,00	11.08.2024 20:10:00	Total	36,31

11.08.2024	20:10:00	0,00
11.08.2024	20:20:00	7,22
11.08.2024	20:30:00	2,84
11.08.2024	20:40:00	2,01
11.08.2024	20:50:00	4,42
11.08.2024	21:00:00	3,65
11.08.2024	21:10:00	13,59
11.08.2024	21:20:00	1,25
11.08.2024	21:30:00	1,33
11.08.2024	21:40:00	0,00

Figure 22. Data from the OTT rain gauge on the day of the mudflow

As a result of modeling, the following parameters were obtained for the lower reaches of the river, Figure 23. The peak flow (the area above the town of Cholpon-Ata) was 26.6 m^3 /s. In the middle part of the basin, the peak flow was 22.6 m^3 /s. In the area of the road and bridge across the town of Cholpon-Ata, the peak flow was 28.8 m^3 / s (Figure 24).

Project: Toguz Bulak Simulation Run: Run 1
Reach: Reach-1

Start of Run:	11Aug2024, 20:00	Basin Model:	Basin
End of Run:	11Aug2024, 21:30	Meteorologic Model:	Met 1
Compute Time:	17Aug2024, 18:41:22	Control Specifications:	Control 1

Volume Units: ○ MM ● 1000 M3

Computed Results

Peak Inflow:	49.4 (M3/S)	Date/Time of Peak Inflow	11Aug2024, 21:20
Peak Discharge:	26.6 (M3/S)	Date/Time of Peak Discharge:	11Aug2024, 21:30
Inflow Volume:	83.0 (1000 M3)	Discharge Volume:	26.6 (1000 M3)

Figure 23. Calculation of the flow rate in the area of the town of Cholpon-Ata

Date	Time	Total Inflow (M3/S)
11Aug2024	20:00	0.0
11Aug2024	20:10	0.0
11Aug2024	20:20	1.3
11Aug2024	20:30	1.5
11Aug2024	20:40	2.8
11Aug2024	20:50	6.1
11Aug2024	21:00	8.4
11Aug2024	21:10	19.7
11Aug2024	21:20	17.4
11Aug2024	21:30	28.8

Figure 24.
Change in flow rate
in the Toguz-Bulak River

For hydrodynamic modeling, the HEC-RAS program was used. The input parameters were a Digital Elevation Model built on the basis of UAV surveys, the accuracy of the Digital Elevation Model of the model was 1 m, and the hydrograph obtained as a result of hydrological modeling in the HEC-HMS program . 2D modeling was used for unsteady flow (unsteady flow).

Figure 25 shows the flood zone and flow height calculated for the hydrograph shown in Figure 24 using the HEC-RAS program .

Figure 25. Height of the flow along the Toguz-Bulak River

Modeling of mudflow-prone areas in Flow -R

Flow -R simulation (at a district scale) was used. Flow -R is used to simulate mass flow processes, mainly calibrated for extreme events in the Alps. For an explanation of the various model parameters, the user is referred to the full description of Flow -R in Horton et al . (2013) [30].

For modeling, a Digital Elevation Model was constructed based on UAV surveys; the optimal resolution of the Digital Elevation Model for modeling in this program was 3 m (Figure 22 A). Then, the affected zones were calibrated based on UAV survey data for all areas where mudflows were recorded (Figure 26 B, C). Based on the modeled calibrated zones, the input data for modeling were obtained: a simplified friction-limited model (SFLM) with a coverage angle of 8° and a maximum velocity of 15 m/s, a modified Holmgren (1994) direction algorithm, a simplified friction-limited model (SFLM) with a coverage angle of 10° and a maximum velocity of 15 m/s, a modified Holmgren (1994) direction algorithm [31, 32] with an exponent x=4 and a height modification dh =2 m, x=4. First, the mudflows that passed through the rivers in 2023 were modeled.

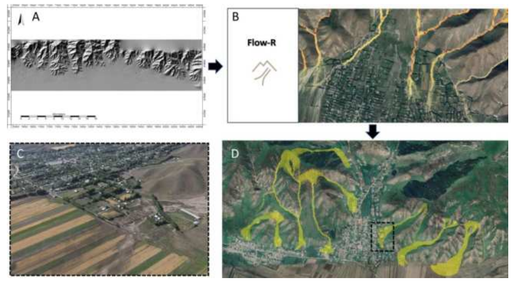


Figure 26. Modeling in Flow -R program

Modeling was also conducted across the entire area to identify susceptibility zones for potentially hazardous areas where future mudflows may occur, taking into account lithological and geomorphological features. The input parameters were the parameters obtained after calibration based on field data. Mudflows in these areas could cause significant damage and infrastructure losses. Potential flow locations are shown in Figure 27.

A very important factor in assessing the accuracy of the model is the comparison of the simulated zones of damage with the real ones, based on the traces of the past flows.

Figure 27. Potential mudflow hazard zones in the Tyup region

Modeling of glacial mudflows

Catastrophic mudflows and floods are the most dangerous processes in the Ala-Archa River basin (northern slope of the Kyrgyz Range), leading to serious destruction and even human casualties. In order to carry out measures to prevent or mitigate the negative consequences of these processes, it is necessary to conduct comprehensive studies of the conditions, factors and prerequisites for their passage, as well as modeling the mudflow process in order to identify the most critical, vulnerable zones. Mudflows caused by breakthroughs of high-mountain lakes with the subsequent formation of a powerful flood downstream of the valley are very likely to pass along the Ala-Archa River valley.

An example of modeling for the purpose of determining zones of possible damage by mudflows is modeling in the RAMMS program (Figure 28 B) of a possible breakthrough of Lake Aksai, for a volume of 200×10^3 m^3. Figure 28 A shows a view of the lake and the Aksai glacier (from which there were emissions from intraglacial reservoirs). In this valley there is a powerful mudflow center, which saturates the flow with loose debris.

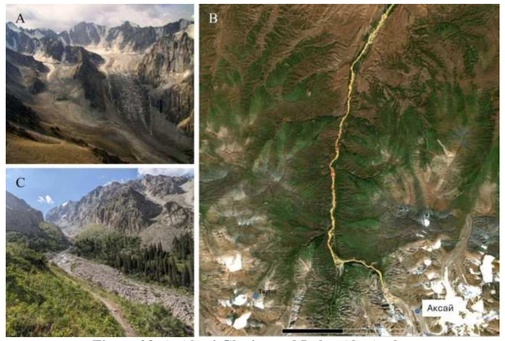


Figure 28. A. Aksai Glacier and Lake, Ala-Archa.
B. Damage zone calculated in the RAMMS program.
C. Mudflow Aksai

The most rational and cost-effective way to protect against hazardous flows in mountain and foothill zones is to select safe areas. Such areas are located outside the mudflow and flood damage zones. However, the area of safe areas in these zones is small, so it becomes necessary to use areas located in the zone of action of hazardous flows for housing and outbuildings. In these cases, it is necessary to provide protection from them: 1) from mudflows by constructing mudflow reservoirs with powerful mudflow -retaining dams and mudflow-directing dams; 2) from sediment flows and floods by constructing spillway and water-directing canals, as well as reservoirs. Thus, to pass floods along the Ala-Archa River, it is necessary to increase the capacity of its channel to 50-70 m3 / sec by embanking and strengthening the banks, otherwise the coastal areas along the Ala-Archa River will be flooded (according to the modeling results). When a breakthrough flow is formed, a flood with a density of up to 1.1 g/cm3 will reach Bishkek , such a sediment flow can damage coastal infrastructure, as well as bridges. Considering that for many villages located near Bishkek, bridges are a critical infrastructure facility, it is necessary first of all to strengthen the bridges and clean under them to increase their throughput capacity.

The simulation uses real parameters of past breakthroughs, as shown in Figure 29, which shows an example of the Tez-tor Lake breakthrough in 2012, which damaged the Ala-Archa Nature Park, but the flood flow did not damage the city of Bishkek, since the main mudflow mass was discharged on the Adygene alluvial fan . Such cases help to better understand the mechanics of the process, especially the reverse transformation of the mudflow back into a flood.

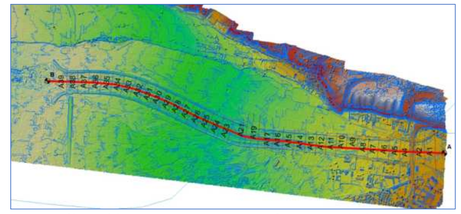
Figure 29. Lake Te Tor outburst in 2012

Results of flood modeling for the Kara-Darya River section

To assess mudflow and flood activity on the Kara-Darya River, a comprehensive assessment of conditions and analysis of aerial photography data, as well as hydrometeorological information and stock reports, was carried out.

Hydrodynamic modeling was used to calculate the potential damage zone using field research data. This study used a combination of classical methods, including riverbed profiling. The study used a profiling method based on a constructed Digital Terrain Model with an accuracy of 20 cm. In the specialized Global Mapper program, transverse riverbed profiles were constructed, which are necessary for calculating the capacity of mudflow and flood flow.

Engineering and geological assessment of geomorphological and hydrogeological conditions of the area was carried out for the purpose of studying and analyzing the development of mudflow and flood processes on the Kara-Darya River in the area of coastal protection works in the Uzgen region of Osh oblast.



Profiling of the Kara-Darya River Based on a Digital Elevation Model

Modeling in HEC - RAS program

To calculate the flood wave height, 1D modeling and “ steady-state” were used in the HEC - RAS program. flow analyses ”, that is, a flow with a steady speed, the so-called steady flow, was modeled. In some areas, there are channel outlets beyond the area (channel diversion area, in the middle of the channel under consideration) in connection with this, according to the model, water outlets are observed on the back side of the wall.

For the calculations, the data given in the Table for the flow of 1%, 2% and 5% probability were used: 1%, recurrence once every 100 years, 2% - recurrence once every 50 years and 5% - recurrence once every 20 years.

Table. Parameters of maximum flow rates on the Kara-Darya River*

River	Observation period	A max , m^3 / s	Runoff layers, mm	year	Q sr	Runoff module, l/sec from 1 km^2	Maximum water flow rates of floods of varying severity, m^3 / s				
							1%	2%	3%	4%	5%
Karadarya , Kampyrravat village	1915-62	1080	468	1936	541	43.6	1050	970	870	794	655

Figure 30. Simulated flow calculated for 2% availability

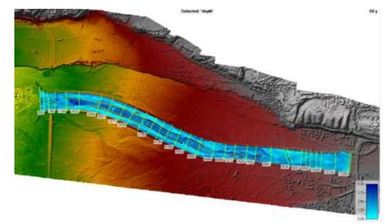


Figure 30 shows a flow calculated for 970 m^3 / s (2% provision, the flow values given in the source “Surface Water Resources” exceed the parameters calculated in the technical document, due to the absence of a provision curve and calculation methods, the data given in the aforementioned book were used for modeling.

**Surface Water Resources. Volume 14. Central Asia. Issue 1. Syr Darya River Basin. 1969. p.184*

Figure 31 shows cross-section #11268, in this section with a flow rate of 970 m^3 / s there is an overflow and a 70 cm excess of the shoreline on the right side of the Kara-Darya River. With a flow rate of 655 m^3 / s there is an excess of the shoreline by 35 centimeters.

Figure 31. Cross-section No. 11268

On the section with profile No. 6486 shown in Figure 32 there is a temporary branch which will be closed after the work is completed. At the moment the same amount of water flows through this branch as through the central channel.

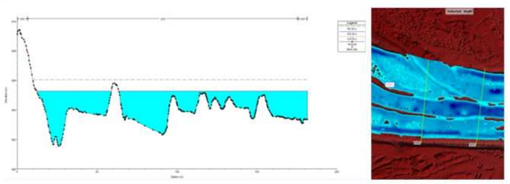


Figure 32. Cross-section No. 6486

In the area between profiles 8481 and 7930, in the area of the bend of the riverbed, there is an impact on the protective wall; in this area, additional reinforcement is required to reduce the level of impact on the wall.

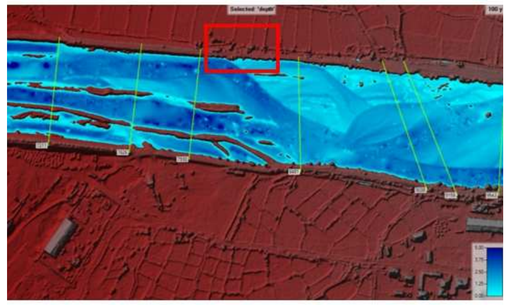


Figure 33. Area of possible deformation of the protective wall

Figure 34 shows a velocity distribution map of the channel, with a maximum velocity of 5.5 m/s in some sections. The slope in this section is 0.01 .

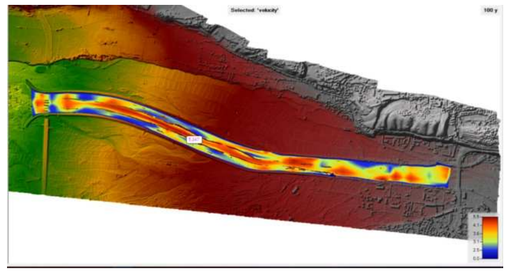


Figure 34. Flow velocity in the area of the conducted simulation

Figure 35 shows the simulated flow calculated for 1% probability with flow direction vectors throughout the entire flow.

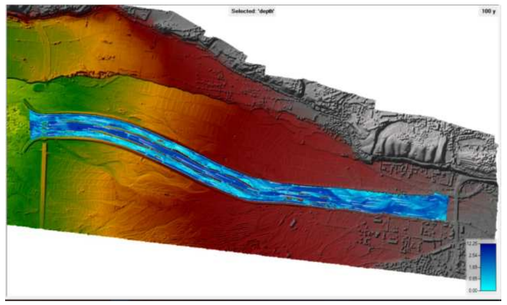


Figure 35. Flow calculated for 1% security

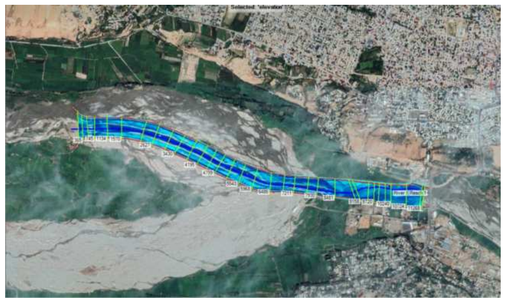
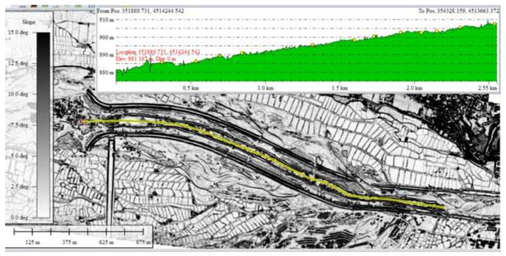
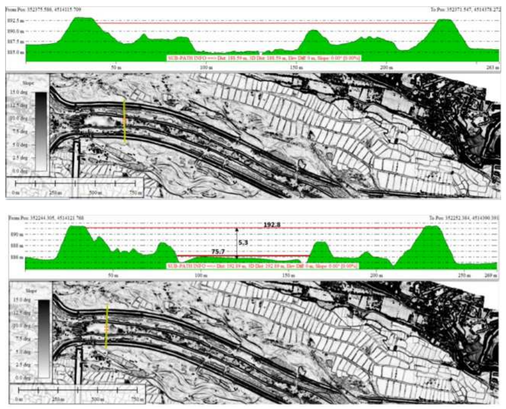


Figure 36. Flow calculated for 1% security (Google Earth)



Longitudinal profile of the site

The slope in the surveyed area is 0.01 or 10 ‰ (27 m height difference over 2553 m).



MUDFLOWS THREATEN THE CITY OF CHOLPON-ATA

As a result of intense heavy rainfall in the amount of 10 mm on September 20, 2023 within 40 minutes (data from the meteorological station on precipitation that fell on September 20, 2023 in the town of Cholpon-Ata), from the mudflow basins "Toguz-Bulak" and "Char-Kuduk" (catchment area - 1257 hectares), a mudflow was formed (according to the DKS of the Ministry of Emergency Situations of the Kyrgyz Republic, the flow rate was 19.5 m^3 / sec), which flooded the courtyards of 36 residential buildings, 2 bank buildings, 6 cafes, 2 stores, the territory of the Rukh-Ordo cultural center, the roadbed of the Balykchy-Cholpon-Ata-Karakol highway, and also destroyed a drinking water pipeline about 8 m long, a pedestrian bridge about 13 m long along the highway.

Figure 37. Mudflow basin

A low-density mudflow transformed into a powerful sediment-water flow as it moved down the slope, which exceeded the capacity of the mudflow channel. The flow carried large stones and woody material (branches, dry bushes, tree fragments, etc.) of various sizes (up to 25 cm in diameter), which resulted in the destruction of the stone sides and the bottom of the channel and led to an erosion process from PK3+00 to PK12+97. Solid sediments formed jams on 8 bridge crossings above the Balykchy-Cholpon-Ata-Karakol highway. As a result of the jams, the mudflow overflowed from the channel bed and flooded the adjacent territories.

Figure 38. Consequences of a mudflow in the town of Cholpon-Ata

At the time of the survey, a subsidence of the left support of the pedestrian bridge was observed, the coordinates of this bridge are: E: 77.101029°; N: 42.655738°. Below the highway, in the channel bed, there are areas of overgrown trees and bushes, which reduce the free passage of mudflows along the channel (Figure 38). During the survey, the method of planned flight was used using the Matrice 300 RTK drone to obtain information about the situation and an orthophotomap of the area. Based on the aerial photography data, a digital terrain model was built , on the basis of which hydrodynamic modeling of the mechanism of movement and transformation of the mudflow was carried out. Flood zones were calculated and objects located within these zones were identified. Below in Figure 39 are the results of the modeling carried out in the specialized Flow - R program .

The results of the modeling show which parts of the city are at risk of flooding and which houses have been and will probably be affected by the flow if protective measures are not taken to reduce the danger. The modeling data allowed us to develop specific practical recommendations:

- carry out emergency recovery work on the mudflow channel on the section from PK 3+00 to PK 12+97;
- restoration of the pedestrian bridge supports, cleaning of the bridge crossings, bank protection works according to a special project over a length of about 700 meters, taking into account the increased mudflow flow;
- dismantle the sewer collector that prevents the flow of flood waters below the bridge Balykchy-Cholpon-Ata-Karakol highway ;

to carry out coastal protection works with the extension of the left and right sides to a height of 2 meters , with a length of about 50 m, on the section of the pedestrian bridge below the road.

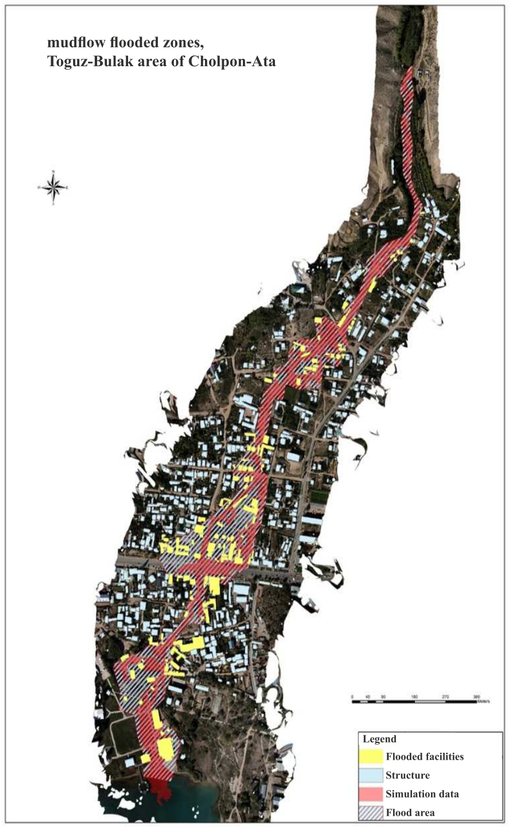
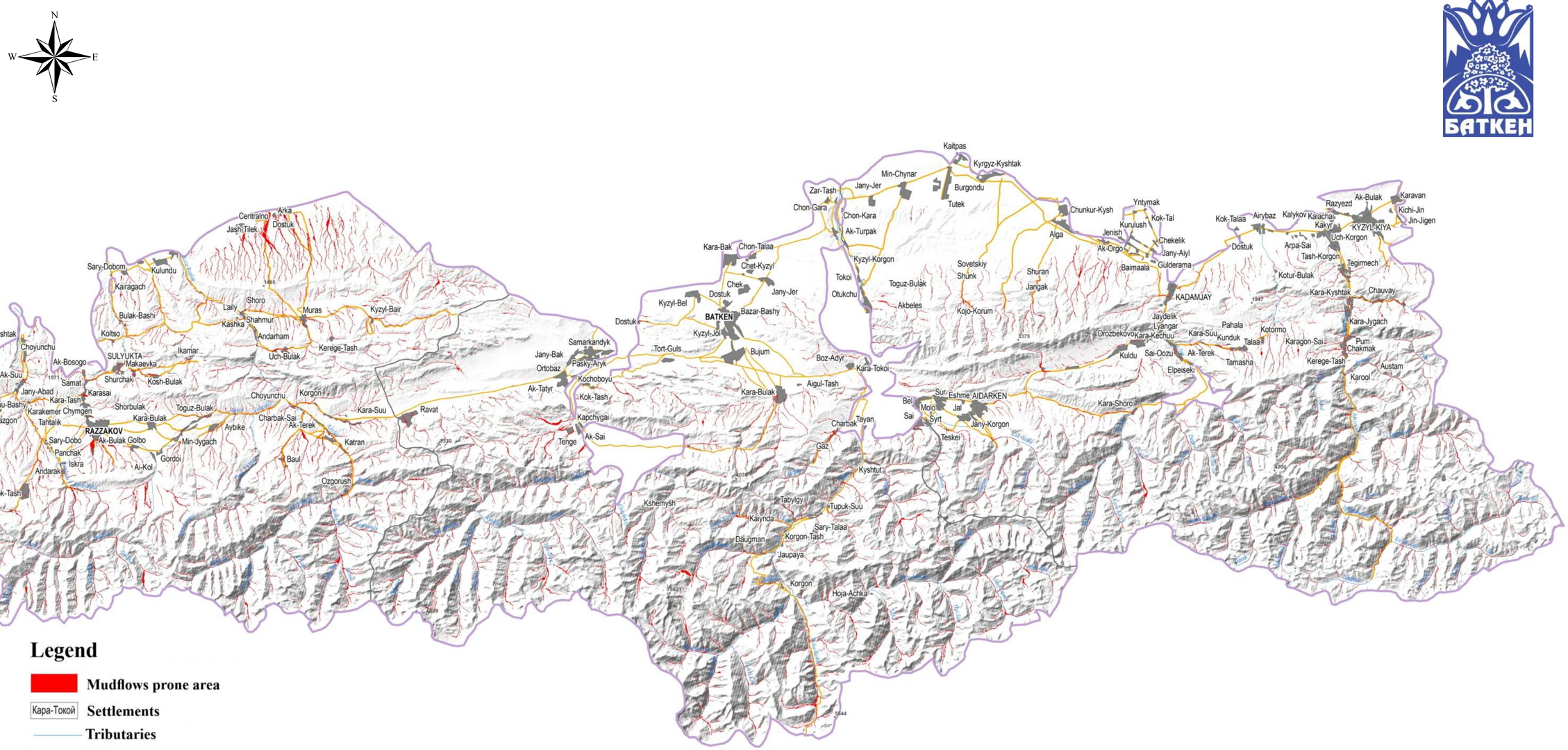


Figure 39. Results of mudflow modeling for the town of Cholpon-Ata

CHAPTER IV

MUDFLOW AND FLOOD HAZARD BY REGION

MAP OF MUDFLOW SUSCEPTIBILITY
BATKEN OBLAST



Legend

- Mudflows prone area
- Settlements (Кара-Токой)
- Tributaries
- Rivers
- Boundaries

Batken oblast was formed in 1999, occupies the southwestern part of the Kyrgyz Republic with an area of 17,048 km² and borders on the north with the Republic of Tajikistan and the Republic of Uzbekistan, on the south and west - with the Republic of Tajikistan, on the east and partly in the south - with Osh oblast Kyrgyz Republic.

The territory of the region is divided into 3 administrative-territorial regions: Batken, Kadamzhai, Leilek.
There are 6 towns in the region: Kyzyl-Kiya, Batken, Sulukta - of regional subordination, Razzakov, Aidarken, Kadamzhai of district subordination, 1 urban-type settlement, 28 rural districts and 199 rural settlements. Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023.

The total permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 583.3 thousand people, including the Batken region 102.1 thousand people, the Kadamjai region 209.9 thousand people, the Leilek region 153.7 thousand people, the city of Kyzyl-Kiya 62.7 thousand people; the town of Sulukta 25.4 thousand people; the city of Batken 29.6 thousand people, the city of Razzakov 35.3 thousand people. The average population density is 34.2 people per 1 km².

The administrative center of the region is the town of Batken. The permanent population of the town of Batken according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 29.6 thousand people (urban population 17.0 thousand people, rural population 12.0 thousand people).

In Batken oblast, the areas of glacial mudflow formation include territories occupied by modern glaciation and moraines. In relief, they are expressed by rocky mountain ridges, cirques, and corries. In this area, there are powerful layers of watered moraines, the territory is characterized by large surface slopes. The lower boundary of the zone passes at an altitude of 3-3.5 thousand meters. In this area, favorable conditions are created for the formation of large volumes of melted snow and glacial waters, the formation of high-mountain breakthrough lakes.

The most dangerous valleys with the possible occurrence of large floods, including those caused by outburst-hazardous lakes, are Isfayram-Sai, Ak-Suu-Shakhimardan, Sokh, Karavshin-Isfara, Leilek-Ak-Suu. The most probable period for the passage of floods resulting from the outburst of high-mountain lakes is July-August (early September).

The area of formation of snow-rain mudflows occupies the territories of mid-mountains, partly highlands, which do not have modern glaciation, with remnants of ancient moraines, a large accumulation of mudflow-forming deposits, and the development of permafrost processes. The cause of the formation of mudflows is the melting of seasonal snow, heavy rains, and the presence of moist mudflow-forming deposits.

The mudflow-hazardous period begins in March and covers the entire warm part of the year, including September. The most probable time for mudflows and floods (April-June) is associated with periods of snowmelt and heavy rainfall.

The most dangerous valleys are Sumbula, Kara-Suu, Dzhangakty, Karakol, Kara-Bulak, Gavian, Kyok-Talaa, Nichke-Suu (Kyzyl-Kiya), Abshir-Sai.

The area where mudflows form is foothills, low mountains, alluvial fans dissected by the channels of temporary and permanent watercourses, composed of modern loose debris deposits.

The main reason for the formation of mudflows in this zone is the occurrence of intense precipitation (from 30 to 80 mm/day), and in the spring, the melting of seasonal snow cover.

REGIONS OF BATKEN OBLAST
BATKEN REGION

The Batken region covers an area of 5948 km² . The total permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 102.1 thousand people, the average population density is 17.2 people per 1 km² .

On the territory of the region there is a town of regional significance Batken, which is the administrative center of the region with a permanent population of 29.6 thousand people (including villages) as of January 1, 2024 and 47 rural settlements belonging to 9 rural regions: Darin (9 settlements), Tert- Gul (5), Kara-Bak (7), Kara- Bulak (2), Kyshtut (6), Samarkandek (4), Ak-Sai (6), Ak - Tatyr (3), Suu-Bashyn (5). According to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023, to suspend the administrative-territorial reform until the completion of the delimitation and demarcation of the state border.

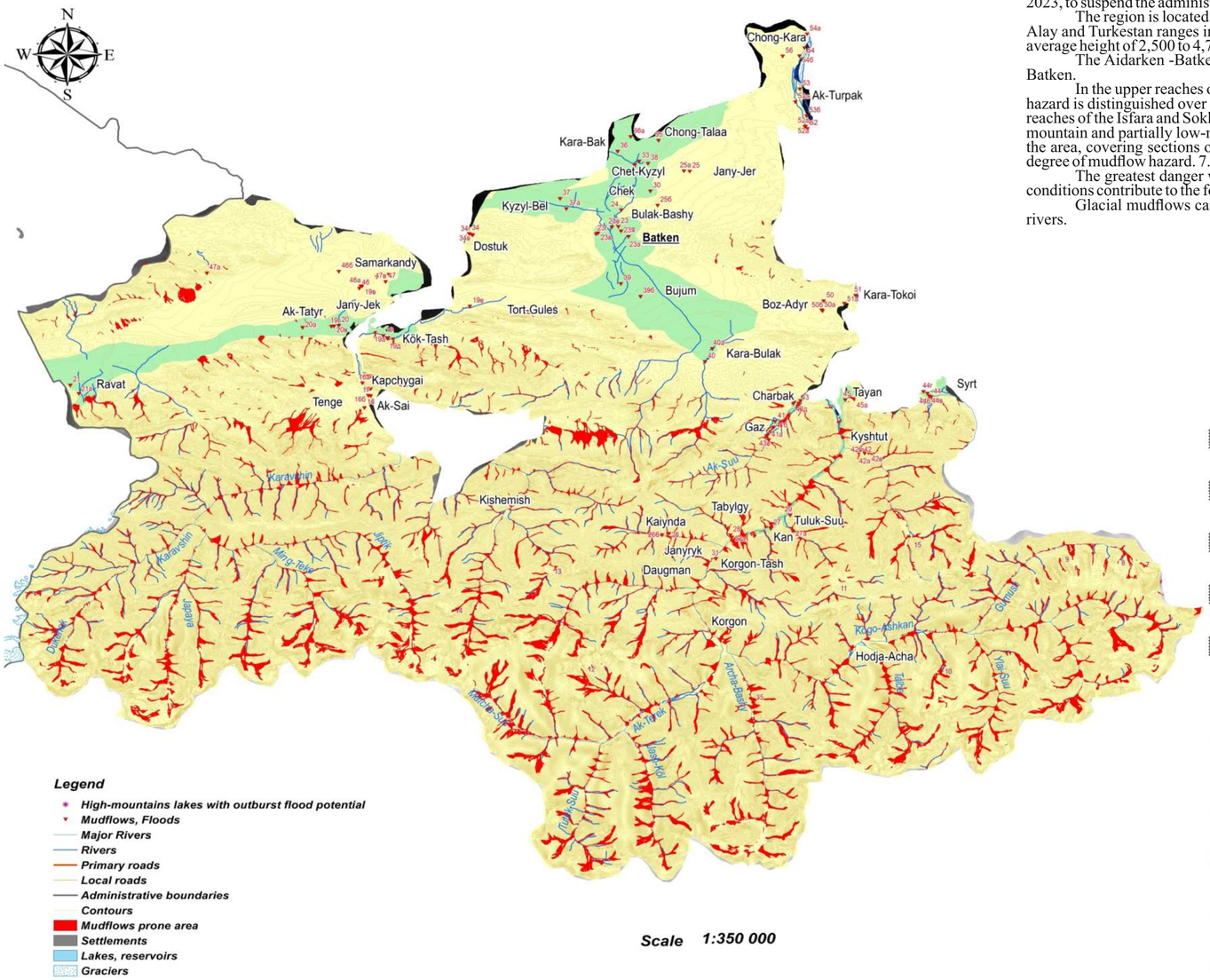
The region is located in the low- mountain Batken depression, which passes into the Fergana Valley, and is bounded by the Alay and Turkestan ranges in the south. The Adygine-Too , Daud, Kek -Bel, Kara-Bel, Akun- Too and Tokhtabuz ranges with an average height of 2,500 to 4,700 m are located within the region. The main rivers of the region are Sokh and Isfara.

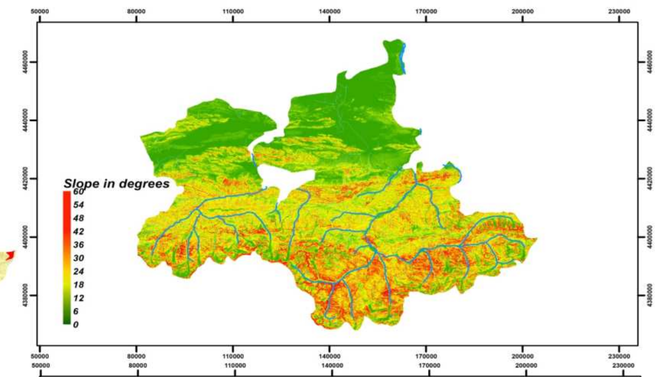
The Aidarken -Batken and Osh-Batken-Razzakov highways pass through the region . There is an airport in the town of Batken.

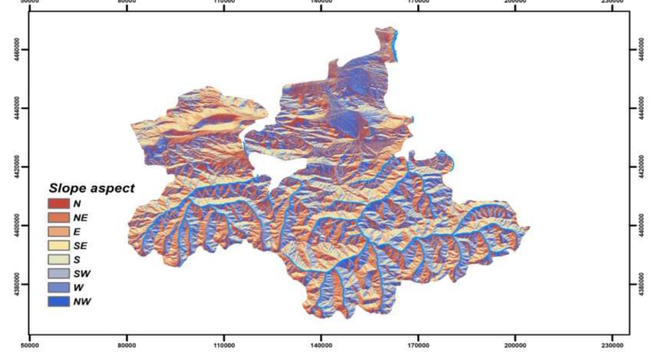
In the upper reaches of the Kyshtut River , a right-bank tributary of the Sokh River, a section of the first degree of mudflow hazard is distinguished over an area of 87 km² . About 10% of the region's area, covering the high-mountain sections of the upper reaches of the Isfara and Sokh Rivers, are classified as the second degree of mudflow hazard . Up to 54% of the region's area in mid-mountain and partially low-mountain zones are represented by the territory of the third degree of mudflow hazard. About 27% of the area, covering sections of mountain structures at various levels of their tiering , are designated as the territory of the fourth degree of mudflow hazard. 7.5% of the region's area, excluding river beds and canals, are not mudflow hazard.

The greatest danger will be posed by mudflows of torrential genesis in the foothills of the Alai Range, where geological conditions contribute to the formation of mudflows.

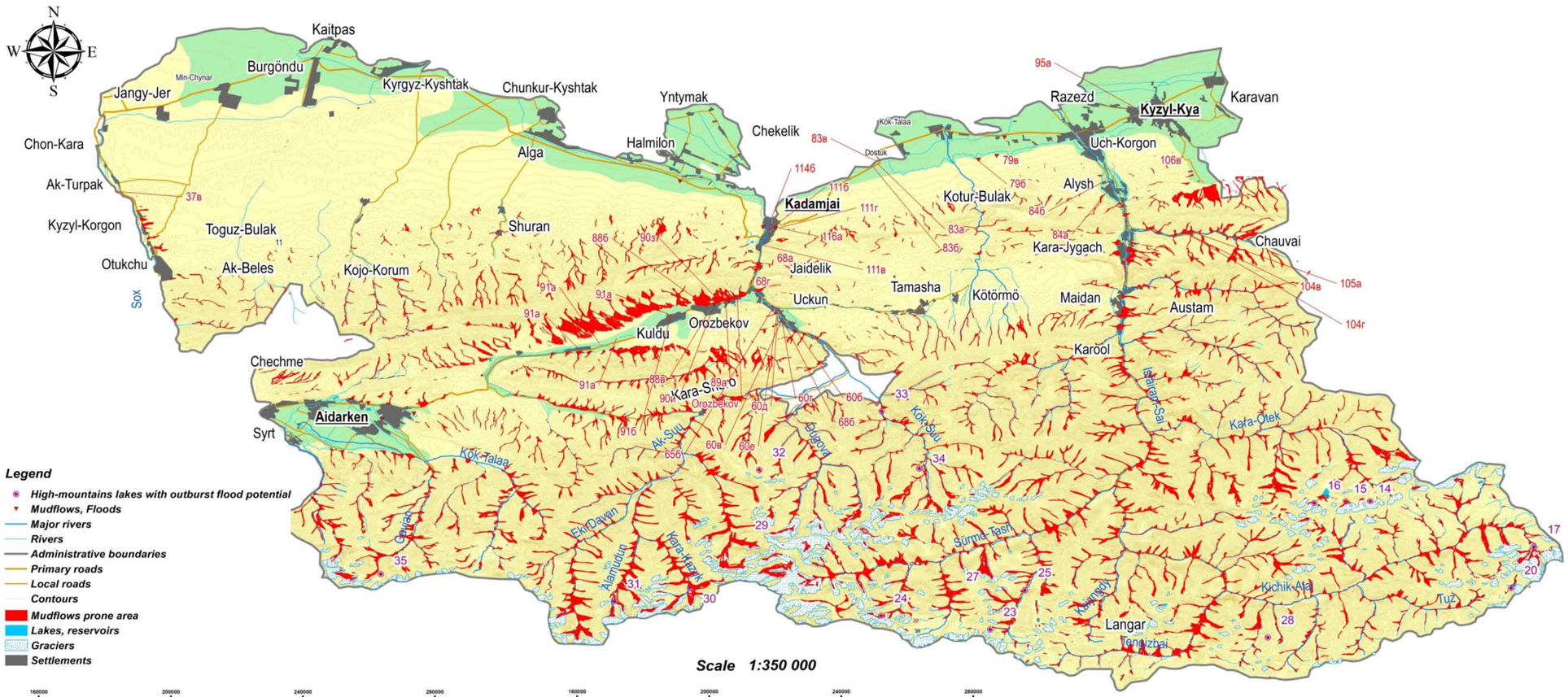
Glacial mudflows can occur in the event of a breakthrough of high-mountain lakes in the valleys of the Sokh and Isfara rivers.

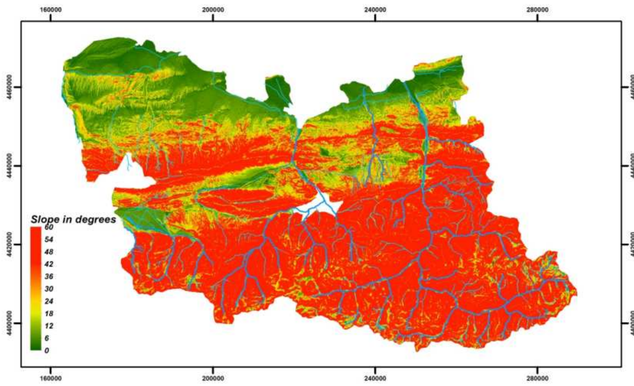


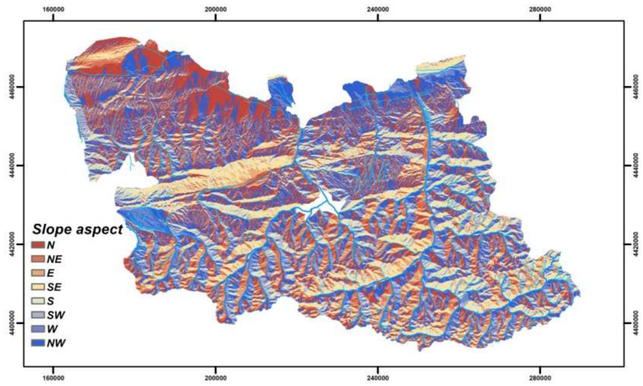




REGIONS OF BATKEN OBLAST
KADAMJAI REGION







Kadamjai region was formed in 1938. The region covers an area of 6146 km² . The permanent population according to the National Statistical Committee as of January 1, 2024 is 209.9 thousand people (urban - 26.7 thousand people, rural - 183.2 thousand people). The average population density is 34.0 people per 1 km² .

On the territory of the region there is a town of regional significance Kyzyl-Kiya with a population of 62.7 thousand people (including villages), 2 towns of district significance - Kadamzhai (including villages) - 15.4 thousand people and Aidarken - 14.0 thousand people according to the National Statistical Committee as of January 1, 2024 and 111 rural settlements belonging to 8 rural regions: Uch-Korgon (unification of the rural districts of Chauvai and Uch-Korgon (except for the villages of Kakyr , Kalacha and Razyezd) (9 settlements); A. Masaliev (annexation of the villages of Kakyr , Kalacha and Razyezd of the Uchkorgon rural district) (11); Maidan, (unification of the rural districts of Ayrybaz and Maidan) (19); Moldo Niyaz (unification of the rural district of Alga except for the village of Shak-Shak), the rural district of Kyrgyz- Kyshtak and the Council (15); Orozbekov (unification of the rural areas of Orozbekov and Kotormo (17); leave the rural areas of Birlik (except for the Airport and Kichi-Aidarken section) (12); Ak- Turpak (15); Ishak- Polotkhan (13) and the town of Kadamjai .

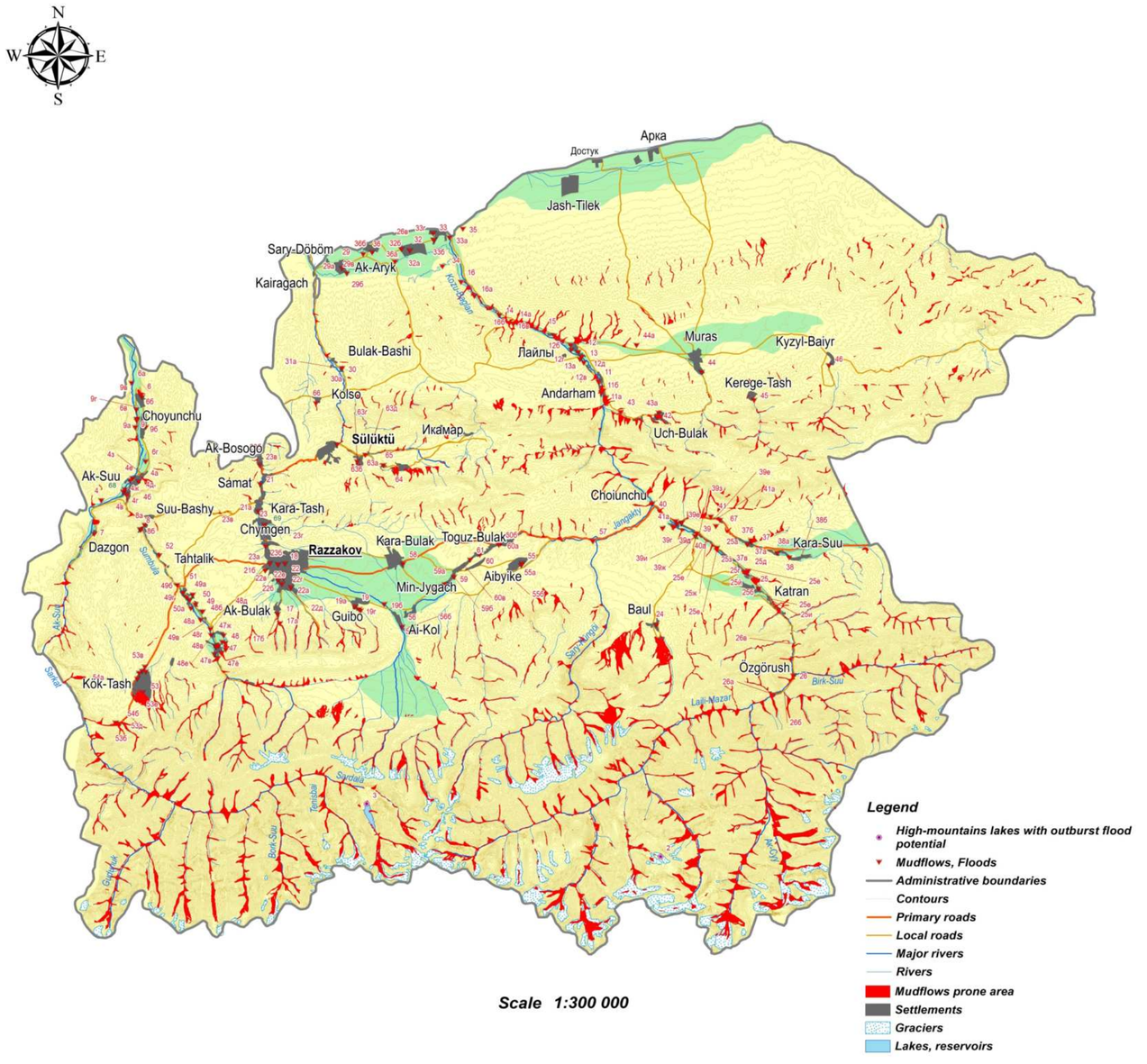
Include in the composition the city of Ok Aidarken , the Aeroport section and the village of Kichi Aidarken, Birlik rural district, Shash-Shak village , Alga rural district. Data according to Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

The administrative center of the region is the city of Kadamzhai with a permanent population of 15.4 thousand people (including villages) according to the National Statistical Committee as of January 1, 2024.

The Kadamjai region occupies the mid-mountain depression of Shakhimardan - Isfayram (the absolute height of the bottom of the depression is 1100-2700 m), bordering the Fergana Valley in the north, and limited by the Alay Range in the south (average height 4500 m, absolute - 5539 m). Inside the region are the Katyrang-Too , Teskey , Kuruk -Sai, Tekesekirdi -Bel, Kollektorsky and Yaruptus ranges with an average height of 3000 to 4400 m above sea level. The valley part is represented by river terraces, a foothill train. The main rivers are Isfayram -Sai and Shakhimardan.

11% of the area of the region under study, covering high-mountain sections of the Kichik - Alai ridge, are classified as the territory with the second degree of mudflow hazard . About 54% of the region's area, covering mid- and low-mountain relief tiers, as well as often valley sections, are characterized by the third degree of mudflow hazard. Up to 32% of the region are represented by high, mid- and low-mountain relief tiers, have the fourth degree of mudflow hazard. 7% of the region's area, excluding river beds and canals, are not mudflow hazard.

REGIONS OF BATKEN OBLAST
LEILEK REGION



Legend

- *High-mountains lakes with outburst flood potential*
- *Mudflows, Floods*
- *Administrative boundaries*
- *Contours*
- *Primary roads*
- *Local roads*
- *Major rivers*
- *Rivers*
- *Mudflows prone area*
- *Settlements*
- *Graciers*
- *Lakes, reservoirs*

Scale 1:300 000

Leilek region was formed in 1928. The district covers an area of 4653 km² . The total permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 153.7 thousand people, the urban population is 35.3 thousand people, the rural population is 118, 4 thousand people. The average population density is 33.0 people per 1 km² .

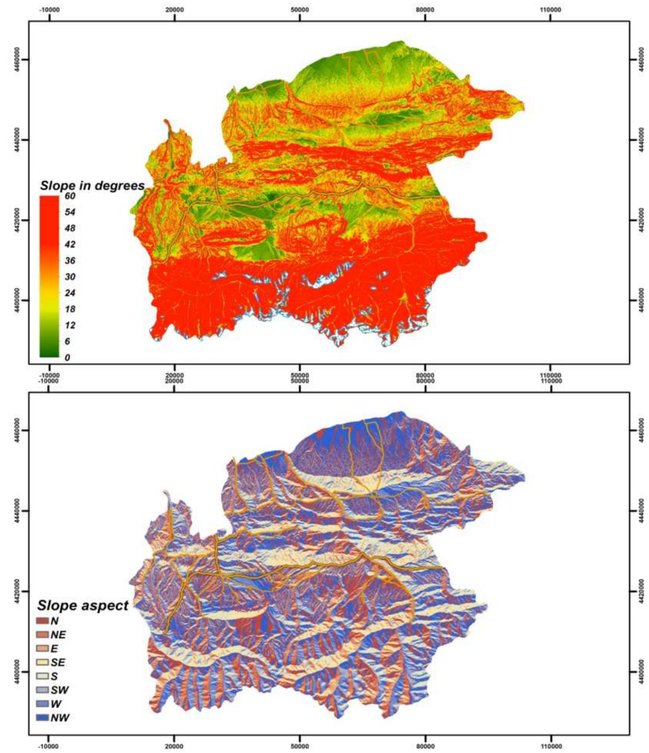
The administrative center of the region is Razzakov, population - 35.3 thousand people (including villages within the town of Razzakov). The city includes 6 villages: Golbo , Samat , Chimgen , Taylan , Ak-Bosogo (Myrza-Patcha), Ai-Bulak.

On the territory of the region there is a town of regional significance Sulukta (area 18 km²) with a permanent population of 25.4 thousand people, including Vostochny - 10.7 thousand people, and the village of Koltso - 0.6 thousand people).

There are 41 rural settlements in the region, belonging to 9 rural regions: Ak- Suu (5 settlements), Beshkent (5), Ken- Taala (Margun) (4), Jany-Djer (3), Leilek (5), Katran (3), Kulundu (6), Sumbul (4), Toguz-Bulak (6). According to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023, suspend the administrative-territorial reform until the completion of the delimitation and demarcation of the state border.

Leilek region occupies the low-mountain Isfara- Isfana depression (the absolute height of the bottom of the depression is 900-1600 m), bordering the Fergana Valley to the north.
From the south, the region is bounded by the Turkestan Range with an average height of 4400 m (the highest point is Pyramidal Peak – 5509 m).
Inside the region there are the Beli- Synyk , Almaly , Kyrk-Karakchy , Kekche-Too and Ak-Tash ranges with an average height of 1200 to 3800 m. The main rivers of the region are Ak- Suu , Sumbula , Kozy- Baghlan and Isfana .

Up to 13% of the region's area is occupied by high-mountain areas with the first degree of mudflow hazard . About 11.5% is classified as the second degree of mudflow hazard . Up to 7% in the mid- and low-mountain relief layers are characterized by the development of the third degree of mudflow hazard . About 6% of the territory, covering low-mountain areas, as well as part of the valley areas, is classified as the territory with the fourth degree of mudflow hazard .
The most dangerous are the valleys of the Leilek and Ak- Suu rivers , in the upper reaches of which there are lakes with a risk of outbursts .



MUDFLOW SUSCEPTIBILITY MAP
JALAL-ABAD OBLAST

Jalal-Abad oblast was formed in 1990, is located in the southwest of the Kyrgyz Republic, occupies an area of 32418 km^2 , in the south, southwest borders with the Republic of Uzbekistan, in the north - with Talas oblast , in the east – with Naryn oblast and in the southeast – with Osh oblast Kyrgyz Republic.

The territory of the region is divided into 8 administrative-territorial districts: Aksy, Ala-Bukin, Bazar-Korgon, Nooken, Suzak, Toguz-Toro, Toktogul, Chatkal

There are 9 cities in the region, including those under regional subordination: Jalal-Abad, Tash-Kumyr, Mailuu-Suu, Kara-Kul, 5 cities under district subordination: Kerben, Kochkor-Ata, Kok-Zhangak Toktogul, Shamaldy-Sai, 4 urban-type settlements, 38 rural areas and 286 rural settlements. Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

The total permanent population of the region, according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024, is 1,335.8 thousand people: of which 302.5 thousand people are urban, 1,008.5 thousand people are rural; Aksy region - 142.5 thousand people; Ala-Buka region - 118.3 thousand people; Bazar-Korgon region - 197.3 thousand people; Nooken region - 155.1 thousand people; Suzak region - 332.3 thousand people, Toguz-Toro region - 28.2 thousand people; Toktogul region - 107.7 thousand people; Chatkal region - 30.8 thousand people; Jalal-Abad 10.6 thousand people, Kara-Kul 27.8 thousand people; Mailuu-Suu towns 29.6 thousand people; Tash-Kumyr 26.1 thousand people. The average population density in the region as a whole is 41.2 people per 1 km2 of area.

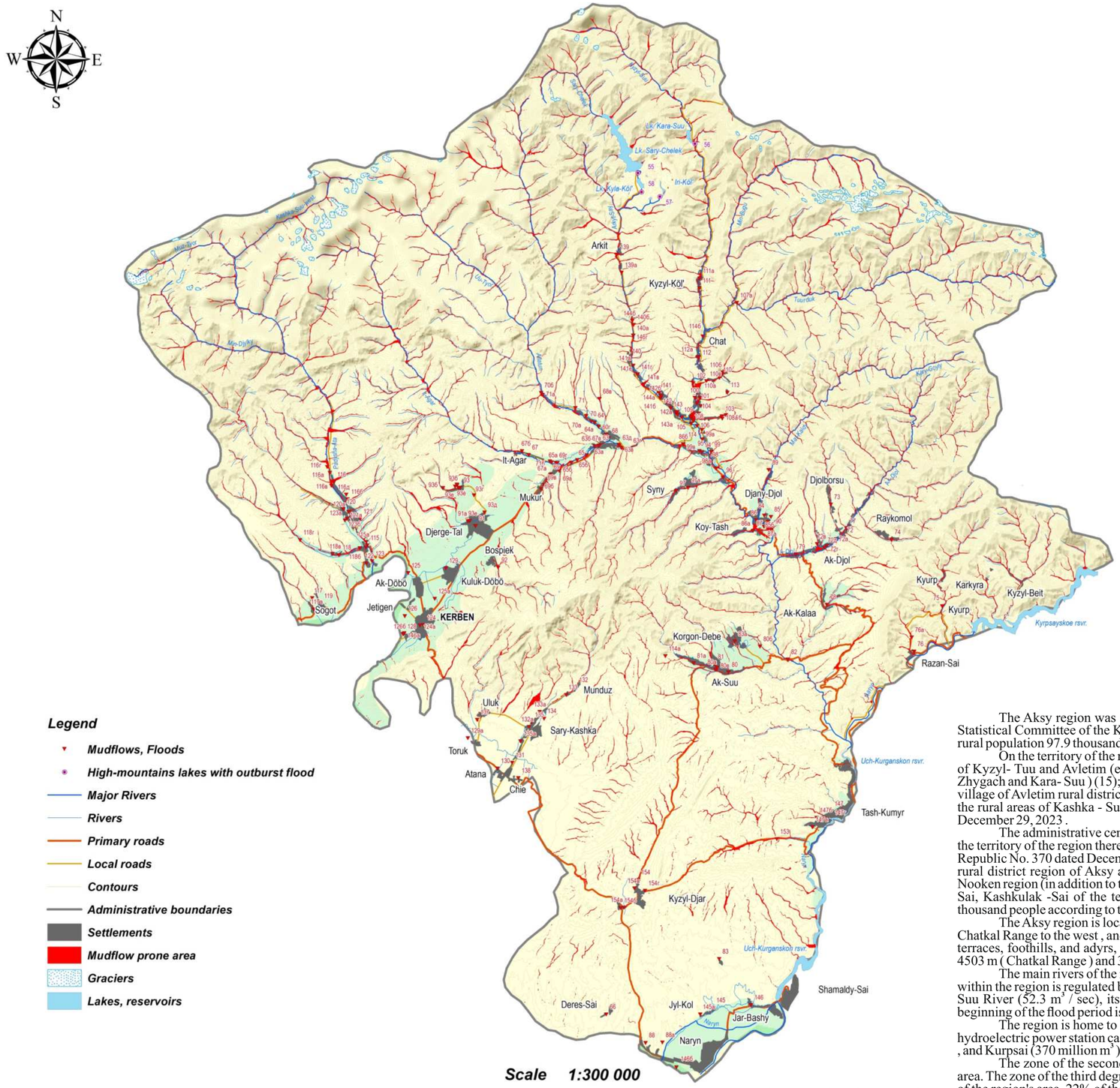
The administrative center of the region is Jalal-Abad (according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023, the rural district of Tash-Bulak, the villages of Domor, Ladan-Kara, Masadan and Yrys of the rural district of Yrys, the village of Choko-Dobo and Prigorodnoye of the rural district of Barpy of the Suzak region are annexed to the city). with a permanent population of 174.0 thousand people (including villages) according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

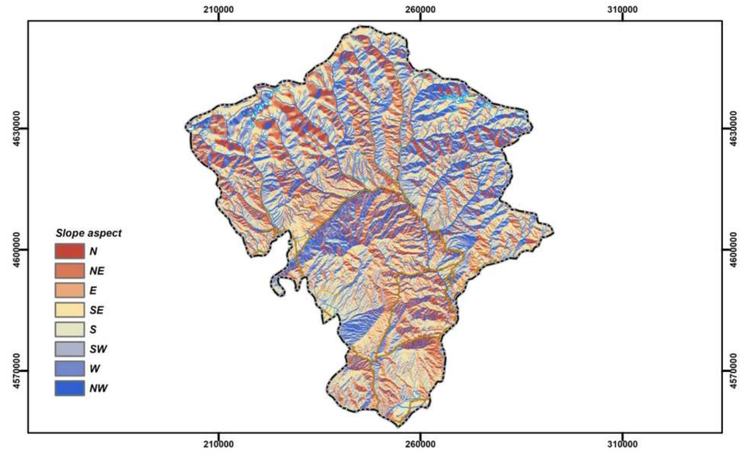
In Jalal-Abad oblast, areas of glacial mudflow formation include territories occupied by modern glaciation and moraines in large mountain valleys. The lower boundary of the zone passes at an altitude of about 3-3.5 thousand meters. In this area, favorable conditions are created for the formation of large volumes of melted snow and glacial waters, the formation of high-mountain outburst-hazardous lakes.

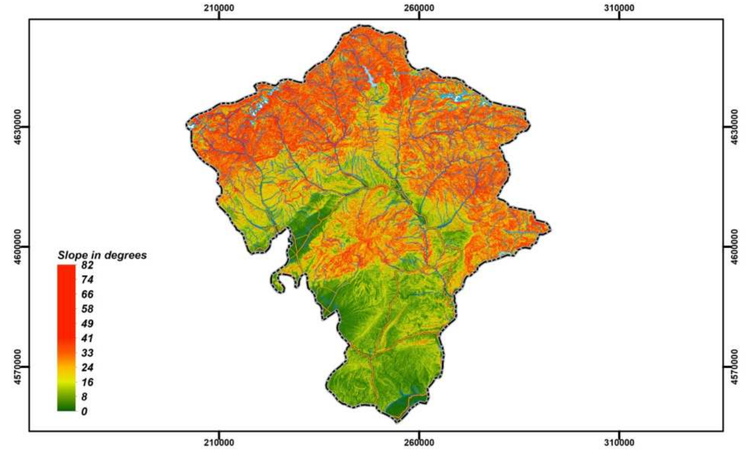
Mudflows in this zone can be caused by high-mountain lake breakthroughs, heavy rainfall, and active melting of snow cover in April-June. Mudflows formed in this zone can cause floods along the rivers: Gava-Sai, Sumsar, Kasan-Sai, Padysha-Ata, Kek-Art, Kara-Unkyur, Mailuu-Suu, Uzun-Akhmat. The most likely period for floods to occur as a result of high-mountain lake breakthroughs is July-August, early September.

The area of formation of snow and rain mudflows occupies the territory of mid-mountains, partly highlands, which do not have modern glaciation, with remnants of ancient moraines, a large accumulation of mudflow-forming sediments. The formation of alluvial mudflows of storm origin is most likely in the valleys of the foothill zone of the interfluves Kara-Suu - Naryn, Naryn-Mailuu-Suu, Mailuu-Suu-Kara-Unkyur, Kara-Unkyur-Kek-Art, Kek-Art-Changet.

Regions of Jalal-Abad oblast
Aksy region







Legend

- Mudflows, Floods
- High-mountains lakes with outburst flood
- Major Rivers
- Rivers
- Primary roads
- Local roads
- Contours
- Administrative boundaries
- Settlements
- Mudflow prone area
- Graciers
- Lakes, reservoirs

Scale 1:300 000

The Aksy region was formed in 1935 and covers an area of 4,578 km^2 . The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 142.6 thousand people (urban population 44.7 thousand people, rural population 97.9 thousand people), the average population density is 31.1 people per 1 km^2 .

On the territory of the region there are 56 rural settlements belonging to 6 rural regions: Sary - Chelek (union of the rural districts of Kyzyl- Tuu and Avletim (except for the village of Deres -Sai) (12 settlements); Kara-Kamysh (union of the rural district of Kara-Zhygach and Kara- Suu) (15); Ak-Zhol (union rural district Ak- Zhol and Zhany - Zhol (except for the village of Ters) (12) ; Deres -Sai village of Avletim rural district and Tes village of Zhany-Zhol rural district) (7); Kosh-Dobo rural district (leave unchanged) (9) Annex the rural areas of Kashka - Suu and Zherge -Tal. Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

The administrative center of the region is Kerben with a permanent population of 44.7 thousand people (including villages). On the territory of the region there is a town of Tash-Kumyr of regional significance (according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023, to annex to the city of Tash-Kumyr Osmonbekov Street , Vostochny, Glinka village Ak- Suu rural district region of Aksy and the villages of Payyz-Bulak , Sary-Kamysh and Aksy -Keldysh of the Dostuk rural district of the Nooken region (in addition to the territorial administration of Shamaldy -Sai, the villages of Tendik , Kyzyl- Alma , Chuyut -Sai, Kuduk - Sai, Kashkulak -Sai of the territorial administration of Tendik) (including villages and towns) with a permanent population 38.0 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

The Aksy region is located in the north-eastern foothills of the Fergana Valley, bordered by the At-Oynok Range to the north, the Chatkal Range to the west , and the Naryn River to the east. The valley section between the mountainous framing is represented by river terraces, foothills, and adyrs, with absolute elevations ranging from 500 to 1500 m. The elevations in the mountainous section reach 4503 m (Chatkal Range) and 3896 m (At-Oynok Range).

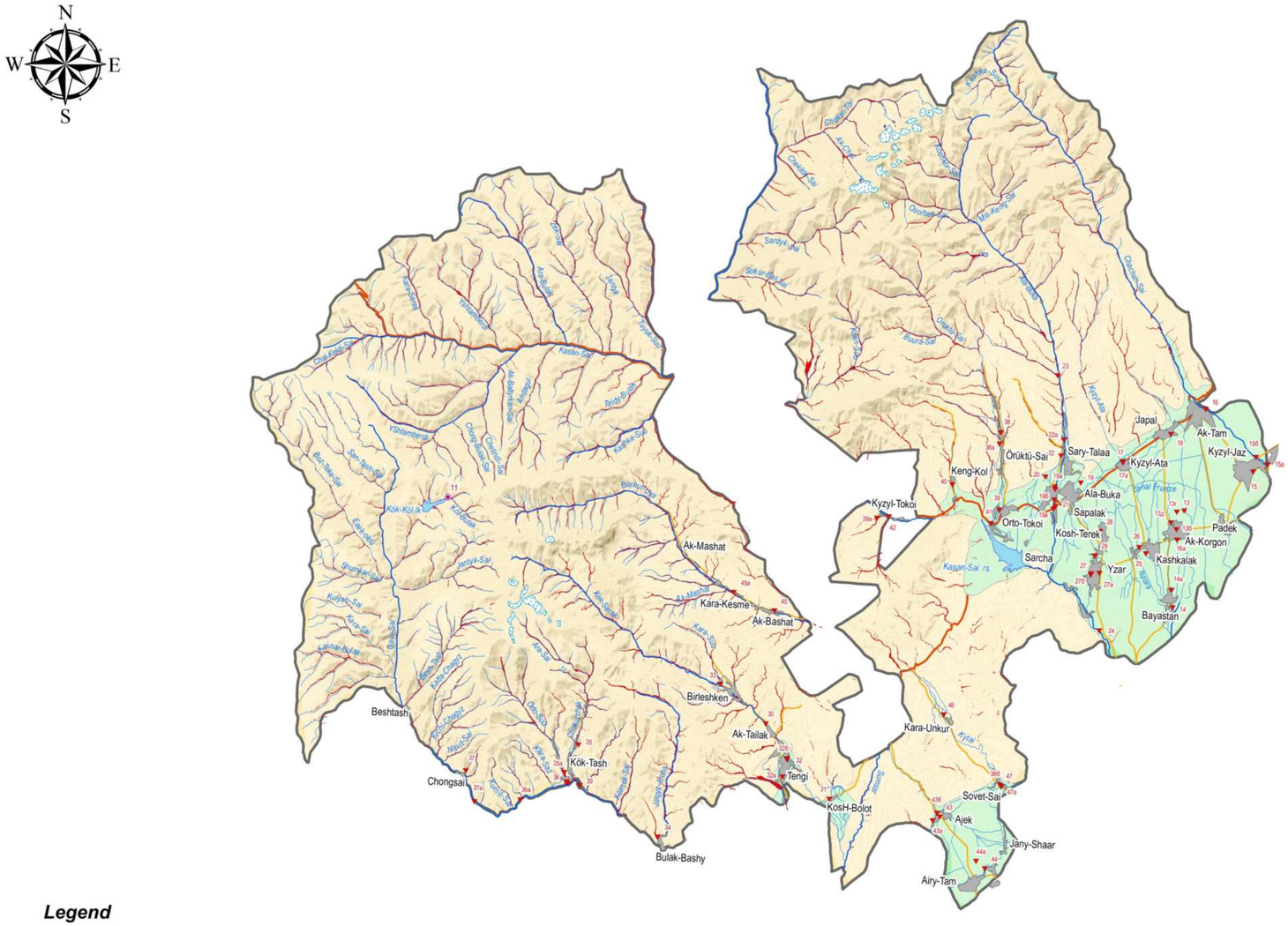
The main rivers of the region are the Naryn River (flow rate 1% of the provision up to 2820 m^3 / sec) (the flow of the Naryn River within the region is regulated by a cascade of hydroelectric power stations), Padysha-Ata (maximum flow rate 48.1 m^3 / sec), the Kara - Suu River (52.3 m^3 / sec), its right tributary the Aflatun River (74.9 m^3/sec). The type of feeding of the rivers is snow-glacial. The beginning of the flood period is March-April.

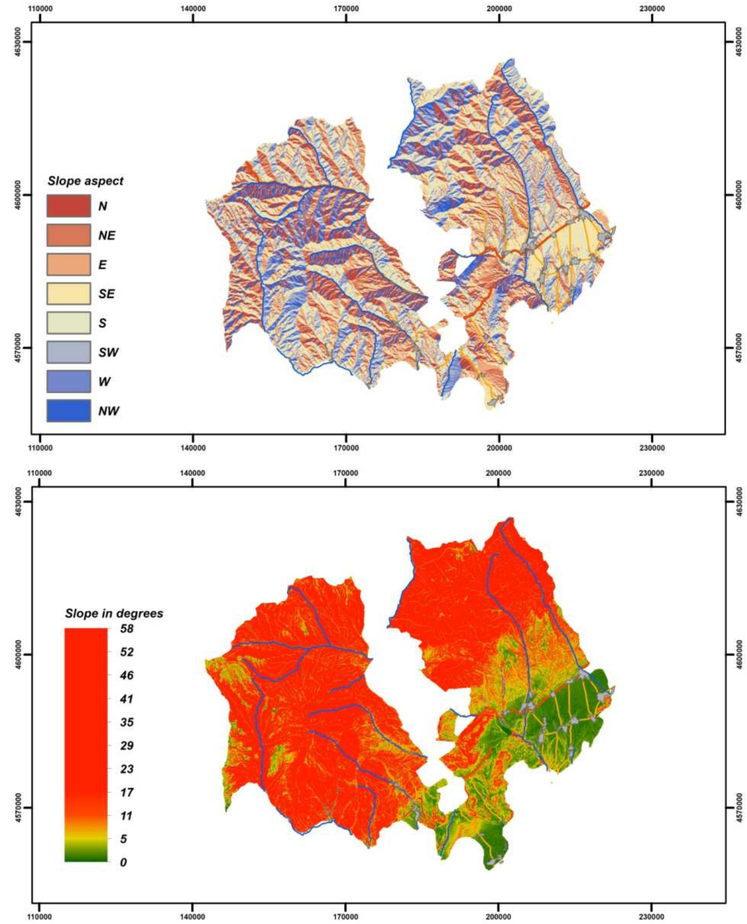
The region is home to Lake Sary- Chelek , and on the eastern border of the region are the reservoirs of the Naryn- Uch -Kurgan hydroelectric power station cascade (with a capacity of 370 million m^3), Shamaldy -Sai (39.4 million m^3) , Tash-Kumyr (140 million m^3) , and Kurpsai (370 million m^3) .

The zone of the second degree of mudflow hazard is developed in the high-mountain parts of the ridges on 9% of the region's area. The zone of the third degree of hazard covers the mid- and high-mountain zones of the surrounding ridges and is developed on 64% of the region's area. 22% of the region's area, mainly in the low and mid-mountain areas, is classified as the fourth degree of hazard. On 5% of the region's area in the flat areas, there is no mudflow hazard.

For most rivers, the flood period from May to July and ice formations from November to February pose a danger. Mudflows of predominantly rainfall genesis are possible on the western slope of the Fergana Ridge, where geological conditions favor mudflow formation . The mudflow danger will be determined by the amount and mode of precipitation.

Regions of Jalal-Abad oblast
Ala-Buka region





Legend

- Mudflows, Floods
- High-mountains lakes with outburst flood potential
- Major rivers
- Rivers
- Primary road
- Local road
- Administrative boundaries

The Ala-Buka region was formed in 1936. The region covers an area of 2976 km^2 , which is 8.64% of the region's area. The permanent population, according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024, is 118.3 thousand people. The average population density is 39.7 people per 1 km^2 .

There are 42 rural settlements in the region, belonging to 8 rural regions: Ala-Buka (association of the rural districts of Ala-Buka, T. Baltagulova and Oruktu) (16 settlements); T. Baltagulov (association, rural district of Ak-Tam and Ak- Korgon) (7); Yntymak (association of the rural district of Kok - Tash and Kok- Serek) (12); rename the rural district of Pervomaysky to the rural district of Ayry-Tam while maintaining the administrative boundaries (7). Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

The administrative center of the region is the village of Ala-Buka with a permanent population of 16.0 thousand people as of January 1, 2024.

The Ala-Buka region is located in the southwestern part of the Jalal-Abad oblast and is bordered by the Chatkal Range in the north and the Fergana Valley in the south. The mountainous areas are characterized by highly dissected relief. Absolute elevations in the area vary from 600 (valley part) to 4000 meters (Chatkal Range).

The main rivers of the region are the following: Kasan-Sai, maximum flow rate 88.5 m^3 / sec, Gava-Sai (72.4 m^3 / sec), Ala-Buka, Sumsar, Kek-Serek . The rivers of the region are fed by snow and glaciers, the beginning of the flood period is March-April.

Sai reservoir is located on the territory of the region , the waters of which are used for irrigation purposes.

Mudflow hazard. 60% of the area of the region under study, occupying high-mountain and upper parts of mid-mountain tiers of the relief of the southern edge of the Chatkal ridge , are characterized by the second degree of mudflow hazard . Up to 29% of the region's area, covering mid-mountain and high foothill zones, have the third degree of mudflow hazard . About 3% of the area, mainly in the low-mountain zone, are classified as territory with the fourth degree of mudflow hazard . The remaining 8% of the region's territory, excluding river beds and canals, are not mudflow hazard.

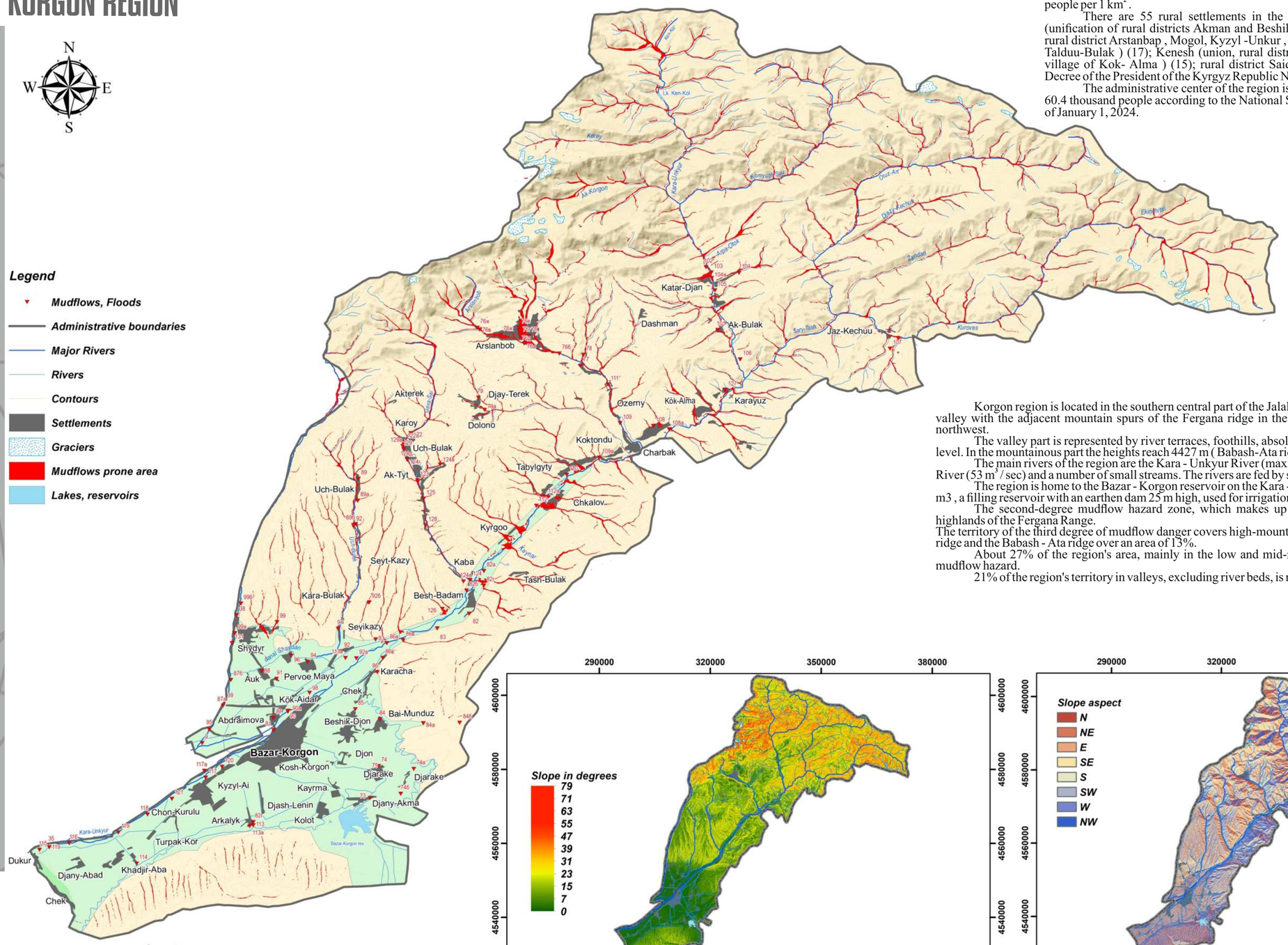
During periods of intense, concentrated atmospheric precipitation, torrential mudflows may occur.

REGIONS OF JALAL-ABAD OBLAST
KORGON REGION

Bazar -Korgon region was formed in 1928. The region covers an area of 1965 km^2 .
The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 197.3 thousand people. The average population density is 100.4 people per 1 km^2 .

There are 55 rural settlements in the region, belonging to 4 rural regions: Akman (unification of rural districts Akman and Beshik-Jon) (10 settlements); Arstanbap Ata (union, rural district Arstanbap , Mogol, Kyzyl -Unkur , annexing the village of Kok- Alma rural district Talduu-Bulak) (17); Kenesh (union, rural district Kenesh and Talduu-Bulak , (except for the village of Kok- Alma) (15); rural district Saidykum left unchanged (13). Data according to Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

The administrative center of the region is Bazar- Korgon with a permanent population of 60.4 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.



Korgon region is located in the southern central part of the Jalal - Abad oblast within the Kara - Unkyur River valley with the adjacent mountain spurs of the Fergana ridge in the northeast and the Babash - Ata ridge in the northwest.

The valley part is represented by river terraces, foothills, absolute marks vary from 600 to 1500 m above sea level. In the mountainous part the heights reach 4427 m (Babash-Ata ridge).

The main rivers of the region are the Kara - Unkyur River (maximum flow rate 350 m^3 / sec), the Shaidan - Sai River (53 m^3 / sec) and a number of small streams. The rivers are fed by snow and glaciers.

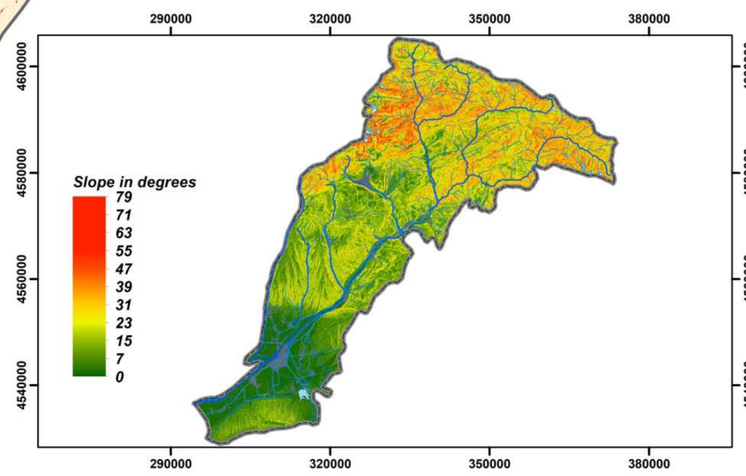
The region is home to the Bazar - Korgon reservoir on the Kara - Unkyur River, with a capacity of 22.5 million m3 , a filling reservoir with an earthen dam 25 m high, used for irrigation.

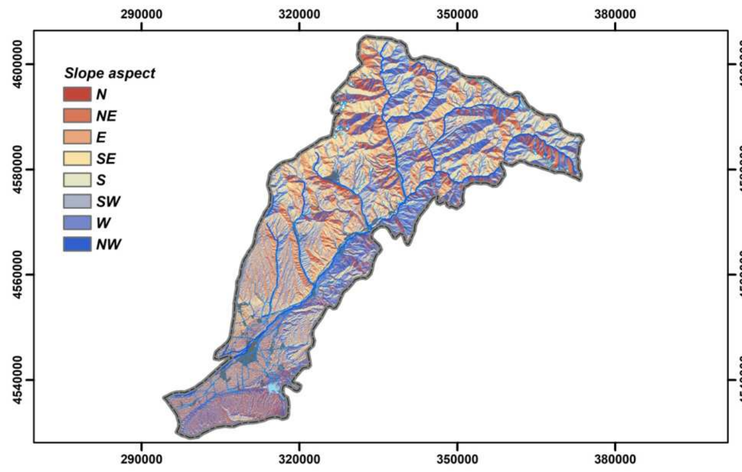
The second-degree mudflow hazard zone, which makes up 39% of the region's area, is located in the highlands of the Fergana Range.

The territory of the third degree of mudflow danger covers high-mountain and mid-mountain sections of the Fergana ridge and the Babash - Ata ridge over an area of 13%.

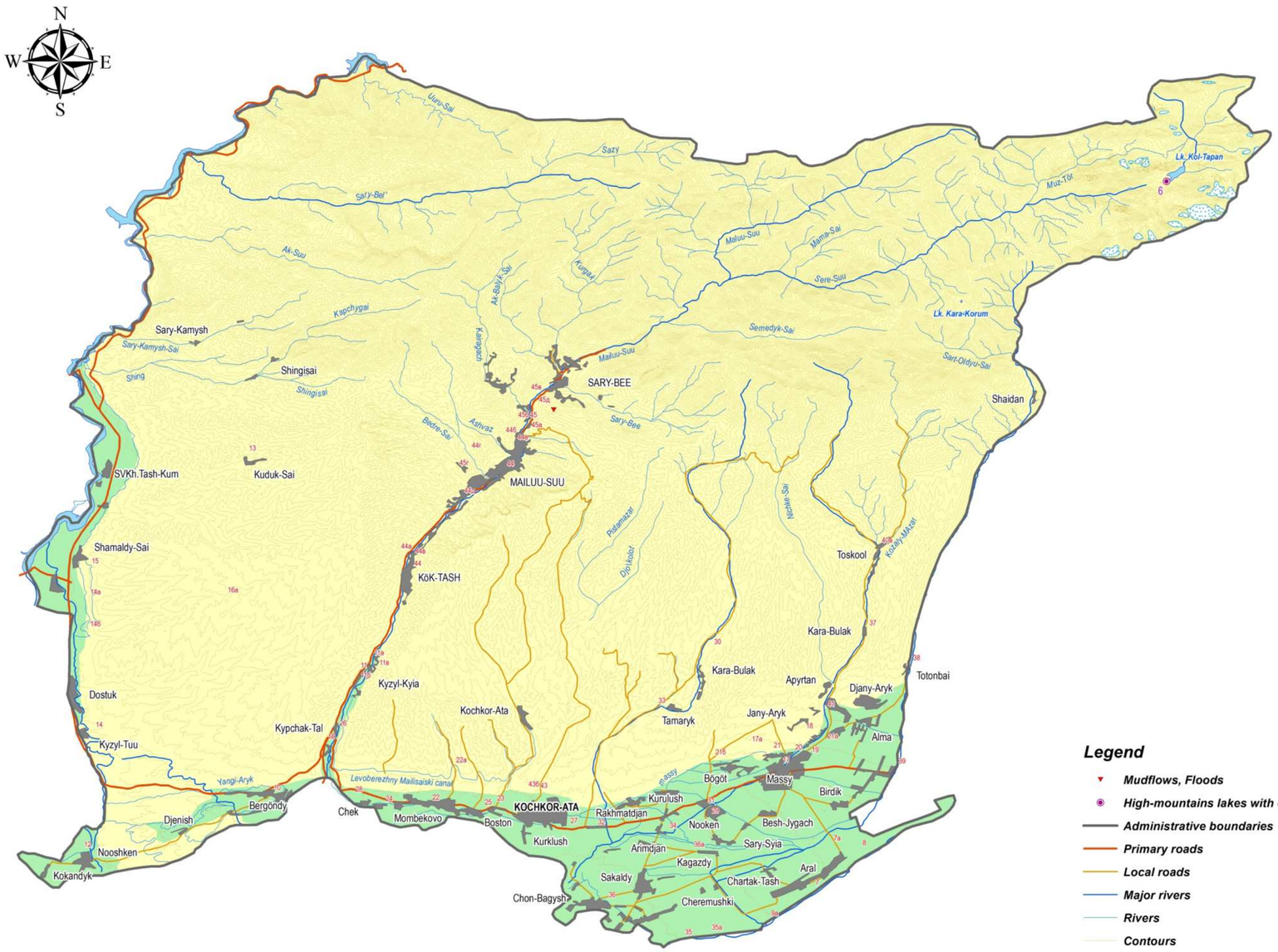
About 27% of the region's area, mainly in the low and mid-mountains, is subject to the fourth degree of mudflow hazard.

21% of the region's territory in valleys, excluding river beds, is not at risk of mudflows.





REGIONS OF JALAL-ABAD OBLAST
NOOKEN REGION

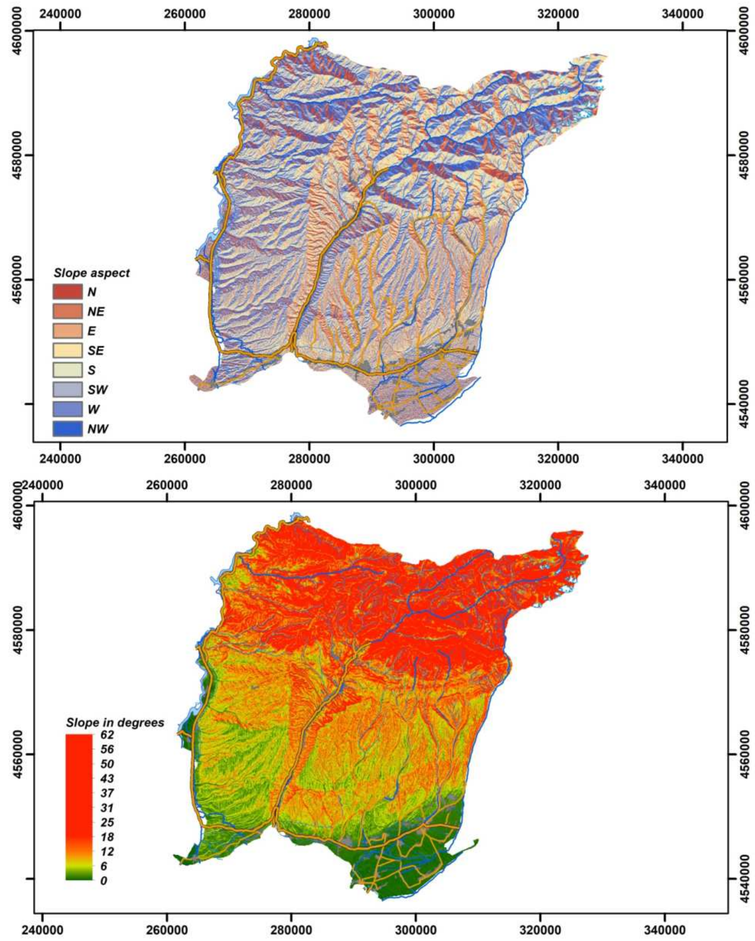


Scale 1:250 000

Nooken region was formed in 1935. The region covers an area of 2336 km^2 .

The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 155.1 thousand people. The average population density is 65.0 people per 1 km^2 .

On the territory of the region there are 57 rural settlements belonging to 5 aiyl aimaks: D. Sadyrbaev (uniting the rural areas of Shaidan , Aral, Massy), (17 settlements); E. Aliyev (uniting the rural areas of Sakaldy and Nooken) (15); Burgondu-Dostuk (uniting the rural areas of Burgondu and Dostuk except the villages of Payiz-Bulak , Sary-Kamysh and Aksy - Keldysh) by annexing the villages of Tendik , Kyzyl- Alma , Chuyut -Sai, Kuduk -Sai and Kashkulak -Sai of the territorial government of the city of Tash-Kumyr) (17); on the basis of the territorial administration of Shamaldy -Sai of the town of Tash-Kumyr, with the removal from the town of Tash-Kumyr of the town of district significance of Shamaldy -Sai as part of the Nooken region ; leaving the rural district of Mombekov (8 settlements) and the city of Kochkor-Ata without changing the district boundaries and centers. Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023.



Legend

- Mudflows, Floods
- High-mountains lakes with outburst flood potential
- Administrative boundaries
- Primary roads
- Local roads
- Major rivers
- Rivers
- Contours
- Settlements
- Lakes, reservoirs
- Gracier

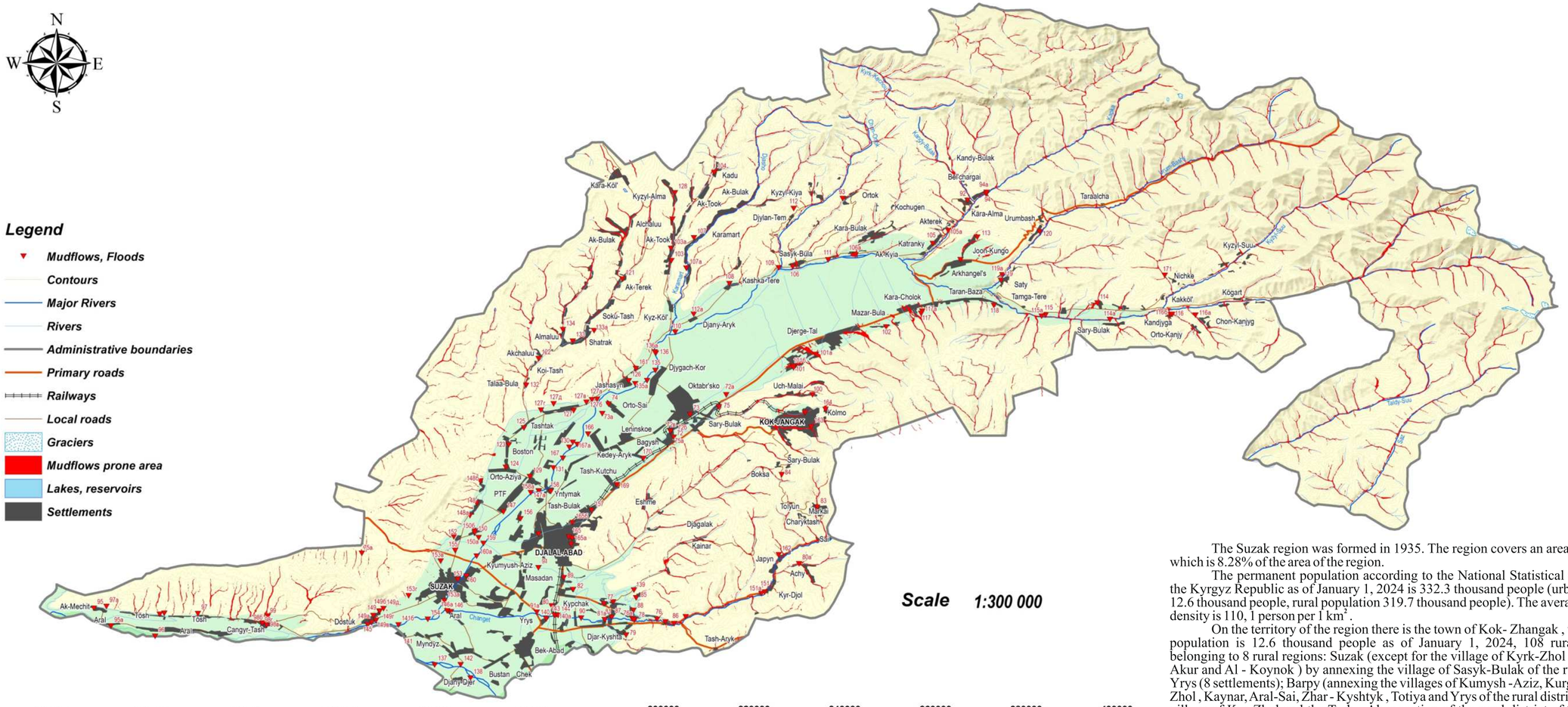
Within the region's borders, there is a city of regional significance, Mailuu-Suu (according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023, to annex to the city the land plots of Kok- Tash , Sadovaya, Dachnaya, Munduz , Yuzhny and Zarechnaya streets of the Kok- Tash territorial administration of the city of Mailuu-Suu of the Kochkor-Ata forestry of the Nooken region), with a permanent population of 26.8 thousand people (including Kek-Tash - 2.8 thousand people) according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

The administrative center of the region is the village of Masy with a permanent population of 20.3 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

The main rivers of the region are the following : Naryn (1% flow rate 2820 m^3 / sec, flow is regulated by a cascade of reservoirs), Mailuu-Suu (maximum flow rate 108 m^3 / sec), Shaidan -Sai (53.0 m^3 / sec), Kara-Unkyur lower part (350 m^3 / sec). The beginning of the flood period is March-April.

The territories of the second degree of mudflow danger occupy an area of 37.4 km^2 (1.5% of the region's area) in the upper reaches of the Mailuu-Suu River . The territory of the third degree of mudflow danger is confined to the mid- and high-mountain zones of the Babash-Ata ridge (about 56% of the region's territory). 32% of the region's area is a zone of the fourth degree of mudflow danger. The remaining territory in the flat part, with the exception of the valley bottoms, does not belong to the mudflow-hazardous territory.

REGIONS OF JALAL-ABAD OBLAST
SUZAK REGION



The Suzak region was formed in 1935. The region covers an area of 3019 km², which is 8.28% of the area of the region.

The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 332.3 thousand people (urban population 12.6 thousand people, rural population 319.7 thousand people). The average population density is 110, 1 person per 1 km².

On the territory of the region there is the town of Kok- Zhangak , the permanent population is 12.6 thousand people as of January 1, 2024, 108 rural settlements belonging to 8 rural regions: Suzak (except for the village of Kyrk-Zhol and the Tash - Akur and Al - Koynok) by annexing the village of Sasyk-Bulak of the rural district of Yrys (8 settlements); Barpy (annexing the villages of Kumysh -Aziz, Kurgak -Kol, Kyr-Zhol , Kaynar, Aral-Sai, Zhar - Kyshtyk , Totiya and Yrys of the rural district of Yrys , the village of Kyr-Zhol and the Tash - Akur section of the rural district of Suzak and the villages of Kaynar and Kara - Zhygach rural district of the village of Atabekova) (23); Kyz-Kol (annexing the Al - Koynok section of the rural district of Suzak, the village of Chymchyk -Zhar of the rural district of Yrys , the village of Ortok of the rural district of Kara - Alma (14); Bagysh (union of the rural district of Bagysh and Lenin) (10); Kok-Art (union Kogart and Kurmanbek annexing the villages of Kara- Alma , Urumbash and Tuura-Zhangak Kara - Alma rural district and Kara-Kul section of Lenin rural district) (15); S. Atabekov except for the villages of Kainar, Kara - Zhygach , Tash-Bulak (15); Leave rural areas of Kara - Daryya (3); 20) and the city of Kok - Zhangak without changing the administrative boundaries and centers. Data according to Decree of the President of the Kyrgyz Republic No. 370 from December 29, 2023 .

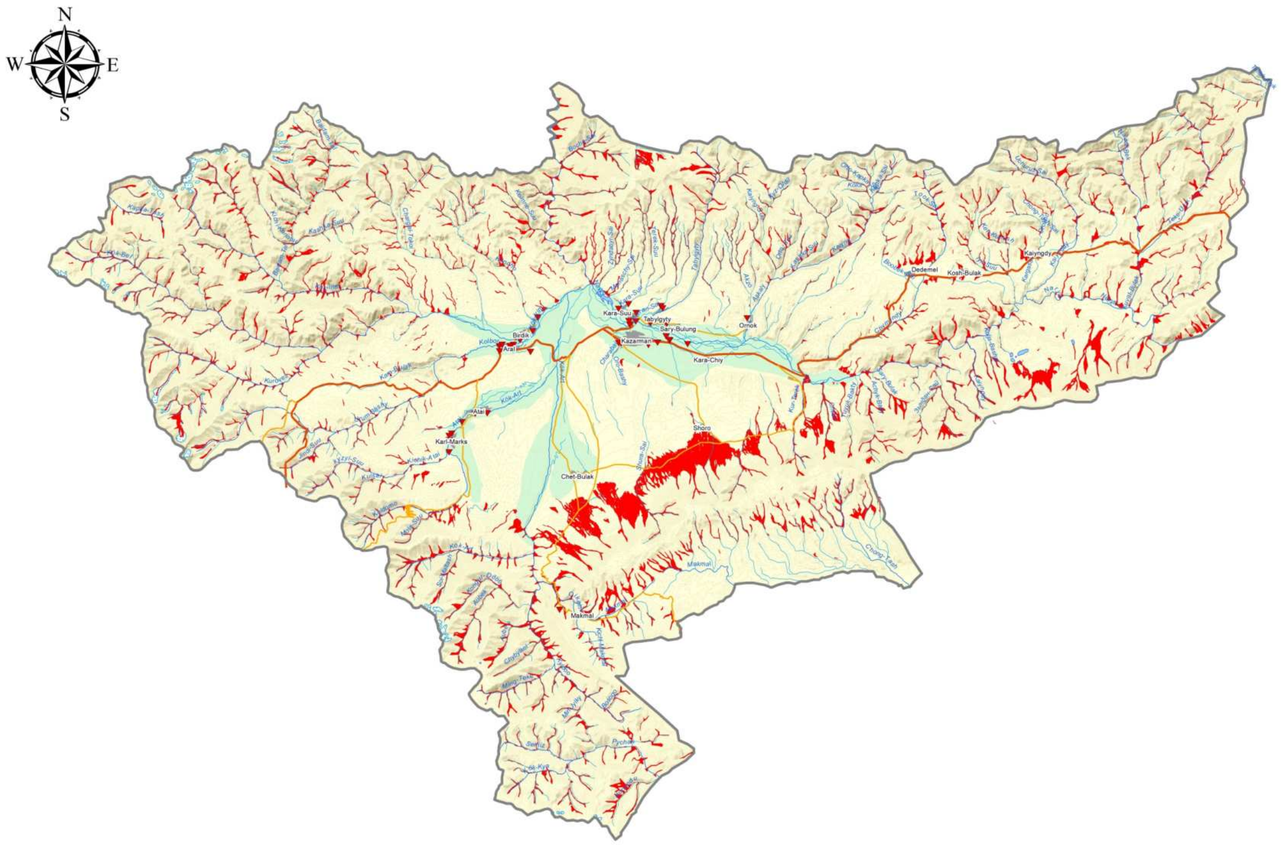
The administrative center of the region is the village of Suzak with a permanent population of 33.4 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

The Suzak region is located in the south of the region in the eastern part of the Fergana Depression within the river valleys of the Kara-Darya, Kök -Art rivers, their tributaries and the adjacent mountainous framework. In the northeast, the region is limited by the Fergana Range. The valley part is located between the spurs and adyrs of the Fergana Range, represented by river terraces, foothill trains at absolute elevations from 650 to 1600 m above sea level. The maximum altitude marks reach 3892 m.

The main rivers of the region are the following: Kara-Darya (maximum discharge 557 m³ / sec), Kök -Art (241 m³ / sec), Kara - Alma (14.6 m³ / sec), Changet (58.0 m³ / sec). The flow of the Kara-Darya River is regulated by the Andijan Reservoir. A network of irrigation canals is widely developed. The rivers are fed by snow and snow-glacier. The flood period begins in March-April.

The mudflow hazard zone of the second degree is distinguished in the northern and southwestern parts on 11% of the territory. The mudflow hazard zone of the third degree covers the areas of the middle mountains in the valley of the Kök -Art River and the southwestern slopes of the Fergana Range, occupying 58% of the region's territory. The mudflow hazard zone of the fourth degree includes the middle and low mountain areas in the southwestern part of the region (16%). About 15% of the territory in the flat part, with the exception of river beds, is not mudflow hazardous.

REGIONS OF JALAL-ABAD OBLAST
TOGUZ -TORO REGION


N
W
E
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Kara-Suu
Tegirgoty
Bary-Bulung
Kazarman
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Kosh-Bulak
Kaiyngdy
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Kara-Choy
Bulak
Kara-Bulak
Kok-Art
Kan-Marks
Chet-Bulak
Shoro
Makmal
Kara-Kyr
Kyzyl-Suu
Kyzyl-Art
Kyzyl-Tuu
Kyzyl-Kiya
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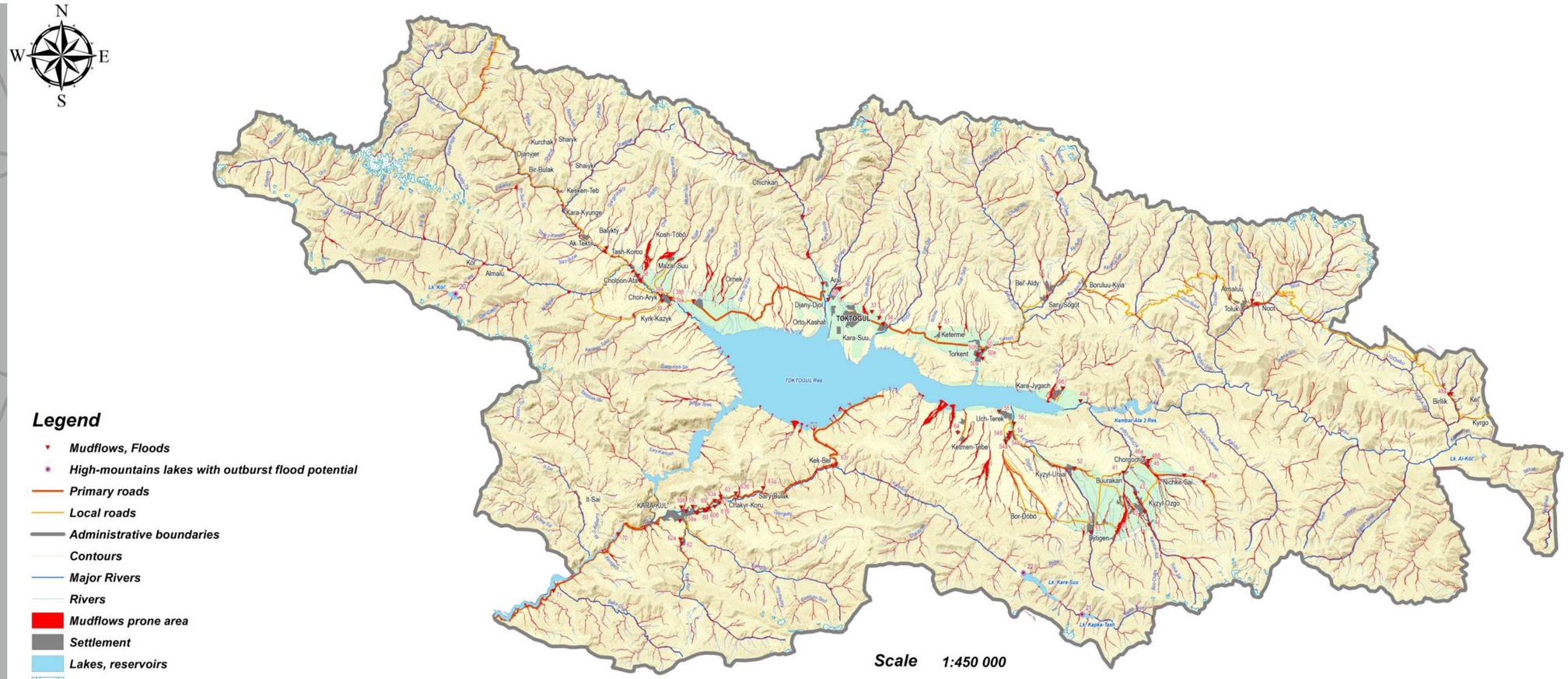
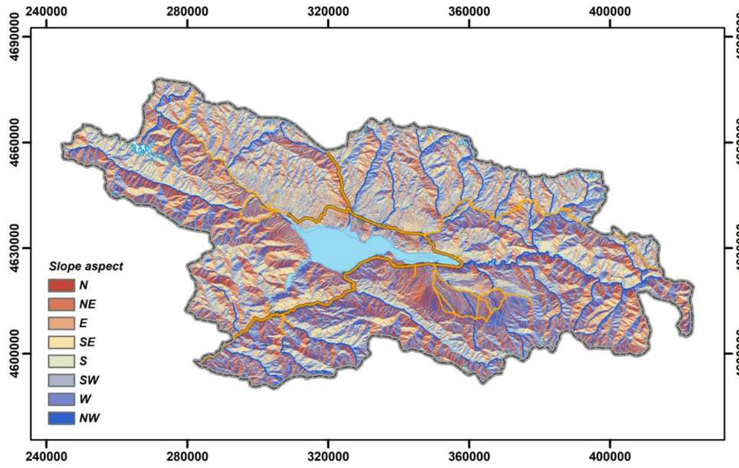
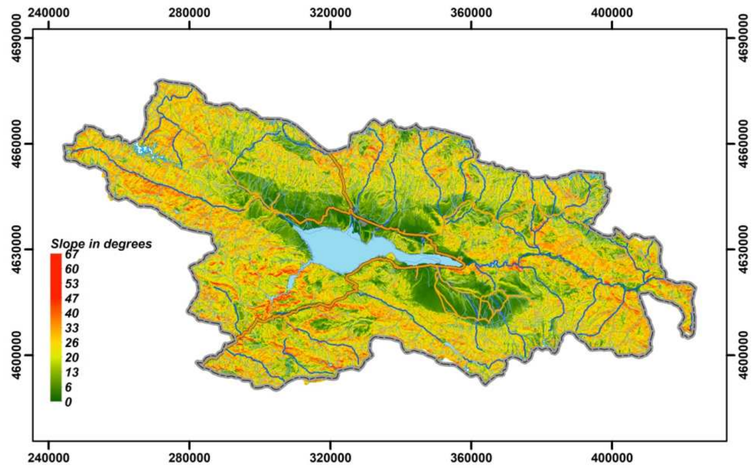
REGIONS OF JALAL-ABAD OBLAST
TOKTOGUL REGION







The district covers an area of 7815 km² . The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 106.2 thousand people (urban population 21.0 thousand people, rural 85.2 thousand people). The average population density is 13.6 people per 1 km² .

The region includes: the city of Toktogul, 40 rural settlements belonging to 6 rural regions: Ketmen- Dobo (association of Ketmen- Dobo and Cholpon- Ata) (12 settlements); A. Suerkulov (3), (association, rural district of A. Suerkulov and Bel- Aldy) (6); Elmirbek Imanaliev (unification of Kyzyl- Ozgorush and Nichke -Sai) (13); leave the rural areas of Uch -Terek (5); Sary-Kamysh (2 and; Toluk (Aralbaev) (4) without changing the administrative borders and centers. Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

The administrative center of the region is the city of Toktogul (the rural district of Zhany-Zhol is being transferred to the city) with a permanent population of 36.3 thousand people as of January 1, 2024.

Territorially, within the region's borders is the city of regional significance Karakul with a population of 27.2 thousand people.

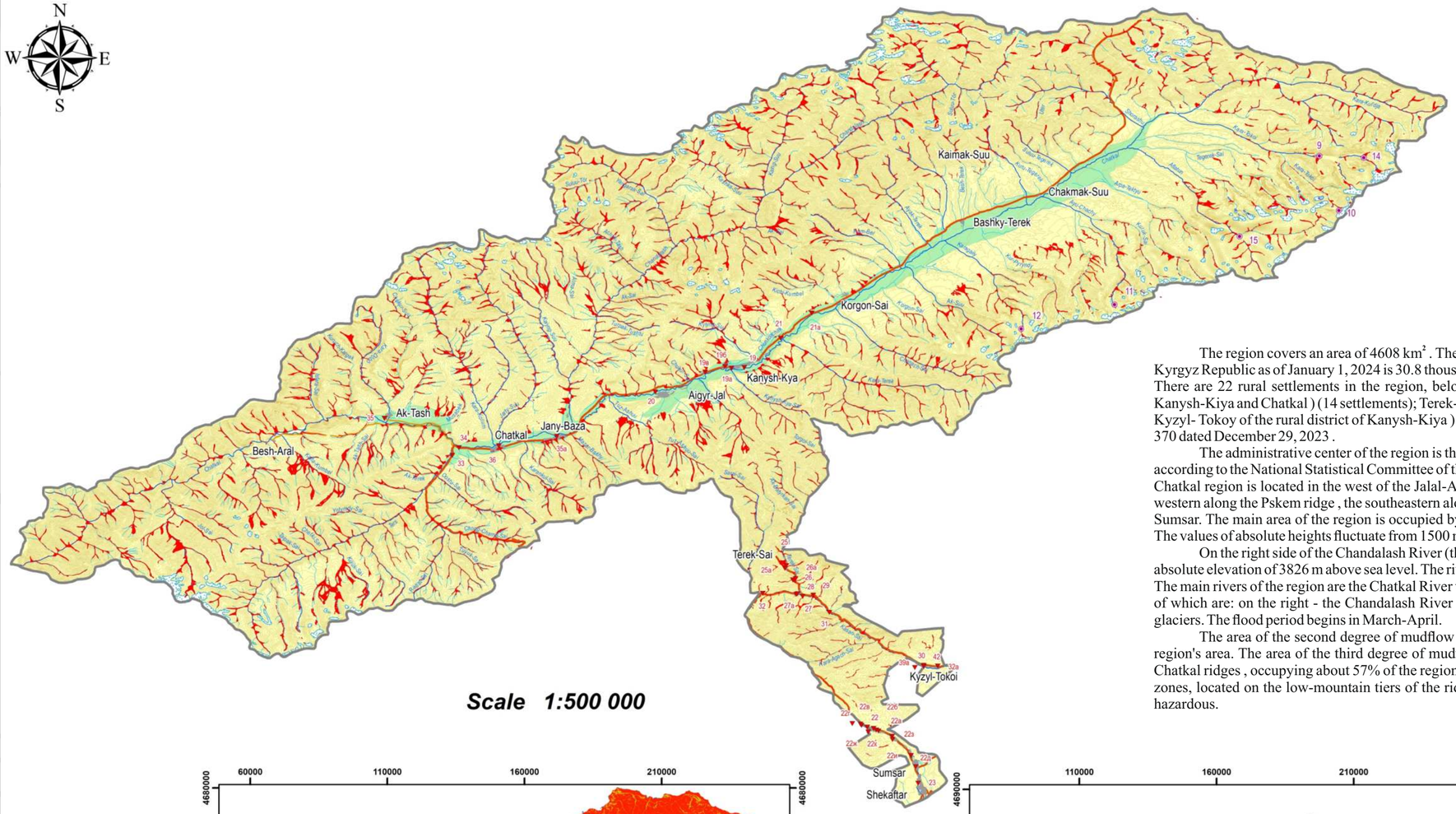
The Toktogul region is located in the northern part of the region within the Naryn River valley and is bordered in the north by the Talas and Suusamyr ranges, in the west by the At - Oinok range , in the south by a complex system of Babash-Ata , Fergana and Kekirim-Too ranges . The mountainous areas are characterized by highly dissected relief. The absolute marks of the mountain ranges are 4165 m (Uzun-Akhmat range), 4351 m (Kekirim-Too range).

The main rivers of the region are the Naryn River (discharge of 1% of the probability – Uch - Terek village, above the Toktogul reservoir 2820 m³ / sec, above the mouth of the Kyokömeren River 1604 m³ / sec), the Kyokömeren River (discharge of 1% of the probability at the mouth 998 m³ / sec), the Torkent (maximum discharge 177 m³/sec), the Chychkan River (119 m³/sec), the Uzung-Akhmat River (203 m³ / sec), the Kara- Suu River (48 m³ / sec).

Toktogul reservoir with a capacity of 19.5 billion m³ , a concrete dam height of 215 m and a capacity of 3,300 m³ / sec is located on the territory of the region . In the southwestern part of the region is located part of the Kurpsai reservoir in the eastern part - Kambar-Ata-2.

The territory of the second degree of mudflow danger is widespread in the northwestern (upper reaches of the Uzun-Akhmat River) and southern parts of the region, occupying about 2% of its area. The territory of the third degree of mudflow danger is widespread on the slopes of the Talas, Suusamyr , Fergana, Atoynok ridges on 42% of the region's territory. The territory of the fourth degree of mudflow danger (19%) is confined to lowlands and valleys of the main rivers.

REGIONS OF JALAL-ABAD OBLAST
CHATKAL REGION



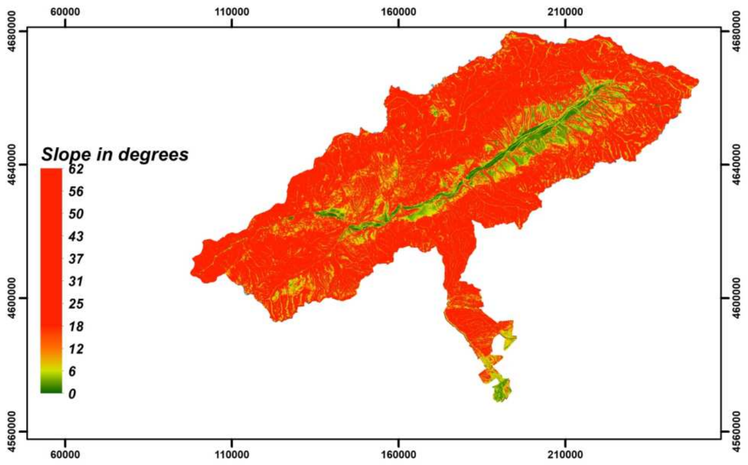
Scale 1:500 000

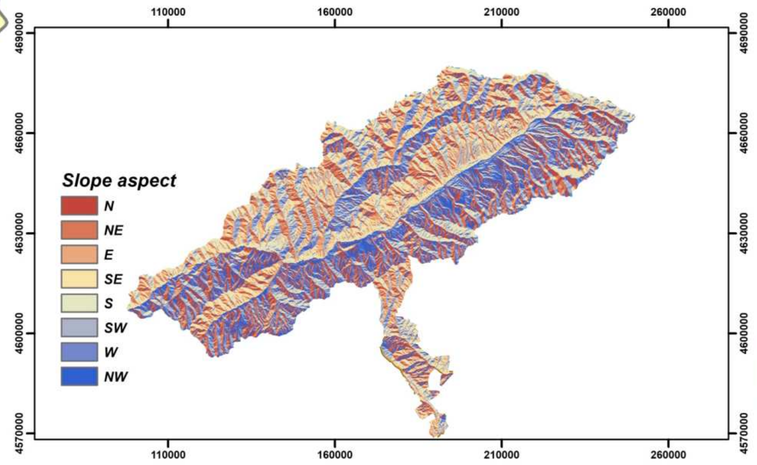
The region covers an area of 4608 km² . The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 30.8 thousand people. The average population density is 6.6 people per 1 km² .
There are 22 rural settlements in the region, belonging to 2 rural regions: Kanysh-Kiya (unification of the rural districts of Kanysh-Kiya and Chatkal) (14 settlements); Terek-Sai (unification, rural district of Terek-Sai and Sumsar by adding the village of Kyzyl- Tokoy of the rural district of Kanysh-Kiya) (8). Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

The administrative center of the region is the village of Kanysh-Kiya with a permanent population of 2.8 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.
Chatkal region is located in the west of the Jalal-Abad oblast . The northern border of the region runs along the Talas ridge, the western along the Pskem ridge , the southeastern along the Chatkal ridge , jutting out in a narrow strip to the south to the village of Sumsar. The main area of the region is occupied by mountain structures, inside which there are poorly developed river valleys. The values of absolute heights fluctuate from 1500 m (the area of the village of Sumsar) to 4503 m above sea level (Chatkal ridge).

On the right side of the Chandalash River (the central part of the region's territory) stretches the Chandalash Ridge with an absolute elevation of 3826 m above sea level. The river valleys are narrow, terraces can be traced in the lower reaches of the rivers. The main rivers of the region are the Chatkal River with a maximum flow rate of 450 m³ / sec and numerous tributaries, the largest of which are: on the right - the Chandalash River , on the left - the Ters River (67.7 m³ / sec). The rivers are fed by snow and glaciers. The flood period begins in March-April.

The area of the second degree of mudflow danger is distributed mainly on the Ters ridge , occupying about 12% of the region's area. The area of the third degree of mudflow danger is confined to the slopes of the Pskem , Chandalash , Talas and Chatkal ridges , occupying about 57% of the region's area. The area of the fourth degree of mudflow danger borders the specified zones, located on the low-mountain tiers of the ridges on 28% of the area. About 3% of the region's territory is not mudflow-hazardous.

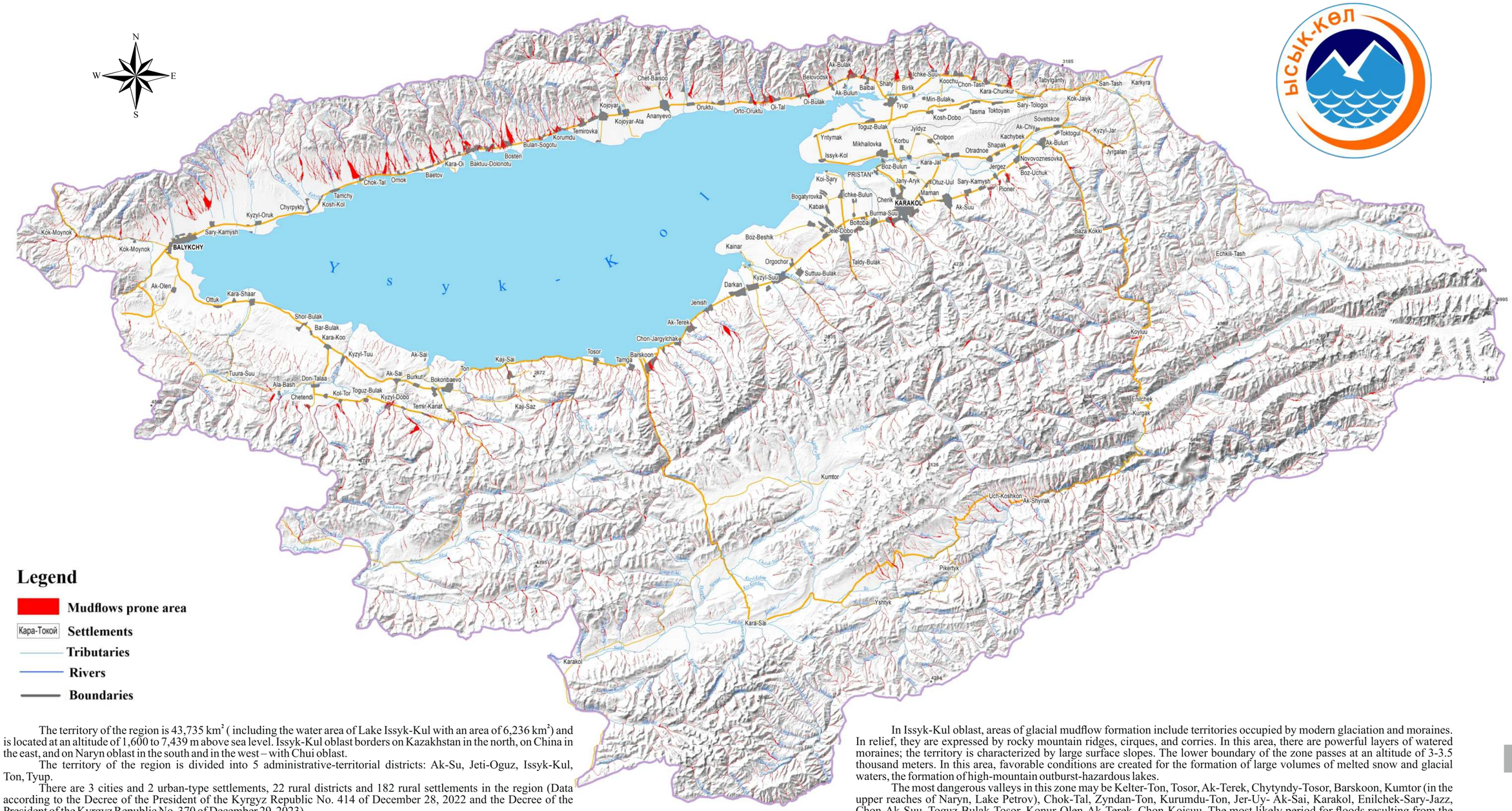




Legend

- *Mudflows, Floods*
- *High-mountains lakes with outburst flood potential*
- *Administrative boundaries*
- *Primary roads*
- *Local roads*
- *Major rivers*
- *Rivers*
- *Contours*
- *Settlements*
- *Lakes, reservoirs*
- *Graciers*
- *Mudflows prone area*

MUDFLOW SUSCEPTIBILITY MAP
ISSYK-KUL OBLAST



The territory of the region is 43,735 km² (including the water area of Lake Issyk-Kul with an area of 6,236 km²) and is located at an altitude of 1,600 to 7,439 m above sea level. Issyk-Kul oblast borders on Kazakhstan in the north, on China in the east, and on Naryn oblast in the south and in the west – with Chui oblast.

The territory of the region is divided into 5 administrative-territorial districts: Ak-Su, Jeti-Oguz, Issyk-Kul, Ton, Tyup.

There are 3 cities and 2 urban-type settlements, 22 rural districts and 182 rural settlements in the region (Data according to the Decree of the President of the Kyrgyz Republic No. 414 of December 28, 2022 and the Decree of the President of the Kyrgyz Republic No. 370 of December 29, 2023).

The total permanent population in the region according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 544.4 thousand people, including: Ak-Su region - 75.1 thousand people, Jeti-Oguz region - 101.1 thousand people, Issyk-Kul region - 99.5 thousand people, Ton region - 60.5 thousand people, Tyup region - 72.3 thousand people.

The region's territory includes the city of regional subordination Karakol with a permanent population of 90.0 thousand people (including Pristan-Przhevalsk - 3.5 thousand people and Chelpek rural district - 7.5 thousand people) and the town of Balykchy with a permanent population of 57.0 thousand people (including Orto-Tokoy - 0.7 thousand people, Kek-Moinok rural district of the Ton region - 7.5 thousand people).

The average population density in the region as a whole is 14.5 people per 1 km² (excluding the area of Lake Issyk-Kul).

The administrative center of the region is Karakol, according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024, with a permanent population of 90.0 thousand people (including Pristan-Przhevalsk - 3.5 thousand people and the rural district of Chelpek in the Ak-Su region - 7.5 thousand people).

In Issyk-Kul oblast, areas of glacial mudflow formation include territories occupied by modern glaciation and moraines. In relief, they are expressed by rocky mountain ridges, cirques, and corries. In this area, there are powerful layers of watered moraines; the territory is characterized by large surface slopes. The lower boundary of the zone passes at an altitude of 3-3.5 thousand meters. In this area, favorable conditions are created for the formation of large volumes of melted snow and glacial waters, the formation of high-mountain outburst-hazardous lakes.

The most dangerous valleys in this zone may be Kelter-Ton, Tosor, Ak-Terek, Chytyndy-Tosor, Barskoon, Kumtor (in the upper reaches of Naryn, Lake Petrov), Chok-Tal, Zyndan-Ton, Kurumdu-Ton, Jer-Uy- Ak-Sai, Karakol, Enilchek-Sary-Jazz, Chon-Ak-Suu, Toguz-Bulak-Tosor, Konur-Olen-Ak-Terek, Chon-Koisuu. The most likely period for floods resulting from the outburst of high-mountain lakes is July-August (early September).

The area of formation of snow and rain mudflows occupies the territory of mid-mountains, partly highlands, which do not have modern glaciation, with remnants of ancient moraines, a large accumulation of mudflow-forming sediments, and the development of permafrost processes.

The cause of mudflows is the melting of seasonal snow, heavy rains, and the presence of moist mudflow-forming deposits. The most probable time for mudflows and floods (April-June) is associated with periods of snowmelt and heavy rainfall. The most dangerous valleys are Cholpon-Ata, Chon-Aksuu, Arasan, Ak-Suu, Chon-Kyzyl-Suu, Jeti-Oguz, Kaji-Sai, Juuka, Chon-Kyzyl-Suu, Kichi-Kyzyl-Suu, Karakol, Cholpon-Ata, Orto-Dolonotu, as well as Shirgi, Baydam-Tal, Kalmak-Ashuu, Dure-Suu, Kabyrga, Orto-Koisuu, Chon-Koisuu, Baktuu-Dolonotu, Tegermenty, Chet-Baisoorun, Orto-Baisoorun, Kara-Debe, Atamkulu, Chon-Oryuktyu, Kichi-Oryuktyu, Kuturga, Kyurmentyu, Balbay, Shaty, Taldy-Suu, Korumdy, Turgen-Ak-Suu, Boz-Uchuk, Jergez, Yrdyk, Kichi-Dzhargylchak, Sary-Bulak, Chon-Dzhargylchak, Tamga.

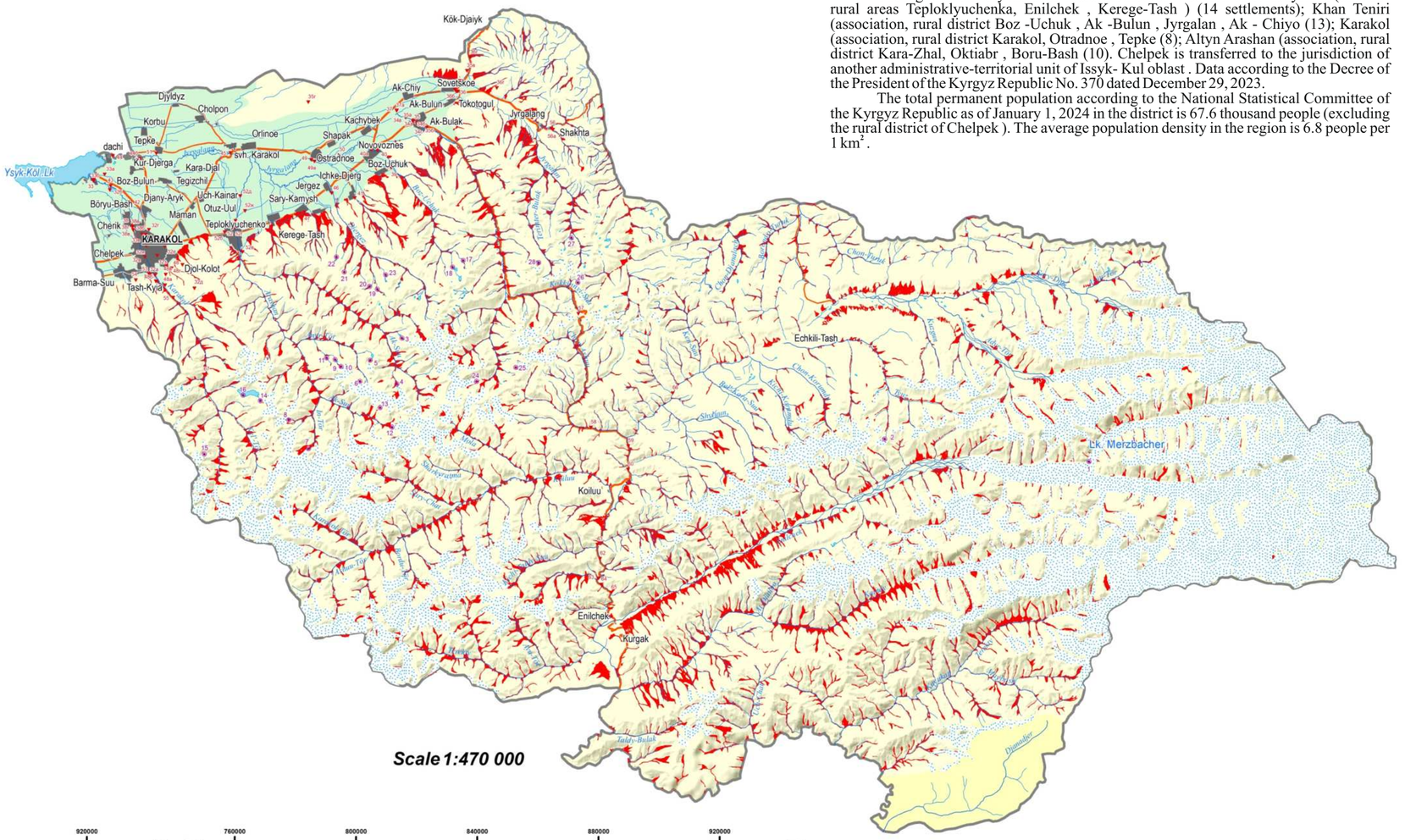
The area of formation of torrential mudflows is foothills, low mountains, dissected by the channels of temporary and permanent watercourses, composed of modern loose debris deposits. The main reason for the formation of mudflows in this zone is the fallout of intense atmospheric precipitation, often on moistened mudflow-forming deposits.

REGIONS OF ISSYK- KUL REGION
AK-SU REGION

The Ak-Su region was formed in 1973. The district is located in the eastern part of the Issyk-Kul basin. The territory of the region is 9917 km^2, in the north it borders with the Tyup region, in the northeast with Kazakhstan, in the southeast with China and in the west with the Jeti -Oguz region.

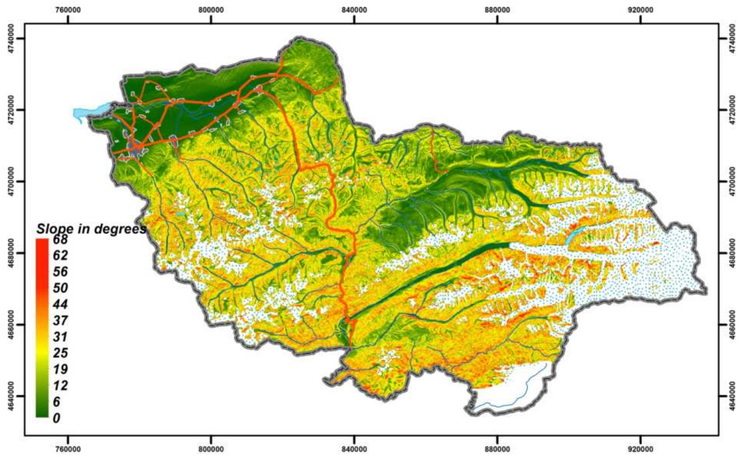
The region's territory includes 4 rural districts of 44 settlements: Kadyr Ake (union of rural areas Teploklyuchenka, Enilchek , Kerege-Tash) (14 settlements); Khan Teniri (association, rural district Boz -Uchuk , Ak -Bulun , Jyrgalan , Ak - Chiyo (13); Karakol (association, rural district Karakol, Otradnoe , Tepke (8); Altyn Arashan (association, rural district Kara-Zhal, Oktiabr , Boru-Bash (10). Chelpek is transferred to the jurisdiction of another administrative-territorial unit of Issyk- Kul oblast . Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023.

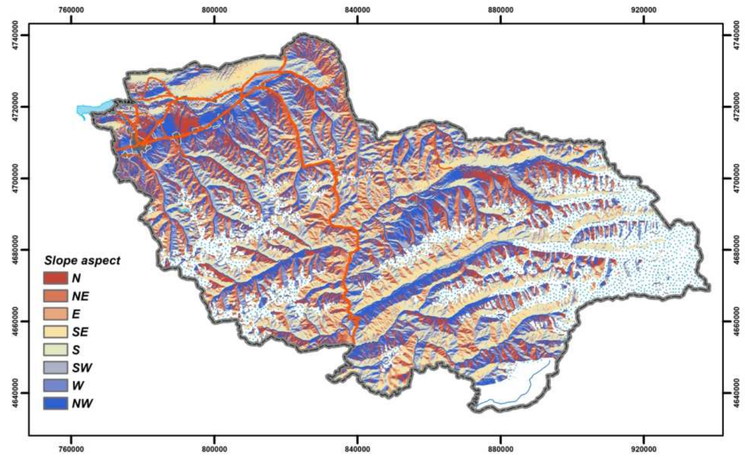
The total permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 in the district is 67.6 thousand people (excluding the rural district of Chelpek). The average population density in the region is 6.8 people per 1 km^2 .



Legend

- *Mudflows, Floods*
- *High-mountains lakes with outburst flood potential*
- *Major rivers*
- *Rivers*
- *Administrative boundaries*
- *Primary roads*
- *Local roads*
- *Mudflows prone area*
- *Lakes, reservoirs*
- *Graciers*
- *Settlements*





The region's territory includes the city of regional subordination Karakol, with an area of 44 km2 and a permanent population of 90,000 people (including Pristan-Przhevalsk - 3,500 people and the rural district of Chelpek - 7,500 people).

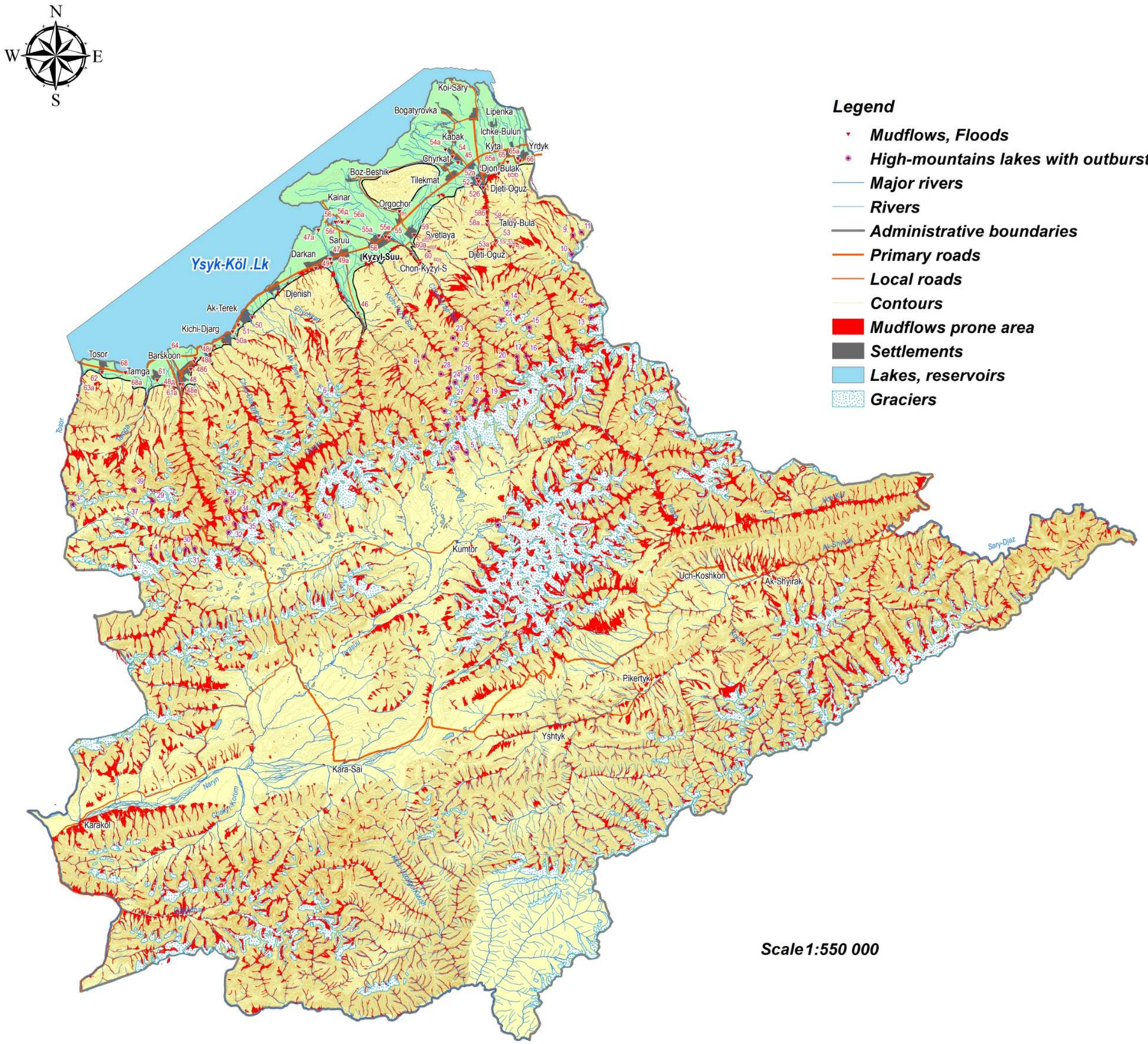
The administrative center of the region is the village of Teploklyuchenka with a permanent population of 14.1 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

The relief of the region is dominated by mountain structures of the Teskey Ala- Too and Kokshaal-Too ranges with extensive syrts. The flat part is represented by the terraced valley of the Jyrgalan River , foothills, and lakeside terraces of Lake Issyk-Kul.

The hydrography of the region is represented by the rivers Karakol, Jyrgalan (maximum flow rate 70 m^3 / sec) and Sary-Dzhaz (258 m^3 / sec) and numerous mountain rivers and dry riverbeds, the high-mountain lake Merzbacher with a catchment area of 318 km^2 , with a water surface area of 4.5 km^2 , and a volume of 129 million m^3 .

Mudflow hazard. About 23% of the region's area, mainly covering high-mountain and mid-mountain relief tiers, is characterized by the second degree of hazard. About 48% of the region's area, occupying mid-mountain zones, has the third degree of mudflow hazard. About 21% of the region's territory, represented by low-mountain relief and individual foothill parts of valleys, is characterized by the fourth degree of mudflow hazard.

REGIONS OF ISSYK- KUL REGION
JETY-OGUZ REGION



The Jety-Oguz region was formed in 1930. The region is located in the southeastern part of the Issyk-Kul basin. The region's territory is 14,499 km 2. It borders on the Ak-Su region in the east, on China in the southeast, and on Naryn oblast in the southwest, to the west with the region of Ton.

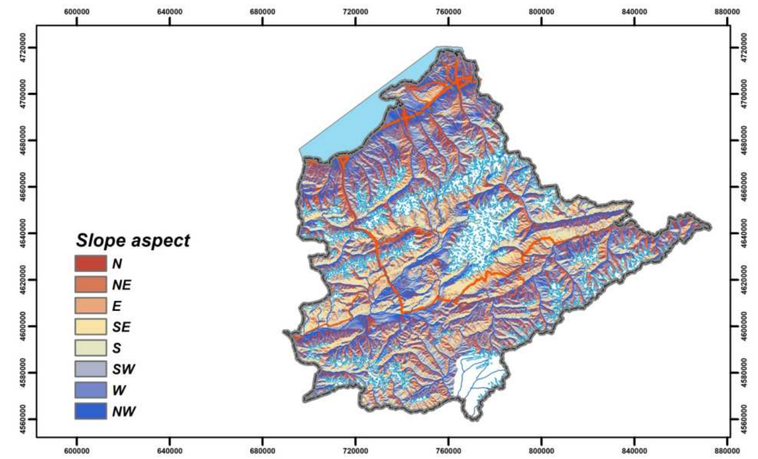
The region's territory is divided into 5 rural districts of 47 settlements: Jeti -Oguz, (union of the rural districts of Jeti -Oguz, Yrdyk , Lipenka (16 settlements); Orgochor (union of the rural districts of Orgochor , Ak-Dobo, Svetlaya Polyana and Ak- Shyirak) (13), Kyzyl- Suu (union, rural district of Kyzyl- Suu and (Saruu) Aldashev (7), Zhargylchak (association, rural district of Zhargylchak and Darkhan) (5); Barskoon , (association, rural district of Barskoon and Tamga (6). Data according to Decree of the President of the Kyrgyz Republic No. 370 of December 29, 2023 year.

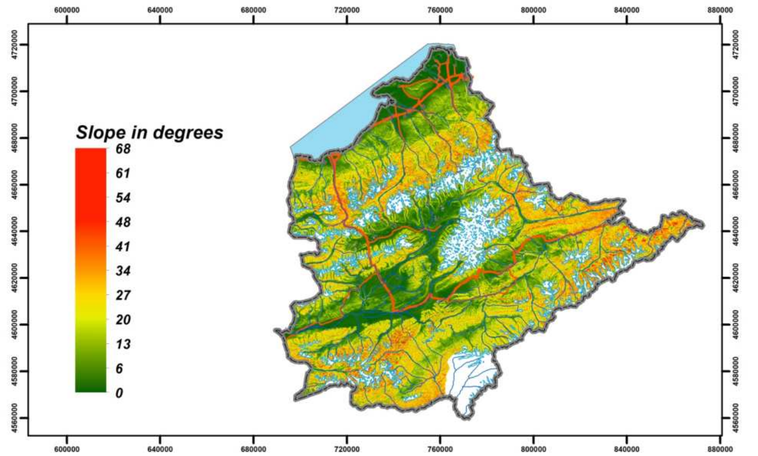
The total number of permanent rural population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 101.1 thousand people. The population density in the district is 7.0 people per 1 km^2 . The administrative center of the region is the village of Kyzyl- Suu with a permanent population of 15.5 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

Jeti -Oguz region is bounded by the waters of Lake Issyk-Kul in the north and by the Teskey Ala - Too ranges and syrts, which stretch south of the range, in the south. The range reaches its highest point in the upper reaches of the Chon-Kyzyl- Suu River (Koyluu peak 5281 m). The syrts are sparsely populated, high-mountain areas with a characteristic alternation of gentle ranges. The valley part is represented by foothill aprons, alluvial-proluvial plains with river alluvial fans, and the lakeside plains of Lake Issyk-Kul.

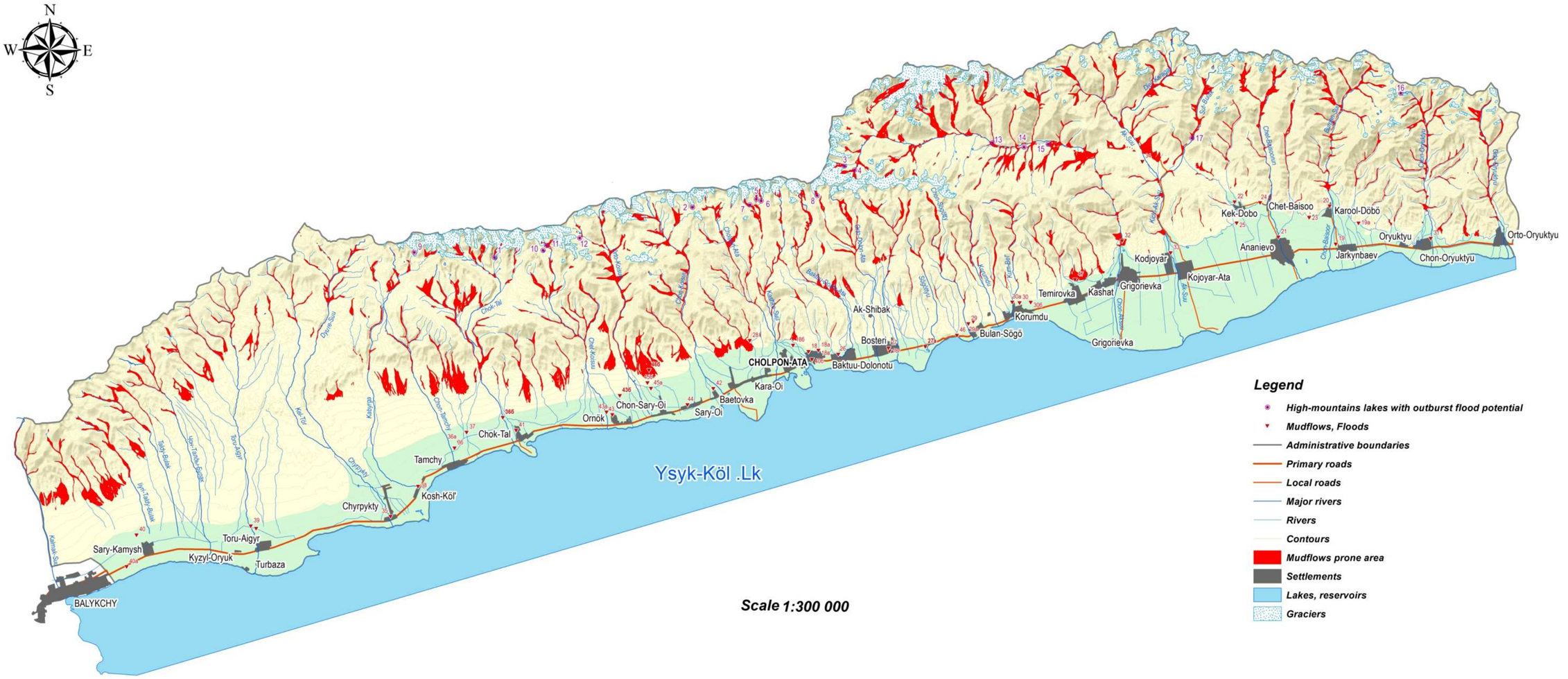
The hydrography of the region is represented by the following rivers: Yrdyk (maximum flow 30 m^3 /sec), Jeti -Oguz (42.2 m^3 /sec), Chon-Kyzyl- Suu (57 m^3 /sec), Kichi -Kyzyl- Suu (45 m^3 /sec), Juuku (65 m^3 /sec), Chon- Dzhargylchak (25 m^3 /sec), Barskoon (55.9 m^3 / sec), Tamga (50 m^3 / sec) and Tosor (65 m^3 / sec).

Mudflows occur once or more times per year.





REGIONS OF ISSYK- KUL REGION
ISSYK-KUL REGION



The Issyk-Kul region was formed in 1930 and is located in the northwestern part of the Issyk-Kul basin. The region's territory is 3,603 km^2 . The Issyk-Kul region borders Kazakhstan in the north, and Kemin in the northwest. Chui region, in the east with the Tyup region.

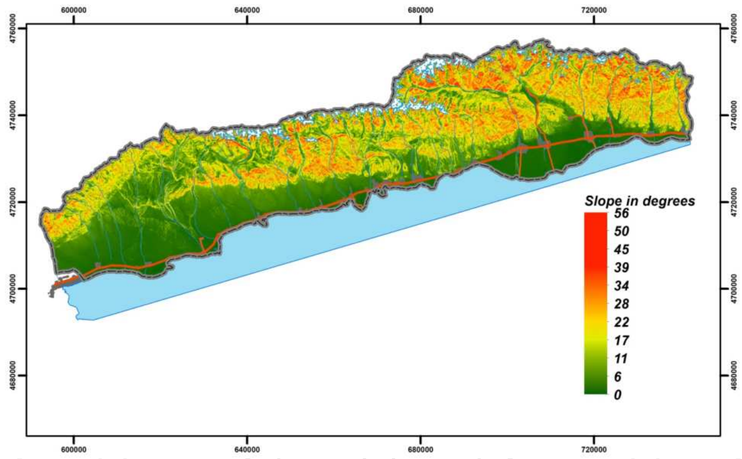
The region's territory is divided into 4 rural districts and 28 settlements: Shaiybek Ata (association of rural districts Chon-Sary-Oy and Kara-Oy), (6 settlements); Sadyr-Ake (association of rural districts Sadyr -Ake, Kum-Bel, Temirov, Kozhoyar (Semyonov) Law of the Kyrgyz Republic No. 1 of 09.01.2024, (8); Zhusup Abdrakhmanov (Zhusup rural district association Abdrakhmanov , Ananyevo, Oruktu) (8); Toru- Aigyr - Tamchy (union of Toru-Aigyr and Tamchy (6). Data according to Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023.

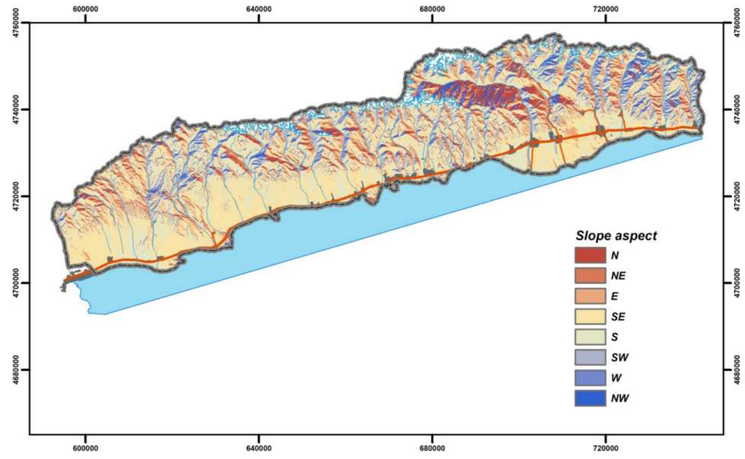
The total permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 99.5 thousand people (urban population - 26.1 thousand people, rural population - 73.4 thousand people). The average population density in the district is 27.6 people per 1 km2 (excluding the area of the water area of Lake Issyk-Kul).

The administrative center of the region is the town of Cholpon- Ata with a permanent population of 26.2 thousand people (including the villages of Bosteri and Baktuu-Dolonotu) as of January 1, 2024.

territory is located between the Kungei Ala- Too ridges and the waters of Lake Issyk-Kul. The region's relief is diverse, with complex folded mid-altitude mountains with erosional dissection, alluvial-proluvial plains and river alluvial fans, river valleys and temporary streams, and a lakeside plain.

The main rivers of the region are Toru- Aigyr , maximum flow 30 m^3 /sec, Orto- Taldy - Bulak (6.5 m^3 /sec), Chon- Taldy - Bulak (7 m^3 /sec), Cholpon- Ata (20 m^3 /sec), Dure-Suu (15 m^3 /sec), Kichi-Aksuu (10 m^3 /sec), Orto- Koisuu (10 m^3 /sec), Orto- Oryuktyu (10 m^3 /sec), Chon- Oryuktyu (20 m^3 /sec), Chet- Baisoorun (15 m^3 /sec), Chon- Baisoorun (20 m^3 /sec sec).





REGIONS OF ISSYK- KUL REGION
TON REGION

It has border with Naryn oblast in the southwest and in the northwest with Chui oblast.

The district is administratively divided into 4 rural districts and 28 settlements: Ak-Terek (an association of the rural districts of Ak-Terek and Kol-Tor) (9 settlements); Kun-Chagysh (an association of the rural districts of Kun-Chagysh, Kadzhi-Sai and Ton) (7); Bolot Mambetov (an association of the rural districts of Bolot Mambetov and Tort-Kul) (7); to leave the aiyl aimak of Ulahol without changing the administrative boundaries, defining the village of Kara-Talaa as the administrative center. (5). The rural district of Kok-Moinok is transferred to the jurisdiction of another administrative-territorial unit of Issyk-Kul oblast. Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023.

The total permanent population of the region according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 56.7 thousand people. The average population density in the area is 7.8 people per 1 km^2.

On the territory of the region there is the city of Balykchy of regional subordination with a permanent population according to the National Statistical Committee as of January 1, 2024 - 57.0 thousand people (including Orto-Tokoy - 0.7 thousand people, the rural district of Kok-Moinok of the Ton region, the village of Ak-Olen - 2.2 thousand people, Kek-Moinok-Pervoe - 1.0 thousand people, Kek-Moinok-Vtoroe - 0.6 thousand people).

The administrative center of the region is the village of Bokonbaevo with a permanent population of 13.3 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

The region's territory is located between the southern shore of Lake Issyk-Kul and the Teskey Ala-Too ridge and has a natural exit to the west from the basin along the Boom gorge. The foothills of the ridge are composed of Mesozoic-Cenozoic deposits, heavily dissected by dry riverbeds, ravines and river valleys.

The lake's coastal zone extends across lakeside plains, river alluvial cones, and is sometimes interrupted, giving way to foothill ridges. To the south of the Teskey Ala-Too ridge, syrts extend.

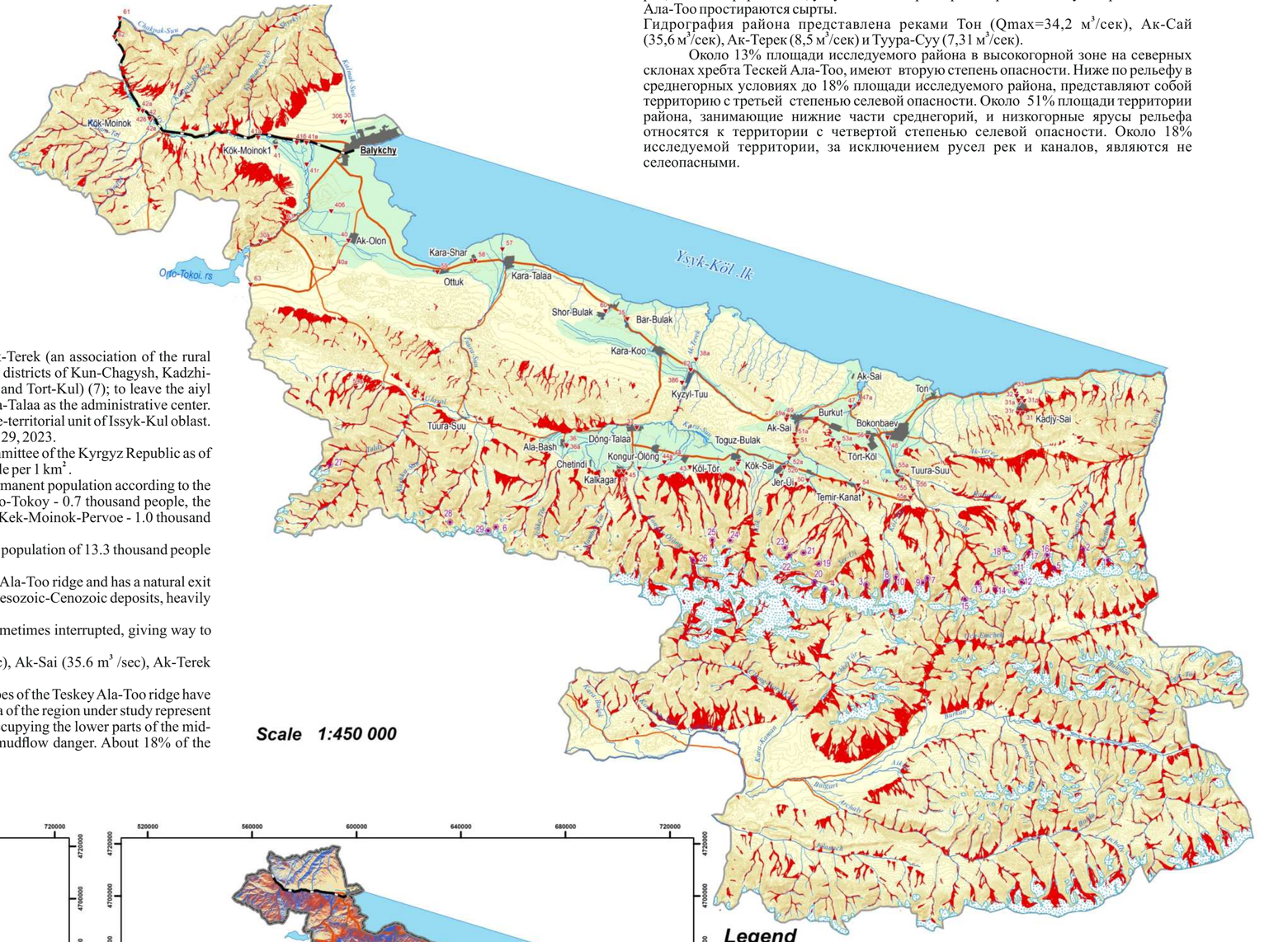
The hydrography of the region is represented by the rivers Ton (Qmax=34.2 m^3 /sec), Ak-Sai (35.6 m^3 /sec), Ak-Terek (8.5 m^3 /sec) and Tuura-Suu (7.31 m^3 /sec).

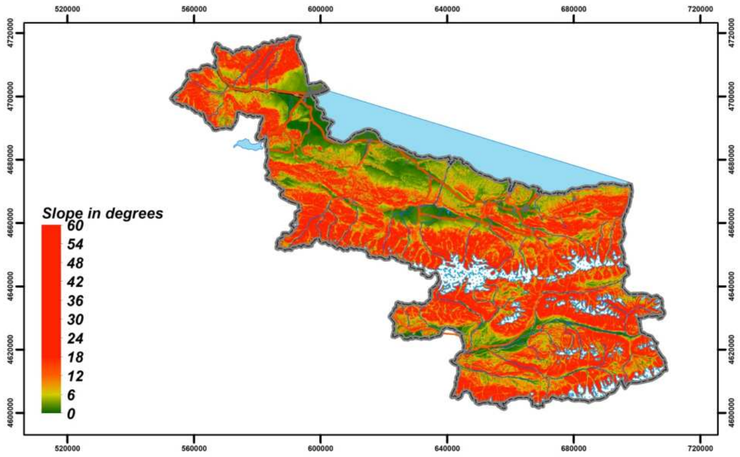
About 13% of the area of the region under study in the high-mountain zone on the northern slopes of the Teskey Ala-Too ridge have the second degree of danger. Below the relief in mid-mountain conditions up to 18% of the area of the region under study represent the territory with the third degree of mudflow danger. About 51% of the area of the region, occupying the lower parts of the mid-mountains and low-mountain relief tiers, belong to the territory with the fourth degree of mudflow danger. About 18% of the territory under study, with the exception of river beds and canals, are not mudflow hazardous.

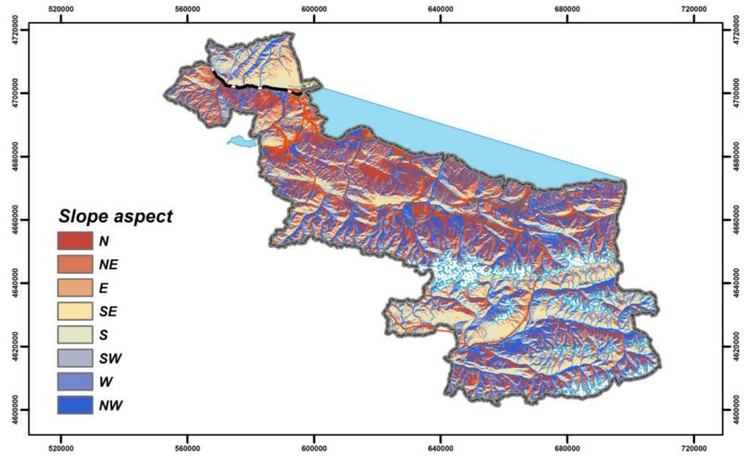
Береговая зона озера простирается приозерными равнинами, конусами выноса рек, иногда прерывается, уступая место предгорным грядам. К югу от хребта Тескей Ала-Тоо простираются сырты.

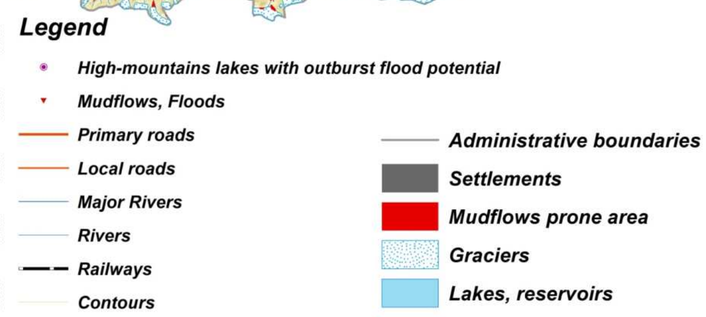
Гидрография района представлена реками Тон (Qmax=34,2 м^3/сек), Ак-Сай (35,6 м^3/сек), Ак-Терек (8,5 м^3/сек) и Туура-Суу (7,31 м^3/сек).

Около 13% площади исследуемого района в высокогорной зоне на северных склонах хребта Тескей Ала-Тоо, имеют вторую степень опасности. Ниже по рельефу в среднегорных условиях до 18% площади исследуемого района, представляют собой территорию с третьей степенью селевой опасности. Около 51% площади территории района, занимающие нижние части среднегорий, и низкогорные ярусы рельефа относятся к территории с четвертой степенью селевой опасности. Около 18% исследуемой территории, за исключением русел рек и каналов, являются не селеопасными.









REGIONS OF ISSYK- KUL REGION
TYUP REGION

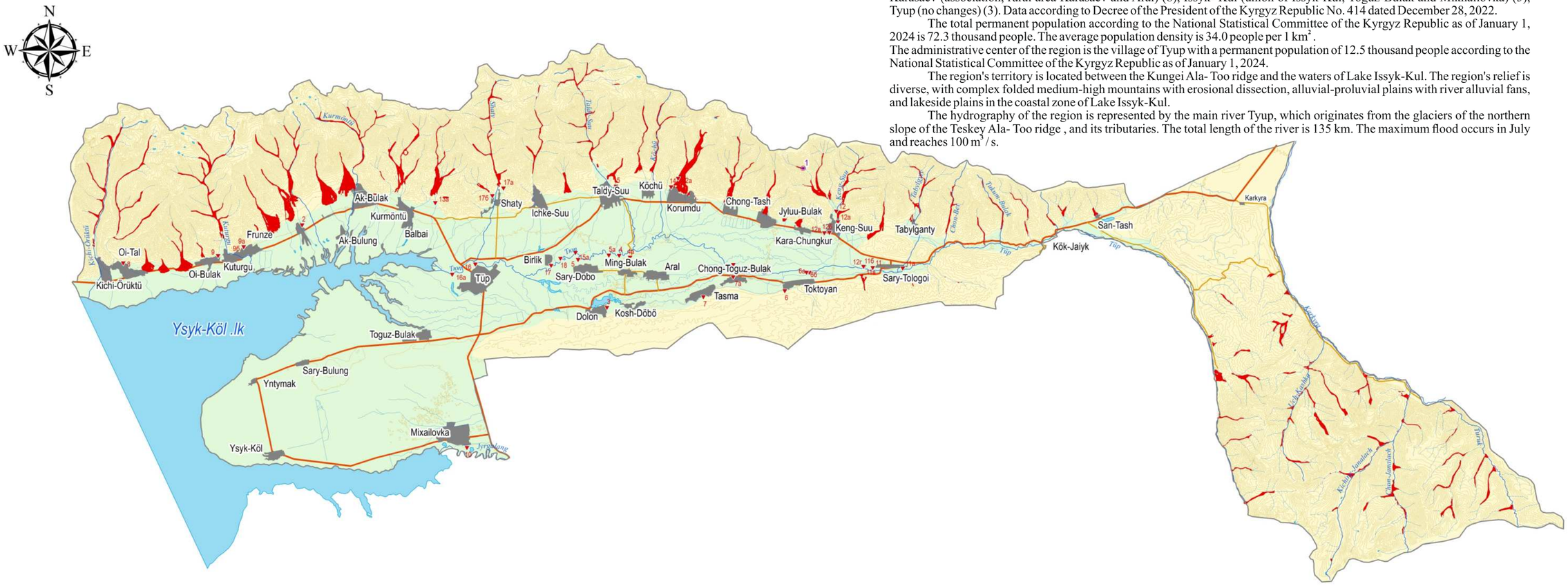
The Tyup region was formed in 1934 and is located in the northeastern part of the Issyk-Kul basin. The region's territory is 2,121 km² and is located at an altitude of 1,606 to 4,000 m above sea level. The Tyup region borders Kazakhstan in the northeast and the Issyk-Kul region, and to the south with the Ak-Su region.

There are 35 rural settlements in the region, belonging to 5 rural regions: Balbay (union of rural districts of Kudurgu , Ak - Bulun , Ak- Bulak and Sary-Bulak) (10 settlements), Karkyra (union, rural district of Taldy-Suu , Chon- Tash and San- Tash) (11), Karasaev (association, rural area Karasaev and Aral) (8), Issyk- Kul (union of Issyk-Kul, Toguz-Bulak and Mikhailovka) (5), Tyup (no changes) (3). Data according to Decree of the President of the Kyrgyz Republic No. 414 dated December 28, 2022.

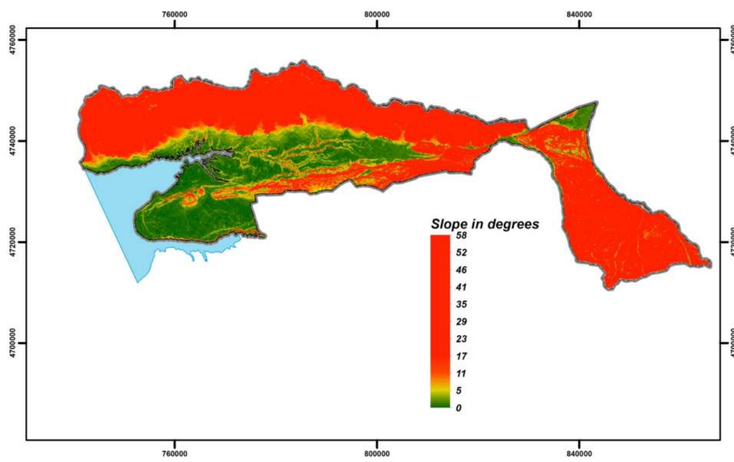
The total permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 72.3 thousand people. The average population density is 34.0 people per 1 km² .
The administrative center of the region is the village of Tyup with a permanent population of 12.5 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

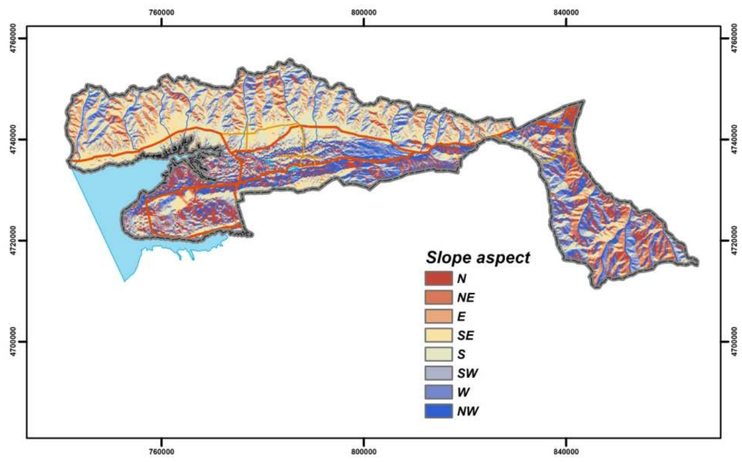
The region's territory is located between the Kungei Ala- Too ridge and the waters of Lake Issyk-Kul. The region's relief is diverse, with complex folded medium-high mountains with erosional dissection, alluvial-proluvial plains with river alluvial fans, and lakeside plains in the coastal zone of Lake Issyk-Kul.

The hydrography of the region is represented by the main river Tyup, which originates from the glaciers of the northern slope of the Teskey Ala- Too ridge , and its tributaries. The total length of the river is 135 km. The maximum flood occurs in July and reaches 100 m³ / s.



Scale 1:250 000

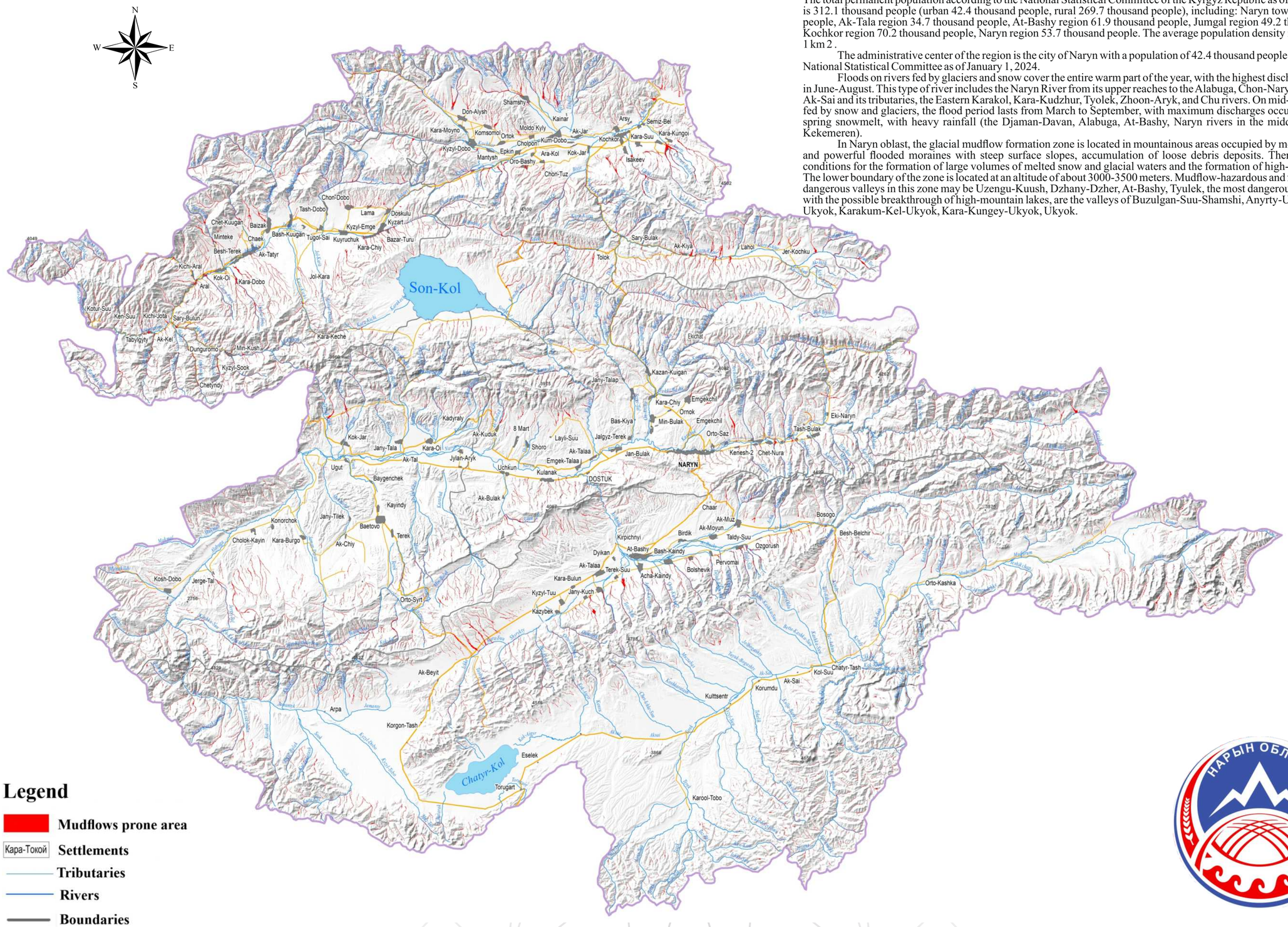




Legend

- *High-mountains lakes with outburst flood potential*
- *Mudflows, Floods*
- *Administrative boundaries*
- *Major rivers*
- *Rivers*
- *Primary roads*
- *Local roads*
- *Contours*
- *Mudflows prone area*
- *Settlements*
- *Lakes, reservoirs*

MUDFLOW EXPOSURE MAP FOR NARYN OBLAST



Legend

- Mudflows prone area
- Кара-Токой — Settlements
- Tributaries
- Rivers
- Boundaries

Naryn oblast was formed on December 11, 1970, occupies the central part of the Kyrgyz Republic and borders on the People's Republic of China to the south, on the Osh and Jalal-Abad oblast to the southwest and west, and on Chui oblast to the north, from the north-east and east from Issyk-Kul oblast of Kyrgyzstan. The area of the region is 44160 km^2 (including the water area of Lake Son-Kul with an area of 283 km^2).

The territory of the region is divided into 5 administrative regions: Ak-Tala, At-Bashy, Zhumgal, Kochkor, Naryn. There is one city, 27 rural districts and 144 rural settlements in the region.

Data according to the Decree of the President of the Kyrgyz Republic No. 85 dated April 3, 2023.

The total permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 312.1 thousand people (urban 42.4 thousand people, rural 269.7 thousand people), including: Naryn town 42.4 thousand people, Ak-Tala region 34.7 thousand people, At-Bashy region 61.9 thousand people, Jumgal region 49.2 thousand people, Kochkor region 70.2 thousand people, Naryn region 53.7 thousand people. The average population density is 7.1 people per 1 km 2 .

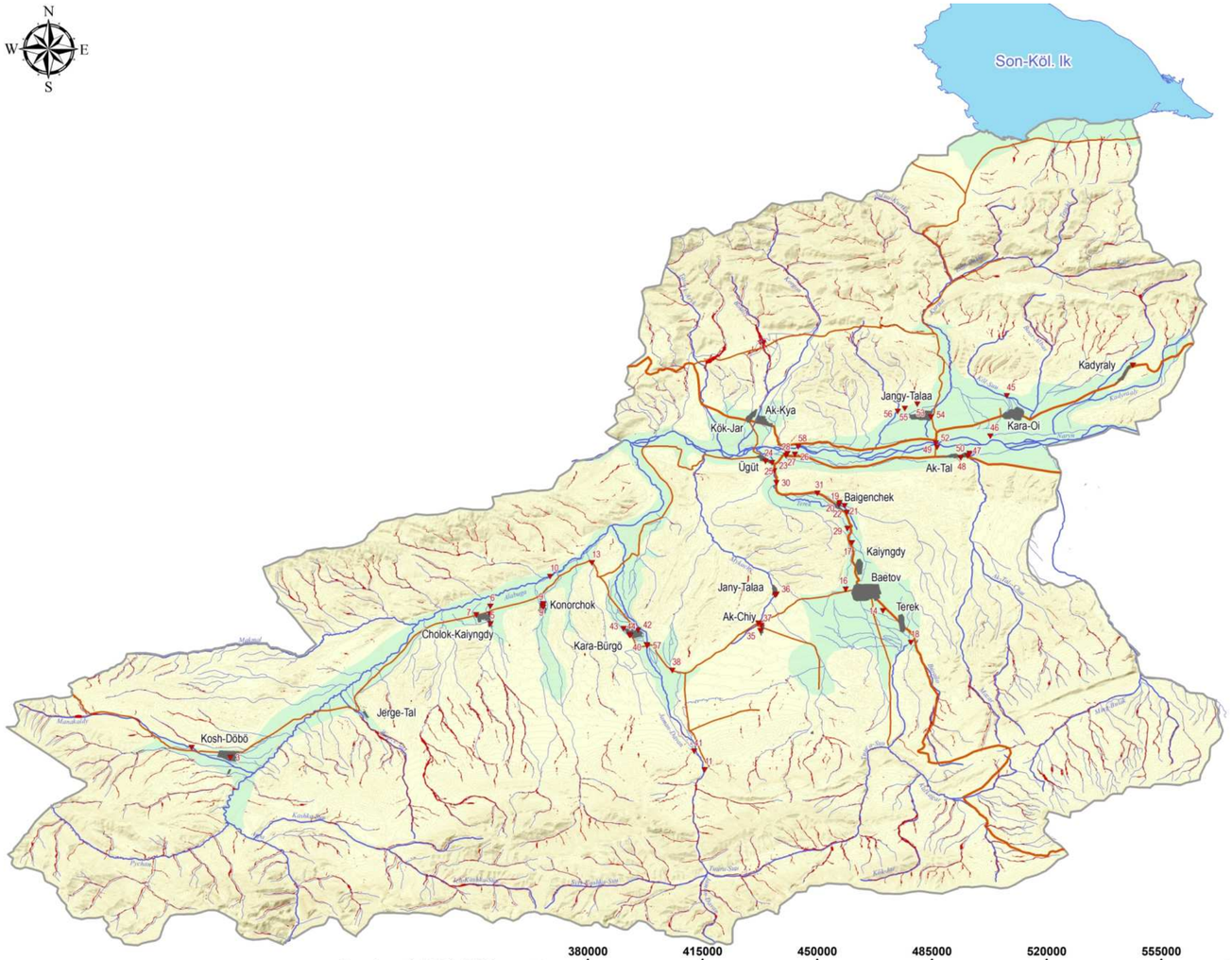
The administrative center of the region is the city of Naryn with a population of 42.4 thousand people according to the National Statistical Committee as of January 1, 2024.

Floods on rivers fed by glaciers and snow cover the entire warm part of the year, with the highest discharges occurring in June-August. This type of river includes the Naryn River from its upper reaches to the Alabuga, Chon-Naryn, Kichi-Naryn, Ak-Sai and its tributaries, the Eastern Karakol, Kara-Kudzhur, Tyolek, Zhoon-Aryk, and Chu rivers. On mid-mountain rivers fed by snow and glaciers, the flood period lasts from March to September, with maximum discharges occurring during the spring snowmelt, with heavy rainfall (the Djaman-Davan, Alabuga, At-Bashy, Naryn rivers in the middle reaches, and Kekemeren).

In Naryn oblast, the glacial mudflow formation zone is located in mountainous areas occupied by modern glaciation and powerful flooded moraines with steep surface slopes, accumulation of loose debris deposits. There are favorable conditions for the formation of large volumes of melted snow and glacial waters and the formation of high-mountain lakes. The lower boundary of the zone is located at an altitude of about 3000-3500 meters. Mudflow-hazardous and flood-hazardous dangerous valleys in this zone may be Uzengu-Kuush, Dzhany-Dzher, At-Bashy, Tyulek, the most dangerous, in connection with the possible breakthrough of high-mountain lakes, are the valleys of Buzulgan-Suu-Shamshi, Anyrty-Ukyok east., Kel-Ukyok, Karakum-Kel-Ukyok, Kara-Kungey-Ukyok, Ukyok.

НАРЫН ОБЛУСУ

REGIONS OF NARYN OBLAST
AK-TALA REGION



Ak-Tala region was formed in 1939. The region covers an area of 7266 km^2 . The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 34.7 thousand people. The average population density is 4.7 people per 1 km^2 .

There are 19 rural settlements in the region, belonging to 4 rural regions: Ala-Buga (association of the rural districts of Kosh- Dobo , Zherge -Tal and Konorchok) (4 settlements), Baetov (association of the rural districts of Baetov , Terek and Ugut) (6), Kara- Burgon (association of the rural districts of Ak-Chii and Kara-Burgon) (3), Togolok-Moldo (association of the rural districts of Ak-Tal, Jany- Talap , Kok-Zhar, Togolok - Moldo , Kyzyl-Bel) (6), Data according to the Decree of the President of the Kyrgyz Republic No. 85 dated April 3, 2023.

The administrative center of the region is the village of Baetovo with a permanent population of 9.4 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

The Ak-Tala region is located in the western part of the Naryn oblast and is bordered to the north and northeast by the Moldo-Too ranges , to the south and southeast by the Baibiche-Too range , and to the west by the Fergana range.

The mountainous area is characterized by highly dissected relief and high gravitational energy of the slopes. The difference in absolute marks in the mountainous zone varies from 2600 to 4737 m, in the valley zone - from 1500 to 2600 m.

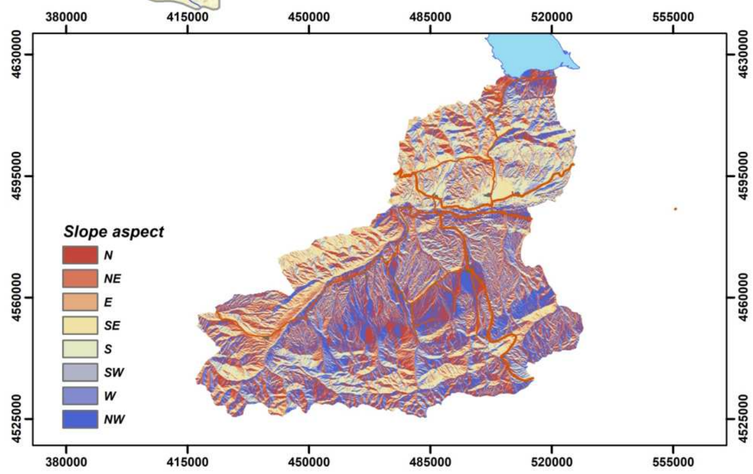
The main rivers of the region are the Naryn River (maximum flow 858 m^3/sec), the Alabuga River (446 m^3/sec) and their tributaries Terek, Zhaman-Davan , Konorchok , Kurtka, Korgon and others. Lake Son-Köl is located on the northern border .

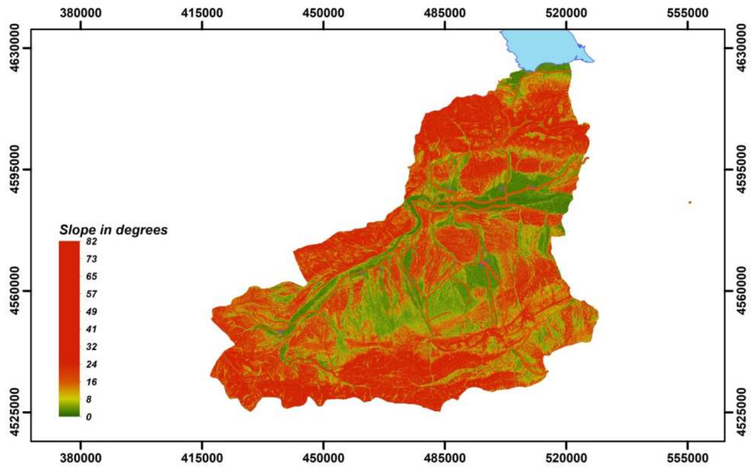
43% of the region's territory is classified as the fourth level of danger. They are confined to low-mountain and valley sections of the southern slopes of the Moldo-Too and Akcha-Tash ridges , as well as the northern slopes of Baibiche-Too . 43% of the territory, confined to high-mountain and mid-mountain areas, is classified as the third level of danger. 14% along the valleys of large rivers is classified as non-mudflow hazardous .

Scale 1:500 000

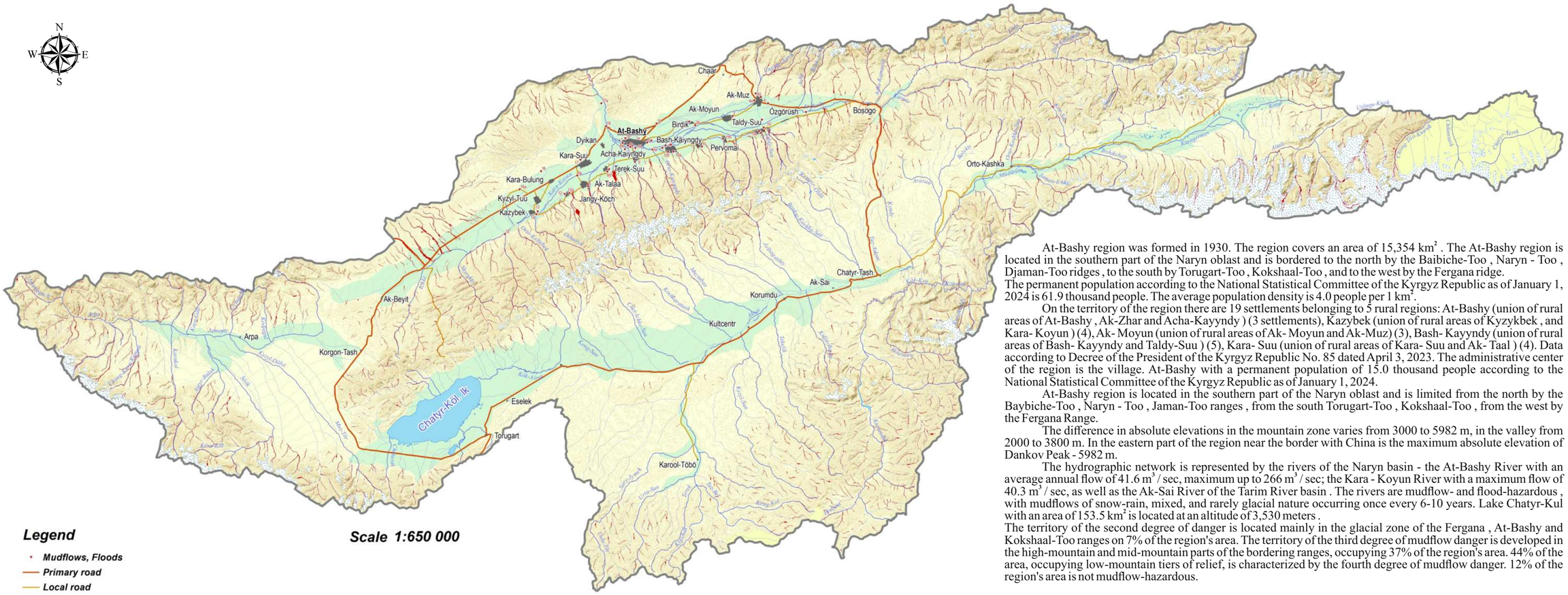
Legend

- *Mudflows, Floods*
- *Primary road*
- *Local road*
- *Major rivers*
- *Rivers*
- *Administrative boundaries*
- *Contour*
- *Settlements*
- *Lakes, reservoirs*
- *Mudflows prone area*





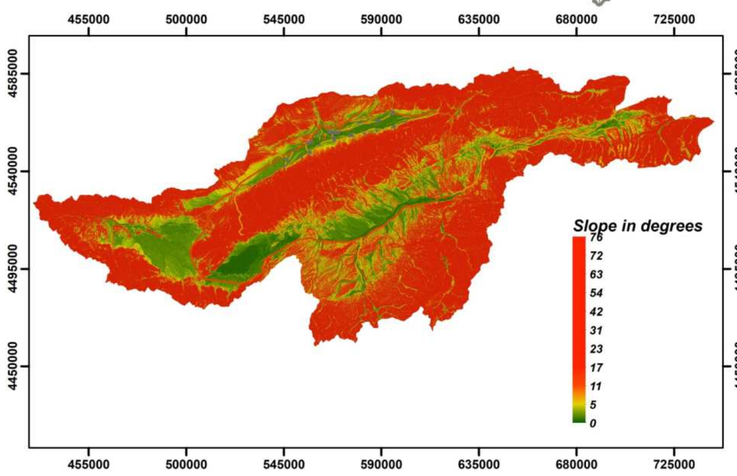
REGIONS OF NARYN OBLAST
AT-BASHY REGION

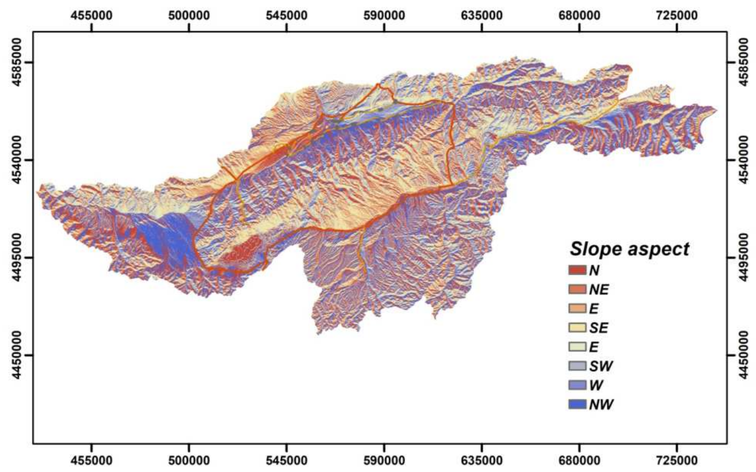


Scale 1:650 000

Legend

- Mudflows, Floods
- Primary road
- Local road
- Major rivers
- Rivers
- Administrative boundaries
- Contour
- Settlements
- Graciers
- Mudflows prone area
- Lakes, reservoirs





At-Bashy region was formed in 1930. The region covers an area of 15,354 km² . The At-Bashy region is located in the southern part of the Naryn oblast and is bordered to the north by the Baibiche-Too , Naryn - Too , Djaman-Too ridges , to the south by Torugart-Too , Kokshaal-Too , and to the west by the Fergana ridge.

The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 61.9 thousand people. The average population density is 4.0 people per 1 km².

On the territory of the region there are 19 settlements belonging to 5 rural regions: At-Bashy (union of rural areas of At-Bashy , Ak-Zhar and Acha-Kayyndy) (3 settlements), Kazybek (union of rural areas of Kyzykbek , and Kara- Koyun) (4), Ak- Moyun (union of rural areas of Ak- Moyun and Ak-Muz) (3), Bash- Kayyndy (union of rural areas of Bash- Kayyndy and Taldy-Suu) (5), Kara- Suu (union of rural areas of Kara- Suu and Ak- Taal) (4). Data according to Decree of the President of the Kyrgyz Republic No. 85 dated April 3, 2023. The administrative center of the region is the village. At-Bashy with a permanent population of 15.0 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

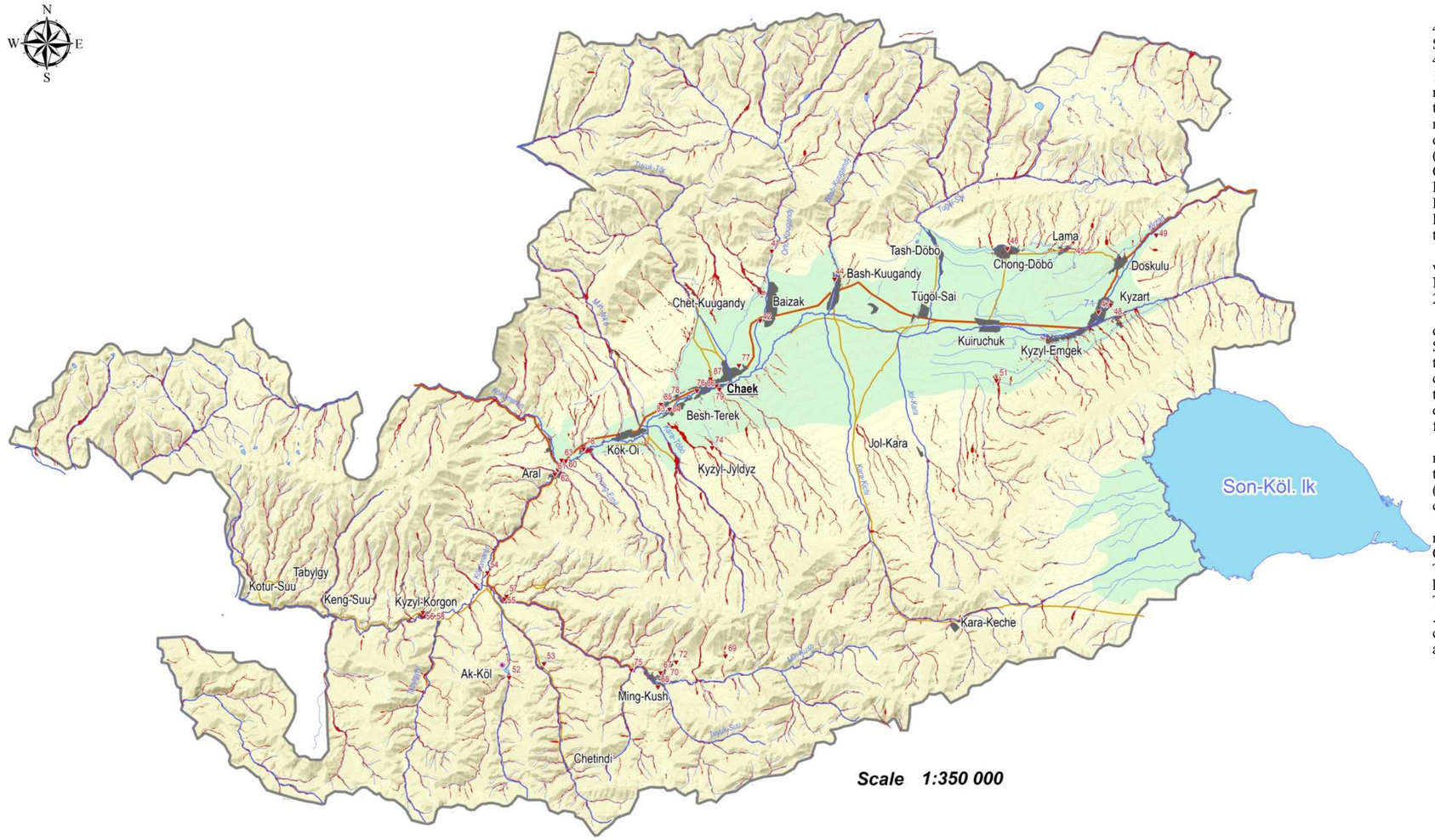
At-Bashy region is located in the southern part of the Naryn oblast and is limited from the north by the Baybiche-Too , Naryn - Too , Jaman-Too ranges , from the south Torugart-Too , Kokshaal-Too , from the west by the Fergana Range.

The difference in absolute elevations in the mountain zone varies from 3000 to 5982 m, in the valley from 2000 to 3800 m. In the eastern part of the region near the border with China is the maximum absolute elevation of Dankov Peak - 5982 m.

The hydrographic network is represented by the rivers of the Naryn basin - the At-Bashy River with an average annual flow of 41.6 m³ / sec, maximum up to 266 m³ / sec; the Kara - Koyun River with a maximum flow of 40.3 m³ / sec, as well as the Ak-Sai River of the Tarim River basin . The rivers are mudflow- and flood-hazardous , with mudflows of snow-rain, mixed, and rarely glacial nature occurring once every 6-10 years. Lake Chatyr-Kul with an area of 153.5 km² is located at an altitude of 3,530 meters .

The territory of the second degree of danger is located mainly in the glacial zone of the Fergana , At-Bashy and Kokshaal-Too ranges on 7% of the region's area. The territory of the third degree of mudflow danger is developed in the high-mountain and mid-mountain parts of the bordering ranges, occupying 37% of the region's area. 44% of the area, occupying low-mountain tiers of relief, is characterized by the fourth degree of mudflow danger. 12% of the region's area is not mudflow-hazardous.

REGIONS OF NARYN OBLAST
JUMGAL REGION



Jumgal region was formed in 1935. The region covers an area of 4803 km^2 . The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 49.2 thousand people. The average population density is 10.2 people per 1 km 2 . There are 31 rural settlements in the region, which belong to 6 rural regions: Kyzart (association of Jany-Aryk, Kuyruchuk (except for the village of Kyrchyn) (5 settlements), Zhumgal (association of the rural districts of Zhumgal and Chon - Dobo) (3), Togul -Sai (association of the rural districts of Togul -Sai and Tash-Dobo) (3), Baizak (association of the rural districts of Baizak and Bash- Kuugandy) (2), Chaek (association of the rural districts of Chaek , Kyzyl -Zhyldyz , Kok-Oi and having annexed the village of Kyrchyn of the rural district of Kuyruchuk) (9), Min-Kush (association of the rural districts of Min-Kush and Kabak) (9). Data according to the Decree of the President of the Kyrgyz Republic No. 85 dated April 3, 2023.

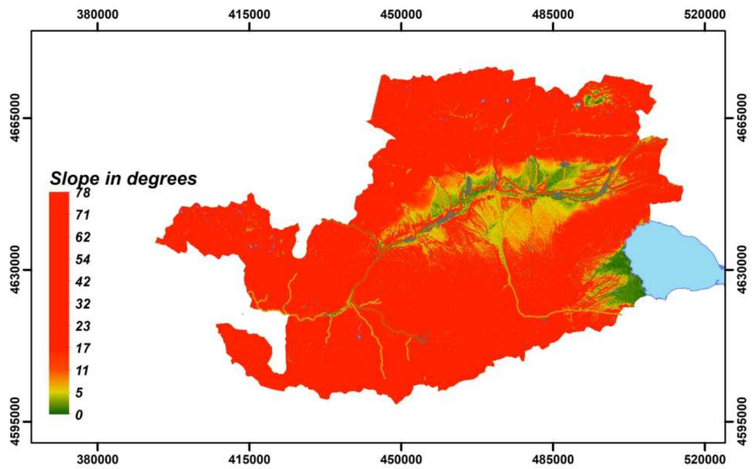
The administrative center of the region is the village of Chaek with a permanent population of 5.2 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

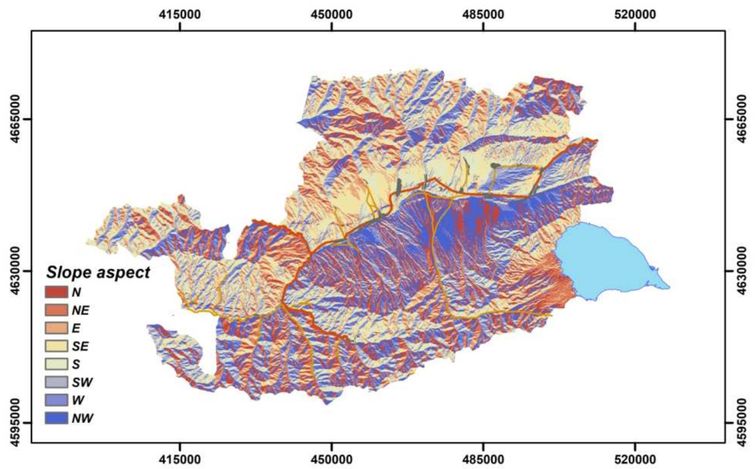
Jumgal region is located in the northwestern part of the Naryn oblast and is bordered by the Jumgal-Too and Sandyk ridges to the north, Suusamyr-Too and Sary-Kamysh to the west , Kabak- Too and Son- Kel to the south, and the Kyzart ridge to the east . The mountainous area is characterized by highly dissected relief and high gravitational energy of the slopes. The difference in absolute marks of the bottom of the depression varies from 1,500 to 2,600 m, and in the mountainous zone from 2,600 m to 4,185 m.

The main rivers of the region are the Kökömeren (average maximum flow rate 436 m^3 / sec, 1% probability flow rate 998 m^3 / sec), the Jumgal River (maximum flow rate 80 m^3 /sec), and the Min-Kush (1% probability flow rate 161 m^3 / sec). Lake Son- Köl is located in the eastern part of the region .

The territory of the second degree of danger is confined to the northern slopes of the Oi - Kaiyng ridge , the left lateral tributaries of the Oi - Kaiyng , Boorondu and Boz - Aldy rivers (1% of the region's area). The territory of the third degree of mudflow danger is developed in the high-mountain and mid-mountain parts of the Moldo-Too , Dzhumgal-Too ridges. Sandyk , Suusamyr-Too , occupying 52% of the region's area . Low-mountain relief tiers, occupying about 39% of the area, are characterized by the fourth degree of mudflow danger. 8% of the region's area is not mudflow-hazardous.

Legend
- Mudflows, Floods
- High-mountains lakes with outburst flood potential
- Contours
- Administrative boundaries
- Primary roads
- Local roads
- Major rivers
- Rivers
- Settlements
- Mudflows prone area
- Lakes, reservoirs





REGIONS OF NARYN OBLAST
KOCHKOR REGION

Kochkor region was formed in 1935. The region covers an area of 5868 km^2. The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 70.2 thousand people. The average population density is 12.0 people per 1 km^2. There are 35 settlements in the region, which belong to 5 rural regions: Kochkor (unification of the rural districts of Kochkor , Ak- Kiyan , Kosh- Dobo , Kok- Zharo , by annexing the village of Semiz -Bel, rural district of Semiz-Bel) (9 settlements), Kum-Dobo (annexation of the village of Arsy and Kara- Too of the rural district of Semiz - Bel to the rural district of Kum -Dobo) (6), Cholpon (annexation of the village of Chekildek of the rural district of Semiz -Bel to the rural district of Cholpon) (10), Kara- Suu (unification of the rural districts of Kara- Suu and Talaa-Bulak) (7), Sary-Bulak (unification of the rural districts of Sary- Bulaksk and Son-Kol) (3). Data according to the Decree of the President of the Kyrgyz Republic No. 85 dated April 3, 2023.

The administrative center of the region is the village of Kochkorka with a permanent population of 10.7 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

Kochkor region is located in the northern part of the Naryn oblast and is bordered by the Kyrgyz ranges to the north, the Kara- Moinok and Sandyk ranges to the east , the Karagatty and Kyzart ranges to the south, and the Kara- Kungey and Ukyok ranges to the east . The mountainous area is characterized by highly dissected relief and high gravitational energy of the slopes. The difference in absolute elevations in the valley part varies from 1,700 to 2,400 m, and in the mountainous zone from 2,400 to 4,502 m.

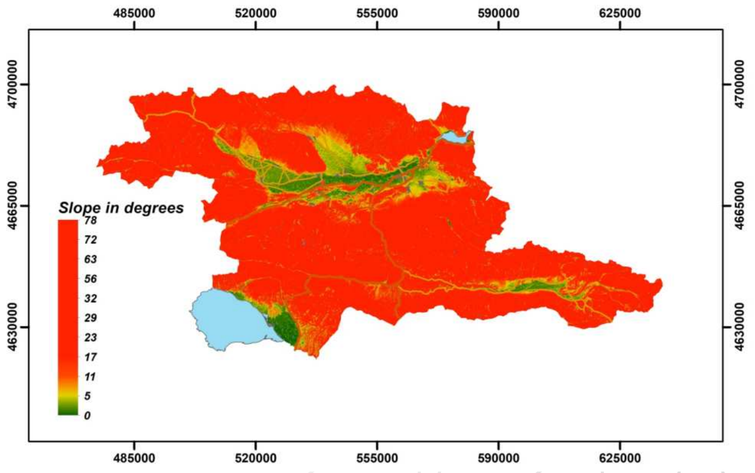
The main rivers of the Chu River basin are the Kara- Kudzhur (maximum flow rate 129 m^3 / sec), Zhoon -Aryk (131 m^3 / sec), Eastern Seok (94.4 m^3 / sec), Eastern Karakol (64.5 m^3 / sec), Tyulek (20.8 m^3 / sec), Shamshy (7.6 m^3 / sec), Tyundyuk (7.8 m^3 / sec).

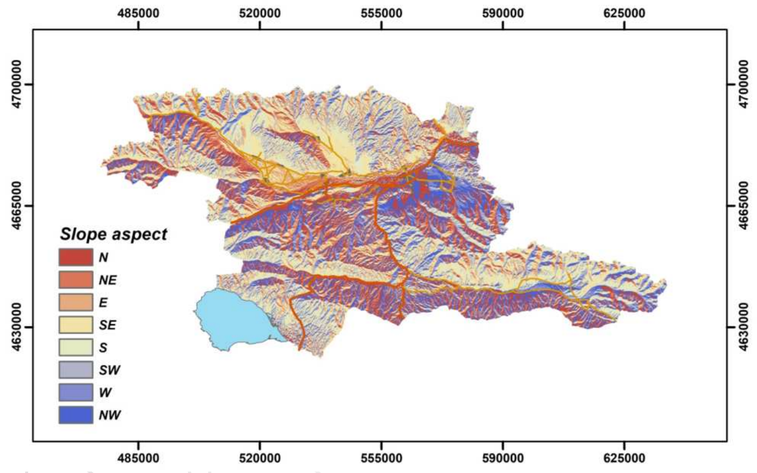
Kyol is located in the southwest of the region .

The territory of the second degree of danger, constituting 4% of the region's area, is developed in the high-mountain part of the Teskey Ala- Too and Karagatty ranges , the Ukyok and Kashka- Suu river basins . The territory of the third degree of mudflow danger (29% of the region's area) covers the high-mountain and mid-mountain parts of the lower slopes of the Kyrgyz ridge, the Teskey Ala- Too , Karagatty , Son- Kyol , Kara- Djorgo ranges , the Chon- Korumdu , Kek-Adyr , Buzulgan-Suu river basins , the upper reaches of the East Karakol River. 55% of the region's area in the mid- and lower mountain parts of mountain structures are classified as the fourth degree of mudflow danger. 12% of the region's area is not mudflow hazardous.

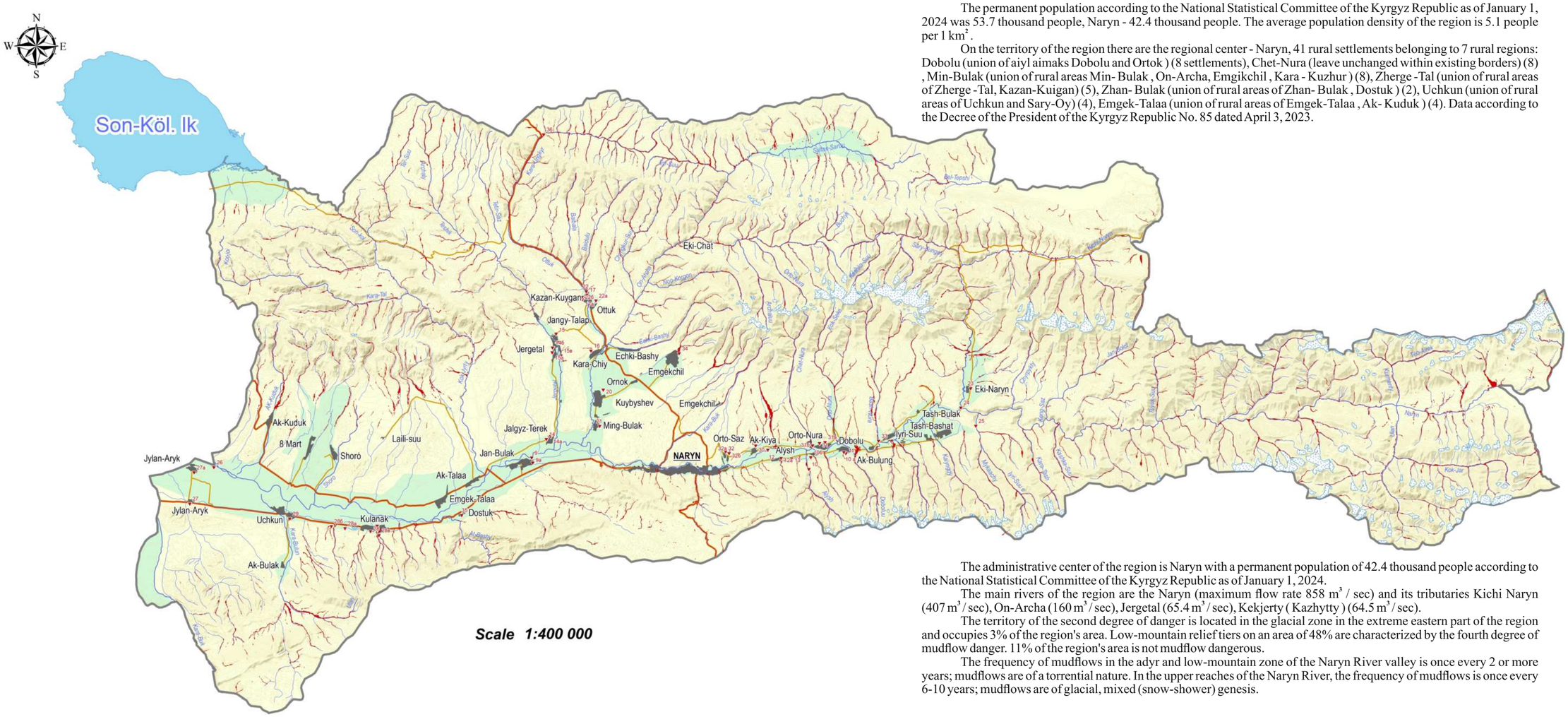
Legend

- *High-mountains lakes with outburst flood potential*
- *Mudflows, Floods*
- *Administrative boundaries*
- *Contour*
- *Major rivers*
- *Rivers*
- *Primary roads*
- *Local roads*
- *Mudflows prone areas*
- *Settlements*
- *Lakes, reservoirs*
- *Graciers*





REGIONS OF NARYN OBLAST
NARYN REGION



The Naryn region was formed in 1930. The region covers an area of 10,586 km² , the city of Naryn - 84 km² . The Naryn region is located in the eastern part of the Naryn oblast and is bordered by the Terskey , Kara- Kaman ridges to the north, the Borkoldo , Jetim , Kapka- Tash ridges to the east , the Naryn - Too ridge to the south, and the Ala- Tash , Itelgi-Ukyok ridges to the west . The mountainous zone is characterized by highly dissected relief and high gravitational energy of the slopes. The difference in absolute marks of the valley part is 1500-3200 m, the mountainous zone - from 3200 to 4499 m.

The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 was 53.7 thousand people, Naryn - 42.4 thousand people. The average population density of the region is 5.1 people per 1 km² .

On the territory of the region there are the regional center - Naryn, 41 rural settlements belonging to 7 rural regions: Dobolu (union of aiyl aimaks Dobolu and Ortok) (8 settlements), Chet-Nura (leave unchanged within existing borders) (8) , Min-Bulak (union of rural areas Min- Bulak , On-Archa, Emgikchil , Kara - Kuzhur) (8), Zherge -Tal (union of rural areas of Zherge -Tal, Kazan-Kuigan) (5), Zhan- Bulak (union of rural areas of Zhan- Bulak , Dostuk) (2), Uchkun (union of rural areas of Uchkun and Sary-Oy) (4), Emgek-Talaa (union of rural areas of Emgek-Talaa , Ak- Kuduk) (4). Data according to the Decree of the President of the Kyrgyz Republic No. 85 dated April 3, 2023.

The administrative center of the region is Naryn with a permanent population of 42.4 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

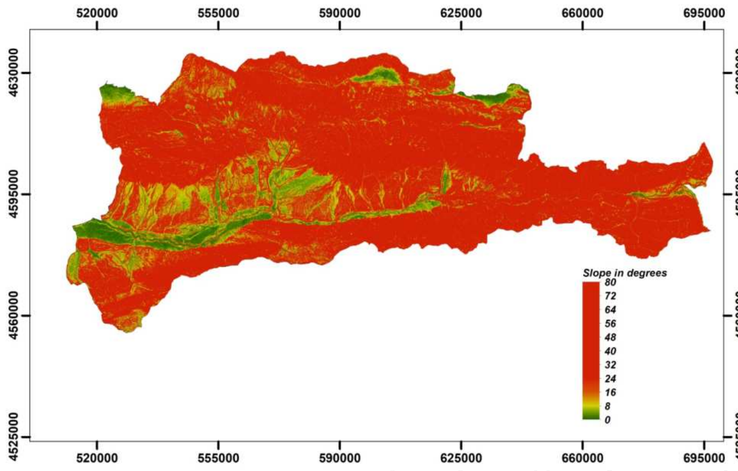
The main rivers of the region are the Naryn (maximum flow rate 858 m³ / sec) and its tributaries Kichi Naryn (407 m³ / sec), On-Archa (160 m³ / sec), Jergetal (65.4 m³ / sec), Kekjerty (Kazhytty) (64.5 m³ / sec).

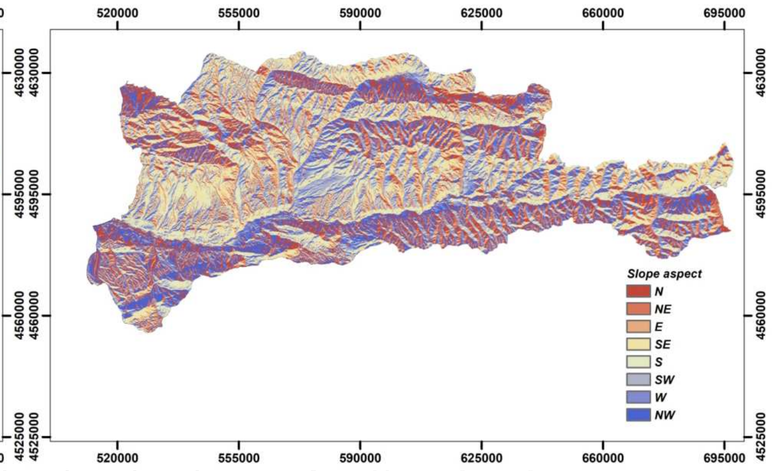
The territory of the second degree of danger is located in the glacial zone in the extreme eastern part of the region and occupies 3% of the region's area. Low-mountain relief tiers on an area of 48% are characterized by the fourth degree of mudflow danger. 11% of the region's area is not mudflow dangerous.

The frequency of mudflows in the adyr and low-mountain zone of the Naryn River valley is once every 2 or more years; mudflows are of a torrential nature. In the upper reaches of the Naryn River, the frequency of mudflows is once every 6-10 years; mudflows are of glacial, mixed (snow-shower) genesis.

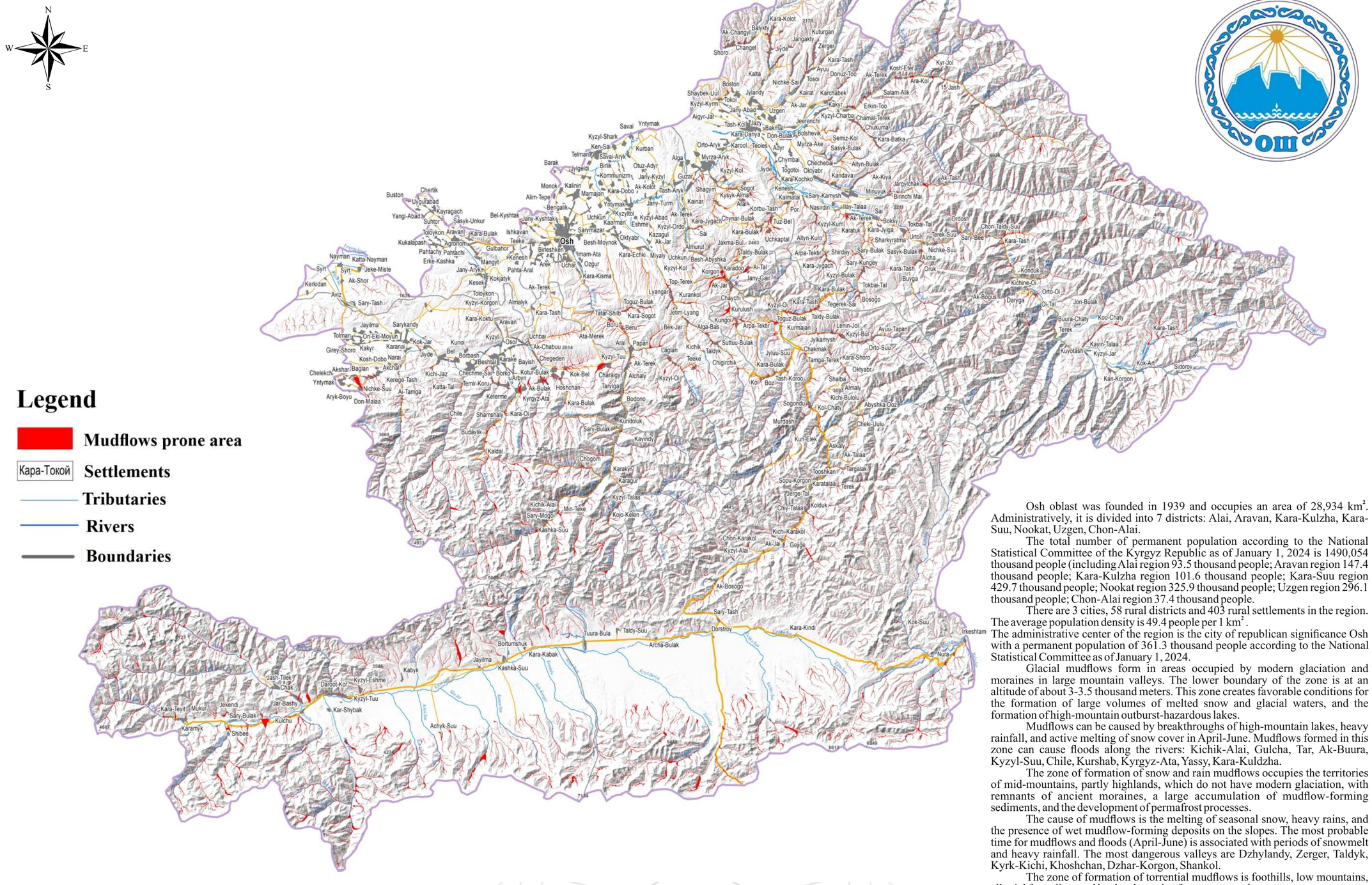
Legend

- Mudflows, Floods
- Major rivers
- Rivers
- Primary roads
- Local road
- Administrative boundaries
- Contours
- Settlements
- Lakes, reservoirs
- Settlements
- Mudflows prone area
- Graciers





MUDFLOW SUSCEPTIBILITY MAP IN OSH OBLAST



Osh oblast was founded in 1939 and occupies an area of 28,934 km². Administratively, it is divided into 7 districts: Alai, Aravan, Kara-Kulzha, Kara-Suu, Nookat, Uzgen, Chon-Alai.

The total number of permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 1490,054 thousand people (including Alai region 93.5 thousand people; Aravan region 147.4 thousand people; Kara-Kulzha region 101.6 thousand people; Kara-Suu region 429.7 thousand people; Nookat region 325.9 thousand people; Uzgen region 296.1 thousand people; Chon-Alai region 37.4 thousand people.

There are 3 cities, 58 rural districts and 403 rural settlements in the region. The average population density is 49.4 people per 1 km². The administrative center of the region is the city of republican significance Osh with a permanent population of 361.3 thousand people according to the National Statistical Committee as of January 1, 2024.

Glacial mudflows form in areas occupied by modern glaciation and moraines in large mountain valleys. The lower boundary of the zone is at an altitude of about 3-3.5 thousand meters. This zone creates favorable conditions for the formation of large volumes of melted snow and glacial waters, and the formation of high-mountain outburst-hazardous lakes.

Mudflows can be caused by breakthroughs of high-mountain lakes, heavy rainfall, and active melting of snow cover in April-June. Mudflows formed in this zone can cause floods along the rivers: Kichik-Alai, Gulcha, Tar, Ak-Buura, Kyzyl-Suu, Chile, Kurshab, Kyrgyz-Ata, Yassy, Kara-Kuldzha.

The zone of formation of snow and rain mudflows occupies the territories of mid-mountains, partly highlands, which do not have modern glaciation, with remnants of ancient moraines, a large accumulation of mudflow-forming sediments, and the development of permafrost processes.

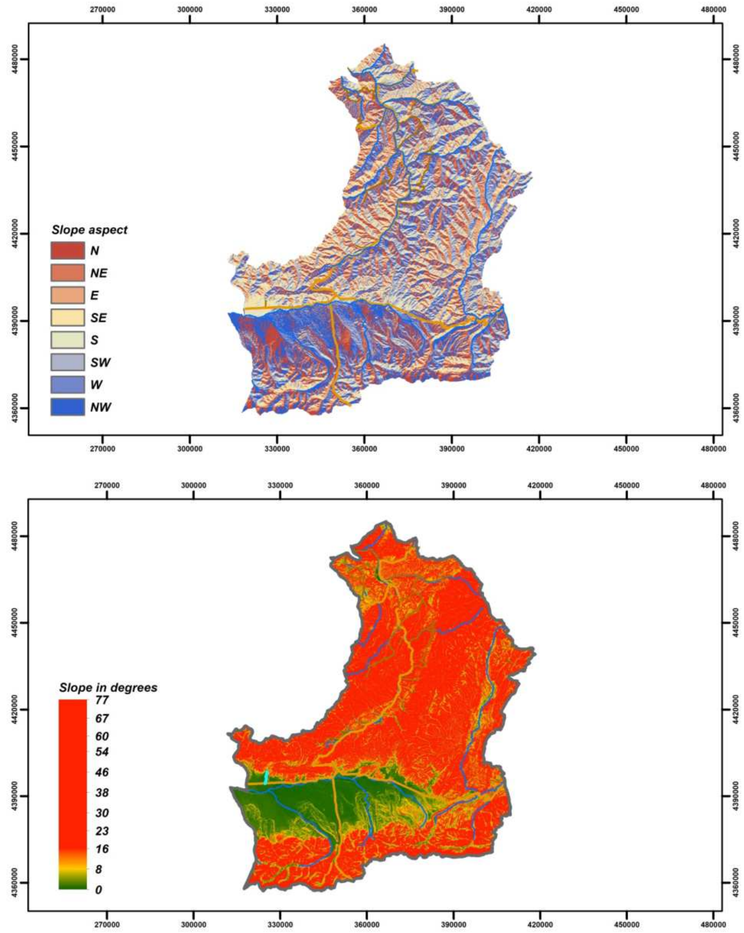
The cause of mudflows is the melting of seasonal snow, heavy rains, and the presence of wet mudflow-forming deposits on the slopes. The most probable time for mudflows and floods (April-June) is associated with periods of snowmelt and heavy rainfall. The most dangerous valleys are Dzhylandy, Zerger, Taldyk, Kyrk-Kichi, Khoshchan, Dzhar-Korgon, Shankol.

The zone of formation of torrential mudflows is foothills, low mountains, alluvial fans, dissected by the channels of temporary and permanent watercourses, composed of modern loose debris deposits. The main reason for the formation of mudflows in this zone is the fallout of intense atmospheric precipitation, often on moistened mudflow-forming deposits.

REGIONS OF OSH OBLAST
ALAY REGION

Legend

- *High-mountains lakes with outburst flood potential*
- *flooding areas*
- *Mudflows, Floods*
- *Administrative boundaries*
- *Primary roads*
- *Local roads*
- *Major rivers*
- *rivers*
- *Mudflows prone areas*
- *Settlements*
- *Lakes, reservoirs*
- *Graciers*



The Alay region was formed in 1928. The area of the Alay region is 6821 km² . The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 93.5 thousand people. The average population density is 13.7 people per 1 km² .

On the territory of the region there are 65 rural settlements belonging to 7 rural regions: Pamir-Alay (9 settlements) (union of rural areas Taldy-Suu , Sary-Tash, Sary-Mogol); Uch - Dobo -Alai (union of rural districts of Alai named after K. Belekbaev and Uch-Dobo) (13); Zhibek Zholu (union of rural areas of Bulolu and Lenin) (8); Gulcha (union of rural areas Gulcha and Budalyk) (12); Kurmanjan Datka (unification of the rural districts of Konur- Dobon and Kabylan -Kul) (9); Tilektesh (unification of Korul and Zhosholu) (12); Jany-Alai (leave unchanged) (2). Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated 29 December 2023 .

The administrative center of the region is the village of Gulcha with a permanent population of 14.2 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

The Alai region occupies the territory that coincides with the middle and upper reaches of the Gulcha River basin, the upper reaches of the Kyzyl- Suu River basin and the Kök-Suu River basin and is bounded in the south by the eastern part of the Trans-Alay Range, in the northeast by the Academician Adyshev Range and in the west by the Ak-Ter Range. The relief is mid- and high-mountain.

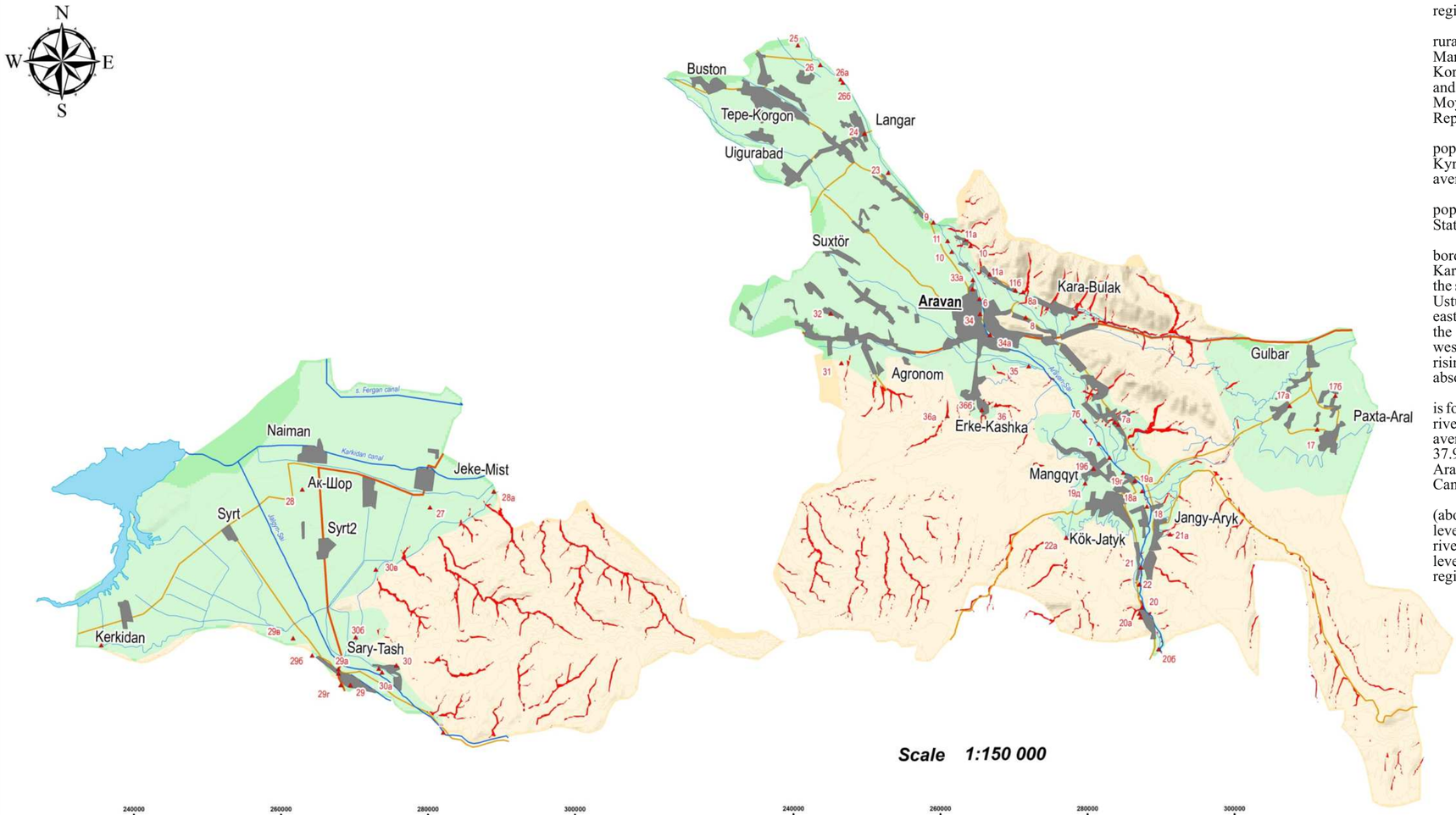
There are flat areas in the eastern part of the Alai Depression and on individual terrace surfaces along the banks of the Gulcha River and its tributaries, where settlements are located.

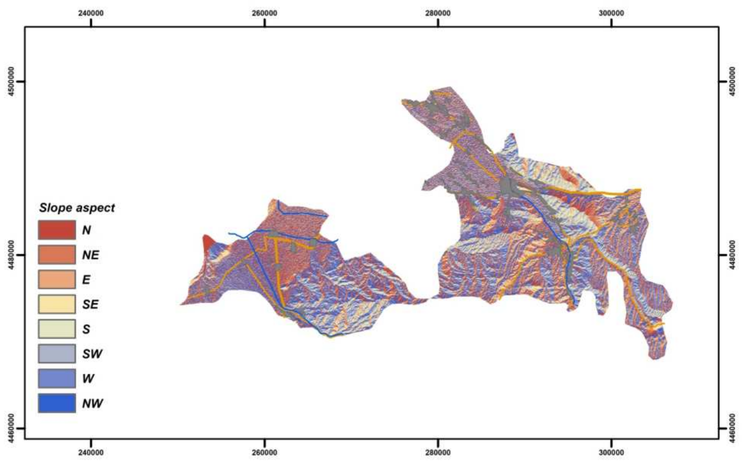
The district center, the village of Gulcha, is located on the surface of the first floodplain terrace, about 1 km wide, along the right bank of the Gulcha River. The Gulcha River, which originates from the spurs of the Alay Range, cuts through mainly Paleozoic rock formations in its course. In these areas, the valley is narrow with steep slopes. In areas cutting through Mesozoic semi-rock formations, the valley takes on gentle slopes with wide terraces.

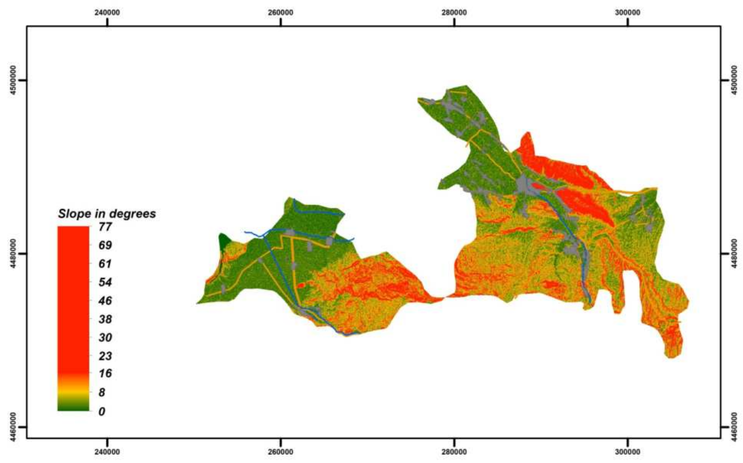
The main waterway of the region is the Gulcha River with numerous tributaries (the maximum flow rate reaches 138 m³ / s). There are 4 irrigation canals in the area, the largest of which are the Savay and Otuz canals. adyr ".

The territory of the second degree of mudflow danger occupies 19% of the region's area and is located on the northern slopes of the Zaalaysky ridge. The territory of the third degree of mudflow danger occupies 48% of the region's area and is located in the Gulcha- Kyok - Suu interfluve , in the Murdash and Zhyluu-Suu river basins . The territory of the fourth degree of mudflow danger occupies 6% of the region's area and is located along the Gulcha and Kyok-Suu river valleys and along the right bank of the Kyzyl- Suu river . Mudflow manifestations are absent on 27% of the region's area.

REGIONS OF OSH OBLAST
ARAVAN REGION







The Aravan region was formed in 1935, the territory of the region occupies 1340 km² .

There are 6 rural districts and 50 settlements in the region: the rural district of Dostuk (union of the rural districts of A. Anarov and Mangyt (12 settlements); Dobo-Korgon (union, rural district of Tepe-Korgon and Nurabad) (11); leave unchanged administrative borders and centers of rural areas of Chek- Abad (8); S. Yusupov (5) ; Too-Moyun (7). Data according to Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

The area of the Aravan region is 1340 km². The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 147.4 thousand people. The average population density per 1 km2 is 110.0 people.

The administrative center is Aravan with a permanent population of 19.8 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2025.

The district is located in the western part of Osh oblast , bordered by the Republic of Uzbekistan to the north, the regions of Kara - Suu to the east and Nookat to the south . The district occupies the southeastern part of the Fergana Depression, bordered by the Chil-Ustun ridge to the northeast and the Keklik- Too mountain range to the east . The mountains of Dzhalgyz -Archa and Ulu- Too pass through the south of the region . It borders on the Kerkydon Reservoir to the west. In orographic terms, the northern part of the region is a flat area, rising to the south and turning into the adyr zone. The difference in absolute marks from north to south is 500-750 m.

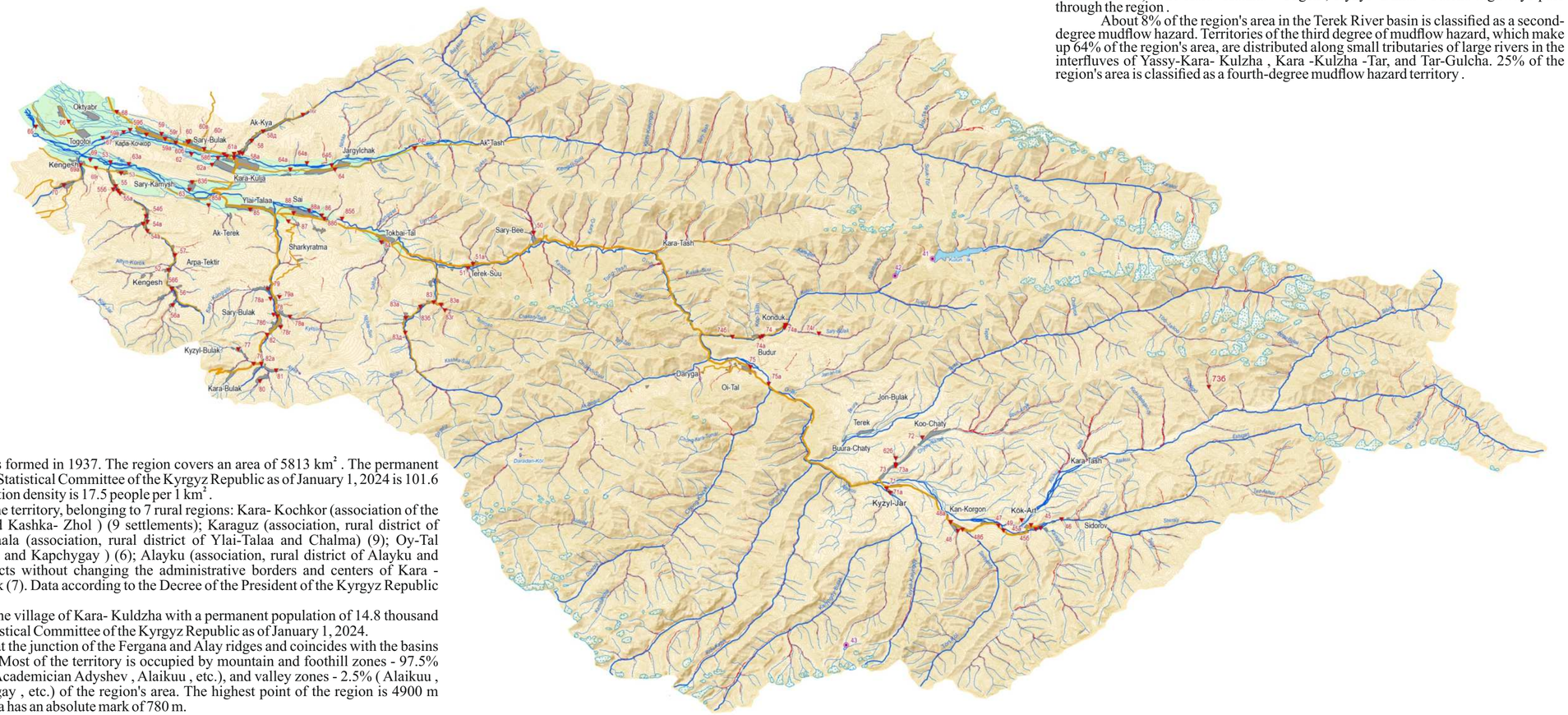
The full-flowing Aravan-Sai River flows through the region. It is formed after the confluence of the Khoschan , Kyrgyz- Ata and Chile rivers , which originate on the northern slopes of the Alay ridge. The average annual flow of the river is 9.3 m³ / sec, the average minimum is 37.9 m³ / sec, and the maximum is 52.7 m³ / sec. The waters of the Aravan-Sai River are widely used in irrigation. The South Fergana Canal runs through the northern part of the region.

The floodplains and low terraces of the Aravan-Sai River (about 4% of the region's territory) are classified as being at the second level of mudflow danger. The floodplains and low terraces of other rivers (about 2% of the territory) are classified as being at the third level of mudflow danger. The Adyr and mountainous areas of the region are classified as being at the fourth level of mudflow danger.

Legend

- Mudflows, Floods
- Primary road
- Local road
- Major rivers
- rivers
- Contour
- Mudflows prone area
- Settlements
- Lakes, reservoirs

REGIONS OF OSH OBLAST
KULZHA REGION



The Kara- Kulzha region was formed in 1937. The region covers an area of 5813 km^2 . The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 101.6 thousand people. The average population density is 17.5 people per 1 km^2 .

There are 55 settlements on the territory, belonging to 7 rural regions: Kara- Kochkor (association of the rural districts of Kara- Kochkor and Kashka- Zhol) (9 settlements); Karaguz (association, rural district of Karaguz and Kenesh) (8); Ylai-Taala (association, rural district of Ylai-Talaa and Chalma) (9); Oy-Tal (association, rural district of Oy-Tal and Kapchygay) (6); Alayku (association, rural district of Alayku and Kyzyl-Zhar) (12); leave rural districts without changing the administrative borders and centers of Kara - Kuldzha (4) (unchanged); Sary-Bulak (7). Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

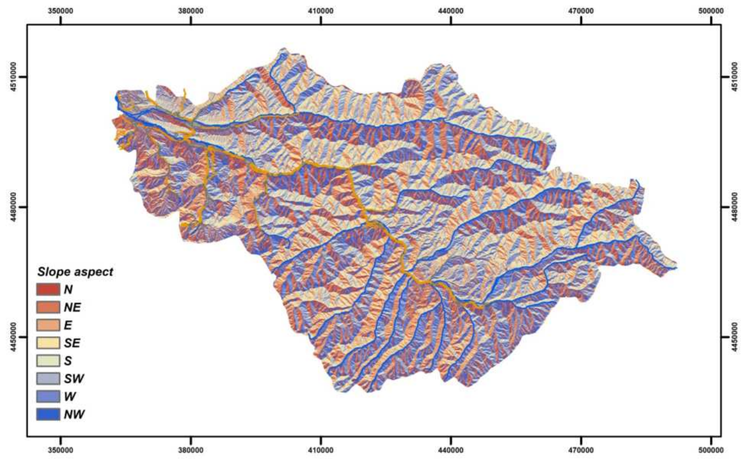
The administrative center is the village of Kara- Kuldzha with a permanent population of 14.8 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

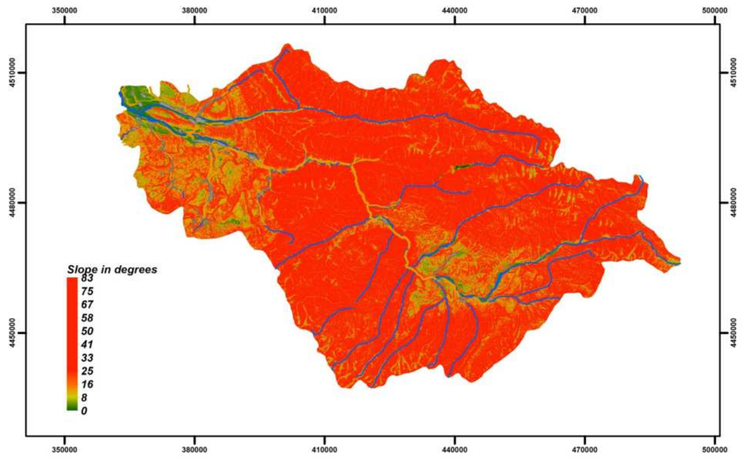
The territory of the region is located at the junction of the Fergana and Alay ridges and coincides with the basins of the Tar and Kara- Kulzha rivers . Most of the territory is occupied by mountain and foothill zones - 97.5% (mountains Uch-Seyit , Tasyrakay , Academician Adyshev , Alaikuu , etc.), and valley zones - 2.5% (Alaikuu , Kara- Kulzha , Tar, Kulun , Kapchigay , etc.) of the region's area. The highest point of the region is 4900 m (mountain Uch-Seyit), the lowest area has an absolute mark of 780 m.

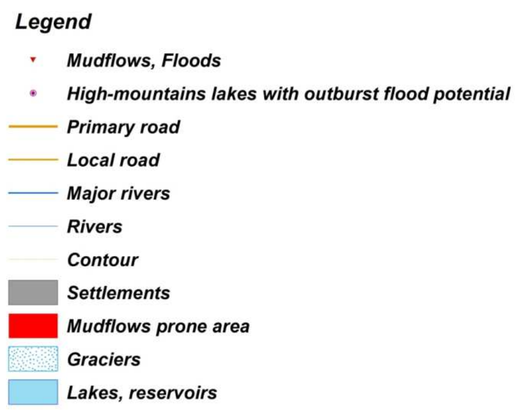
The main waterways of the region are the Tar and Kara- Kulzha rivers (with tributaries Buiga , Kyzyl- Suu , Karaguz , Zhalpak-Tash). The maximum discharge of the rivers is confined to June-July and is 492 m^3 / sec (Tar River) and 245 m^3 / sec (Kara-Kulzha River). The Kara- Kulzha - Uzgen , Kyzyl- Dzhar -Gulcha highways pass through the region .

About 8% of the region's area in the Terek River basin is classified as a second-degree mudflow hazard. Territories of the third degree of mudflow hazard, which make up 64% of the region's area, are distributed along small tributaries of large rivers in the interfluves of Yassy-Kara- Kulzha , Kara -Kulzha -Tar, and Tar-Gulcha. 25% of the region's area is classified as a fourth-degree mudflow hazard territory .

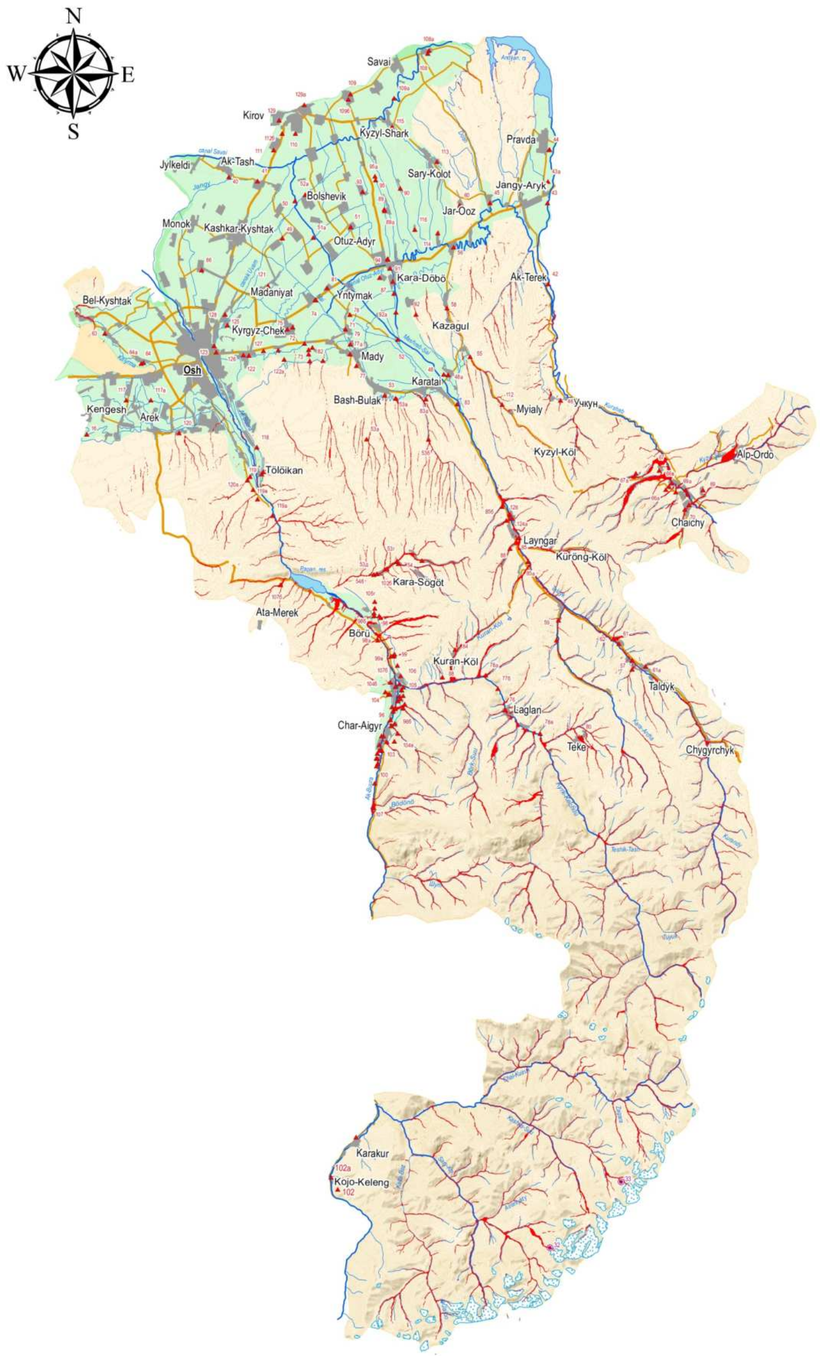
Scale 1:400 000







REGIONS OF OSH OBLAST
SUU REGION



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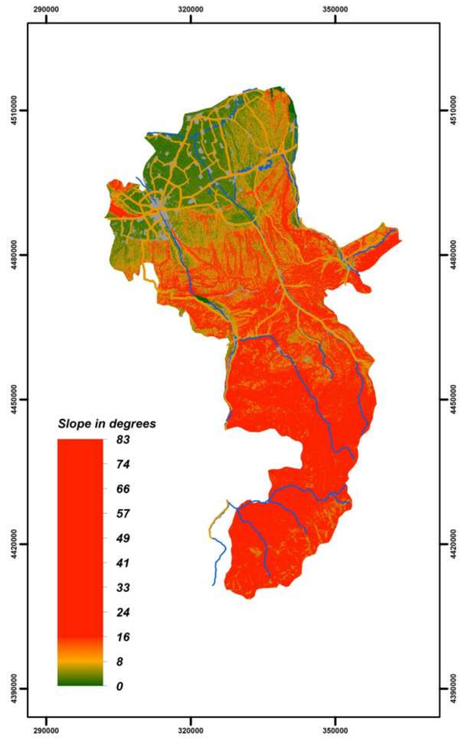
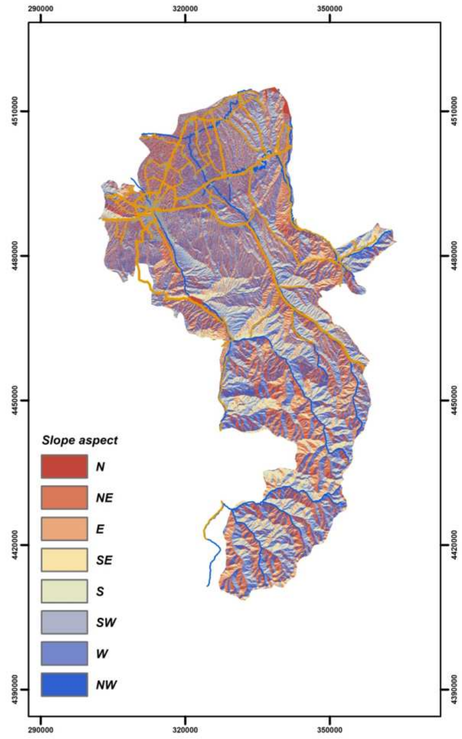




Legend

- Mudflows, Floods
- High-mountains lakes with outburst flood potential
- Major rivers
- Rivers
- Primary road
- Local road
- Contour
- Settlements
- Mudflows prone area
- Lakes, reservoirs
- Graciers

The Kara- Suu region was formed in 1935, the area of the region is 3616 km^2 . The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 429.7 thousand people. The average population density is 118.8 people per 1 km^2 .

There are 111 rural settlements in the territory, belonging to 10 rural regions: Otuz-Adyr (an association of the rural districts of Otuz-Adyr and Sary-Kolot) (16 settlements); Yntymak (an association of the rural districts of Zhany-Aryk and Kyzyl-Suu) (12); Ala- Too (union of the rural districts of Kashgar- Kyshtak and Ak- Tash (11); leave without changing the administrative boundaries and centers the rural districts of Papan (except for sections of Ak- Buura 1,2,3 and 4) (14); Joosh (11); Madyn (11); Savai (9); rename the rural areas of Nariman (except for the sections of Zhany- Maala , Zhim and Zheydilik) to the rural district of Manas, defining the village of Nurdar as the administrative center (11); Shark (6) (except for the Imam- Ata section) to the rural district of Datka ; the rural district of Katta -Taldyk (10) to be renamed to the rural district of Bash-Bulak Data according to Decree of the President of the Kyrgyz Republic No. 370 of December 29, 2023 .

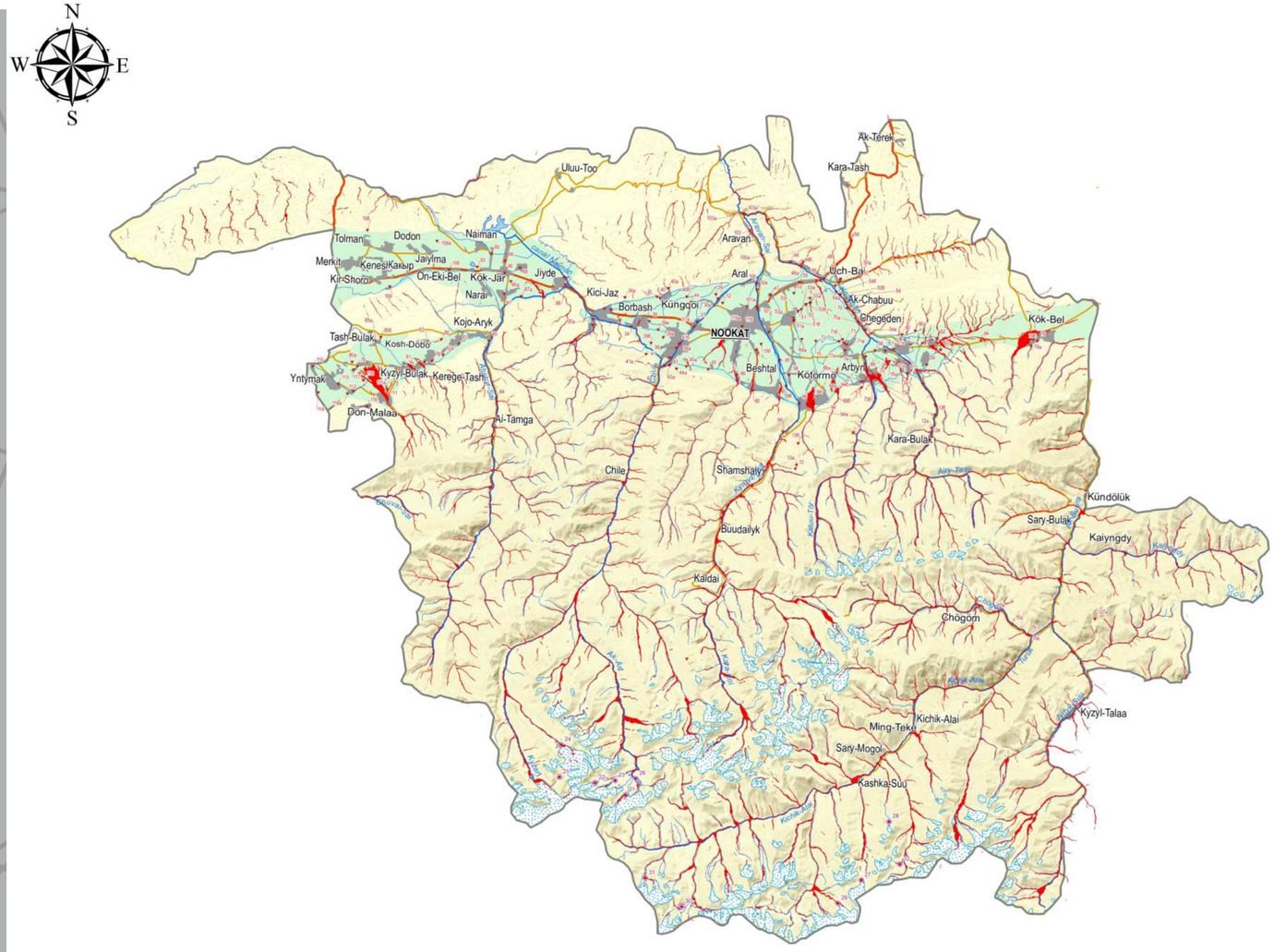
The regional center is Kara- Suu (include the rural district of Sarai) according to the National Statistical Committee as of January 1, 2024, with a permanent population of 55.7 thousand people.

The region occupies the Osh-Kara-Su oasis, the northern spurs of the Alai ridge and partly the adyr zone of the Kichik -Alai ridge. The altitude marks of the oasis vary from 800 to 1200 m. The relief of the region in the northern part is flat (22%), which is replaced in the southern direction by the adyr zone (20%), higher up are the mid-mountain and high-mountain zones. Mountain and foothill zones occupy 78% of the region's territory and 22% are flat areas.

The main waterways are the middle and lower reaches of the Ak- Buura River , the lower reaches of the Kurshab River and the Taldyk River. The Papan Reservoir and the southern part of the Andijan Reservoir are located on the territory.

13% of the region's area is classified as the second degree of mudflow hazard and occupies the lateral tributaries of the Taldyk River from the village of Karatai to the very headwaters of the river. 33% of the region's area is classified as the third degree of mudflow hazard and occupies the southern part of the region's territory and the elevated areas of the Taldyk-Ak- Buura interfluve . 27% of the region's area is classified as the fourth degree of mudflow hazard and occupies the adyr and low-mountain zones in the Kurshab -Taldyk-Ak- Buura interfluve and the left-bank slopes of the Ak- Buura River . Mudflow processes are absent in the flat part of the Osh-Kara-Su oasis.

REGIONS OF OSH OBLAST
NOOKAT REGION



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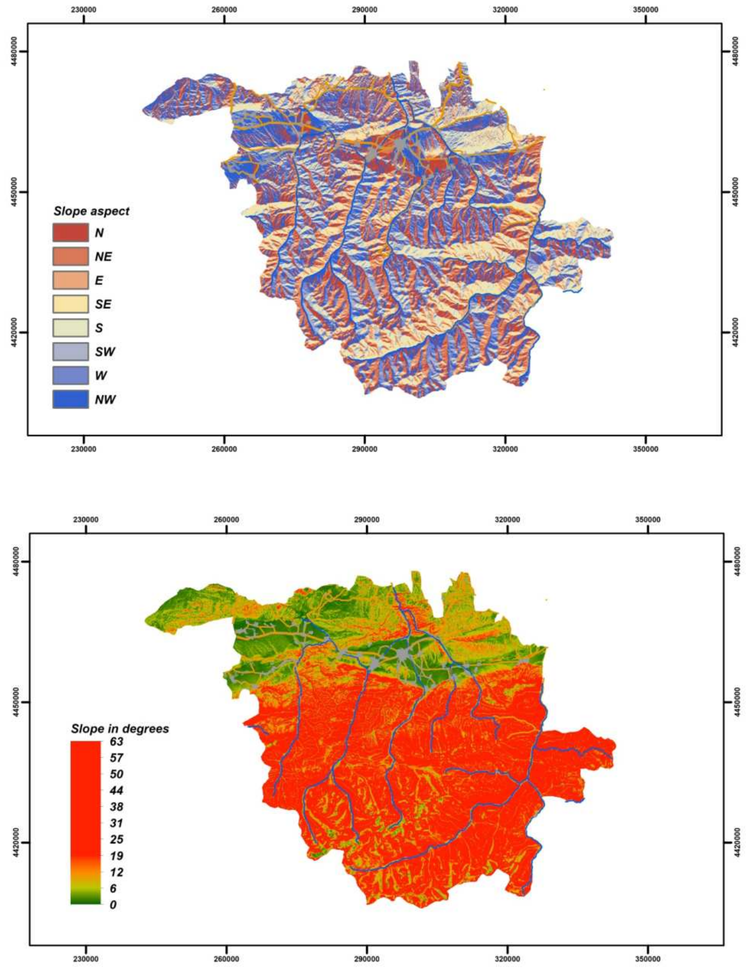


Legend

- Mudflows, Floods
- High-mountains lakes with outburst flood potential
- Administrative boundaries
- Major rivers
- Rivers
- Primary road
- Local road
- Contour
- Mudflows prone area
- Settlements
- Graciers
- Lakes, reservoirs

Nookat region was formed in 1928. The area of the region is 3179 km^2 . The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 325.9 thousand people. The average population density is 102.5 people per 1 km^2 .

There are 99 settlements on the territory, related to 13 rural regions: Kok-Zhar (unification of Kok-Zhar and Naiman rural districts by adding On- Eki - Moinok , On -Eki -Bel, Narai , Myrza -Naiman villages of On -Eki -Bel rural district) (12 settlements); Kulatov (unification of Kulatov and Yntymak rural districts) (16); Toolos (by adding Ornok village of On- Eki - Bel rural district) (10); leave the administrative borders and centers of the rural districts of Jany- Nookat (9); Kenesh (8); Kyrgyz- Ata (7); Kara- Tash (2); Kok-Bel (2); N.Isanov (6); T.Zulpuyev (10); Mirmakhmudov (6); Gulistan (5); Bel (4). Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

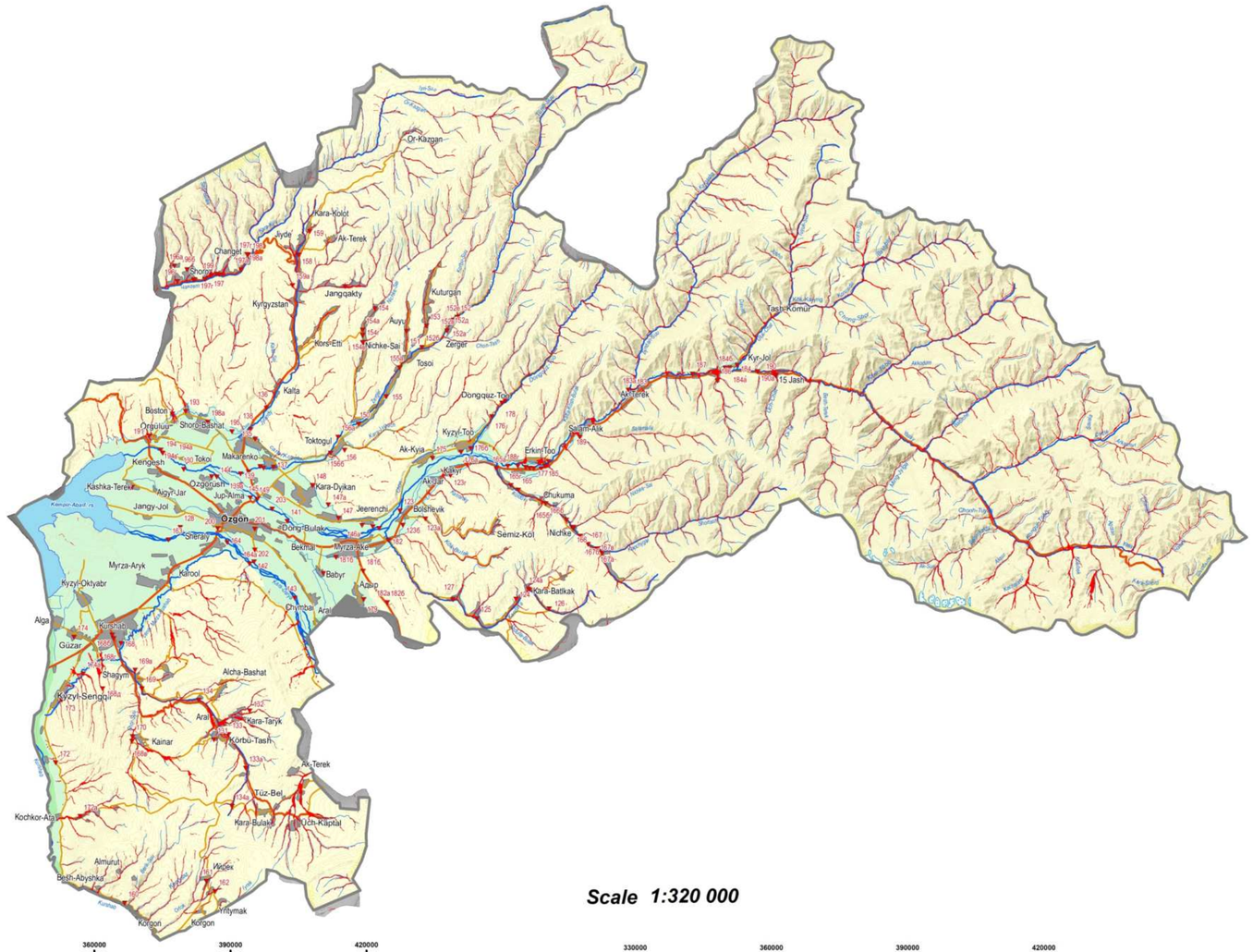
The administrative center of the region is Nookat , formed in 2003. According to the National Statistical Committee, as of January 1, 2024, the permanent population is 16.5 thousand people.

The territory of the region coincides with the Nookat depression , 45 km long, up to 12 km wide, with an area of 120 km^2, located at absolute altitudes of 1200-1700 m. In the west, it covers the Karavan-Kok- Dzhar depression . In the south, the main area of the region is occupied by the northern slopes of the Kichik -Alai ridge (4454 m). Mountainous territory is 88%, and valley territory is 12%.

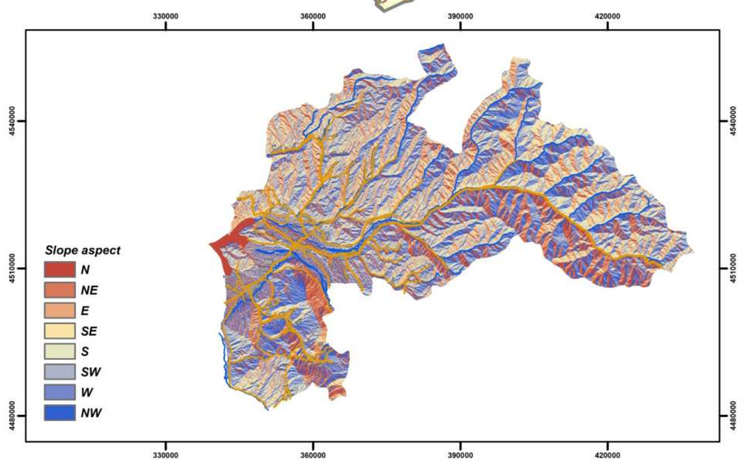
The main waterways of the region are the rivers Kyrgyz- Ata , Khoshchan , Chile , Shankol , Abshir -Sai, originating from the Alai and Kichik -Alai ridges and their spurs. From the rivers Kyrgyz- Ata and Chile , through a canal, water flows into the Naiman reservoir.

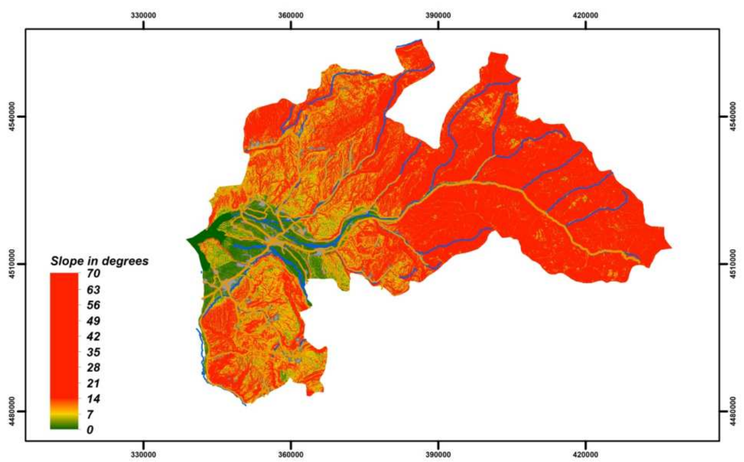
1% of the region's area is classified as the second degree of mudflow hazard and occupies small areas in the Isanov rural district in the villages of Kungey-Kozheke and Teskey-Kozheke (these areas are not shown on the map-scheme due to the scale of the maps); 64% of the region's area is classified as the third degree of mudflow hazard and occupies the mid-high mountain slopes of the Kichik -Alai and Alai ridges; 21% of the region's area is classified as the fourth degree of mudflow hazard and occupies mainly the Nookat and Karavan-Kok- Dzhar depressions with individual areas without mudflow hazard.

REGIONS OF OSH OBLAST
UZGEN REGION



Scale 1:320 000





Legend

- Mudflows, Floods
- Administrative boundaries
- Major rivers
- Rivers
- Primary road
- Local road
- Contour
- Lakes, reservoirs
- Mudflows prone area
- Graciers
- Settlements

The Uzgen region was formed in 1928. The area of the region is 3308 km^2 . The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 296.1 thousand people. The average population density is 89.5 people per 1 km^2 .

The territory contains 82 rural settlements belonging to 12 rural regions: Kara- Shoro (union of the rural areas of Ak- Jar and Kolduk) (6 settlements); Myrza-Ake (union of the rural district of Myrza -Ake and Altyn- Bulak) (9); Zhazy (union of the rural district of Zhazy , Zerger villages of Kyzyl- Too , Ak - Kiya , Donuz-Too of the rural district of Kyzyl -Too) (14); Salam-Alik (annexing the villages of Erkin- Too and Karchabek of the rural district of Kyzyl- Too) (9); Tort-Kol (union of the rural district of Tort-Kol and Zhylaldy) (11); Iyri-Suu (union of rural areas of Iyri-Suu and Changet) (9); Kyzyl- Oktiabr (union of rural districts of Kyzyl- Oktiabr and Kara- Tash) (15); rural areas of Bash- Dobo (5); Don - Bulak (10); Kurshab (3); Zhal- Paktash (10); Carol (4). Data according to Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

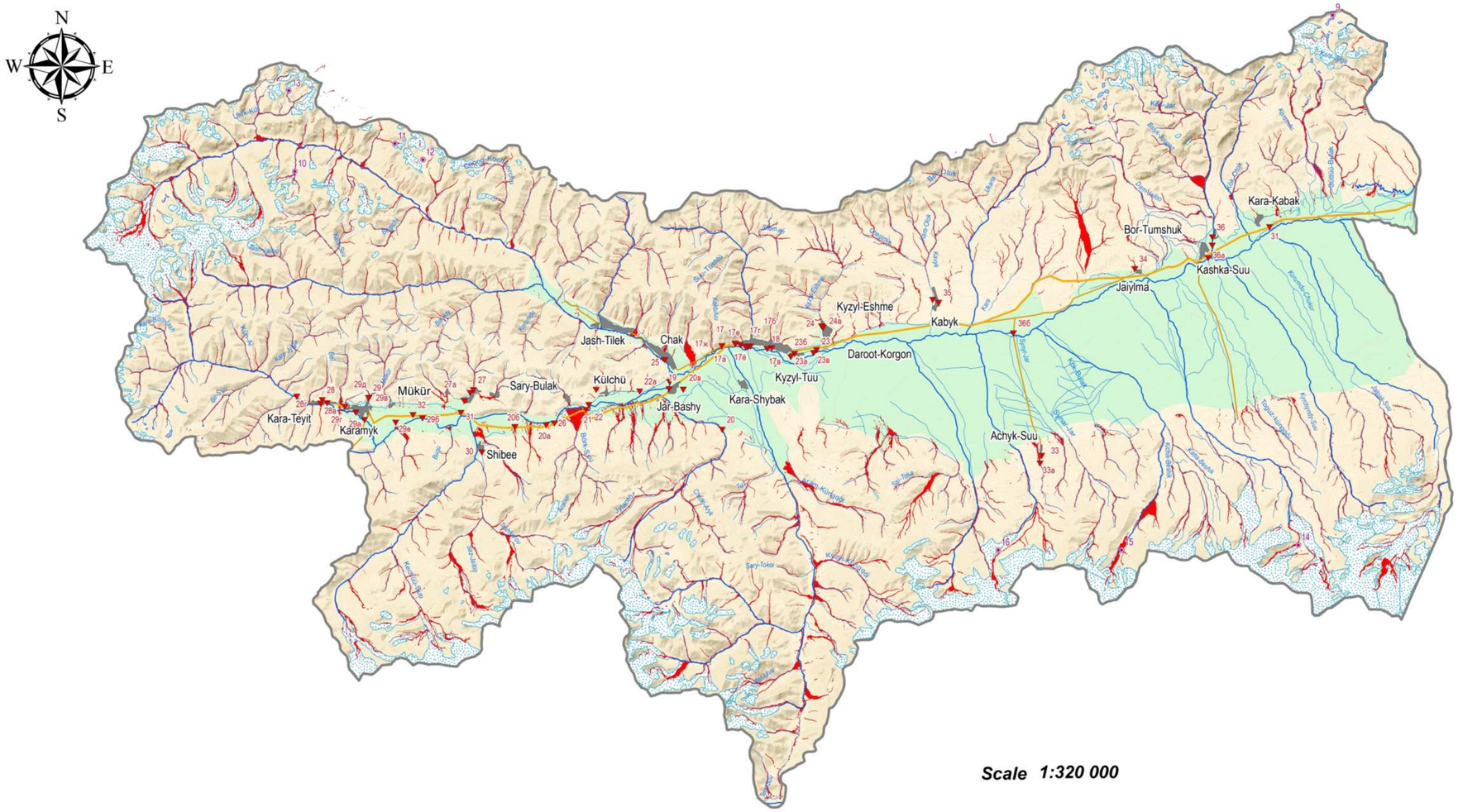
The regional center is Uzgen with a permanent population of 64.1 thousand people according to the National Statistical Committee as of January 1, 2024.

The area covers the southwestern slopes of the Fergana Range, from the south it is limited by the Uzgen and Academician Adyshev Ranges, from the west by the flat part of the Fergana Depression, coinciding with the Uzgen-Kurshab Plain . Most of the territory is occupied by mountain and foothill zones - 88%, and valley zones - 12%.

The main waterways are the Kara Darya, Yassy and Kurshab rivers , which flow into the Andijan Reservoir.

About 21% of the region's area is classified as the second degree of mudflow hazard and occupies the upper and middle reaches of the Changet River and the left-bank tributaries of the Iasi River. About 20% of the region's area is classified as the fourth degree of mudflow hazard and occupies the interfluve of the Zerger - Donuz - Too -Tuyuk- Suu , Kara-Darya- Köldük and the Shorsu River basin. 46% of the region's area is classified as the third degree of mudflow hazard and occupies the valleys of the Zerger , Donuz-Too , Zindan- Suu rivers with tributaries and the left bank of the Iasi River. Mudflows are absent on 26% of the region's area in the Uzgen-Kurshab Plain.

REGIONS OF OSH OBLAST
CHON-ALAI REGION



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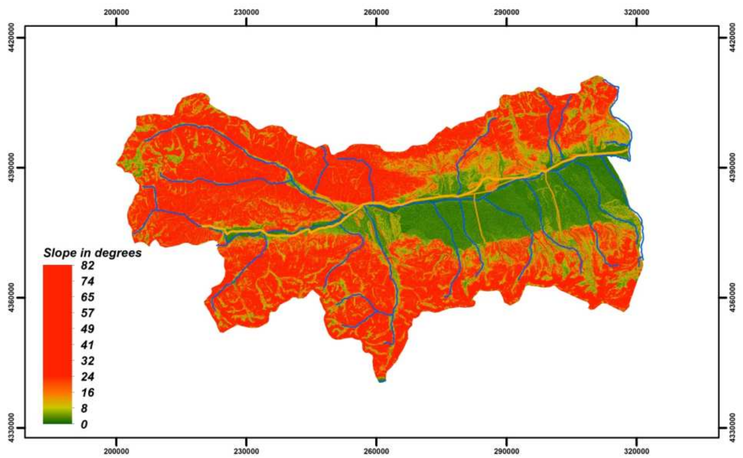
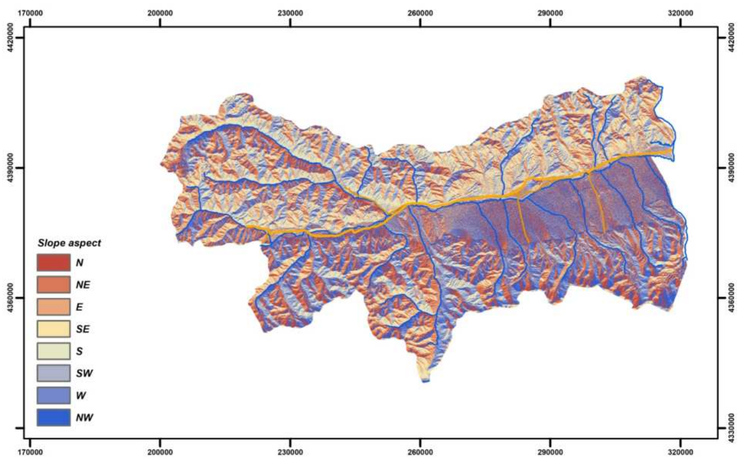




The Chon-Alai region was formed in 1992. The area of the Chon-Alai region is 4857 km^2. The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 37.4 thousand people. The average population density per 1 km^2 is 7.7 people.

There are 23 settlements and 3 aiyl aimaks in the district: Zhekendi (5 settlements), Kashka-Suu (7), Chon-Alai (11). Leave rural areas without changing administrative boundaries and centers. Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023.

The Chon-Alai region is located in the southern part of the Osh oblast and occupies the central and western part of the Alai depression, bounded in the north by the Alai ridge and in the south by the Trans-Alai ridge.

The administrative center of the region is the village of Daroot-Korgon with a permanent population of 6.8 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

The Chon-Alai region occupies 2/3 of the Alai depression. The flat part of the territory exceeds the absolute mark of 2200 m. The highest point of the Zaalai ridge is Lenin Peak (7134 m). The Alai Valley has a width of 3 to 27 km. The main flat part of the territory is located along the left bank of the Kyzyl-Suu River, up to 15 km wide, and is used for the development of livestock farming. Permafrost is developed at altitudes of over 3000 meters.

The predominant relief forms are terraced river valleys, alluvial-proluvial foothills, hilly ridges, high-mountain denudation-tectonic types and glacial relief forms on the slopes of ridges and in the bottom of the depression along the left bank of the Kyzyl-Suu River.

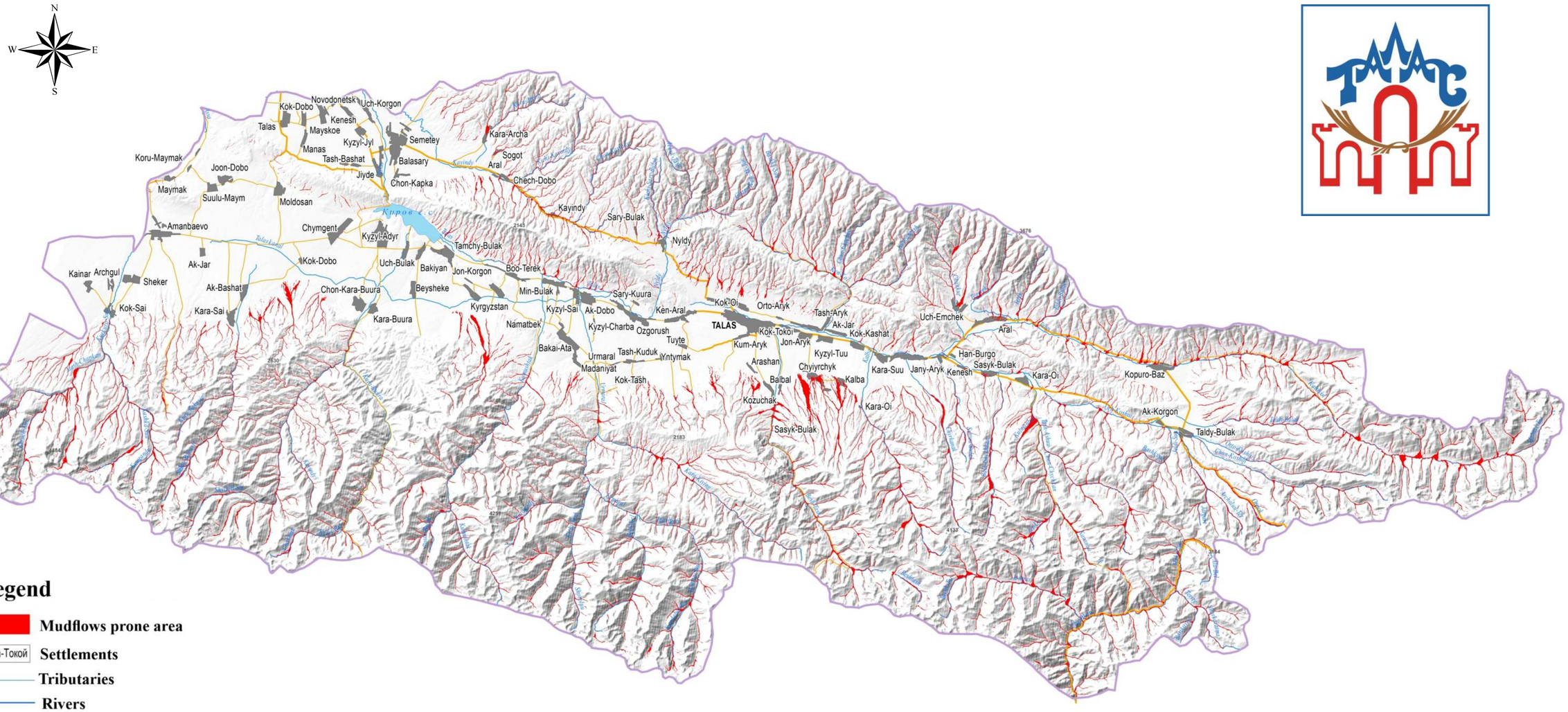
The main waterway of the region is the Kyzyl-Suu River, with its numerous tributaries, which is part of the Amu Darya River basin. The river is fed by glacier-snow, the flood occurs throughout the warm period of the year with the highest flow rates in July-August. The average annual flow rate of 1% of provision is 49.8 m^3/sec.

The region's territory is divided into: the second-degree mudflow hazard zone occupies 8.5% of the total area of the region, which includes the valleys of the Kök-Kiyik and Kangyr-Suu rivers with their alluvial fans and the alluvial fan of the Achyk-Tash river; the third-degree mudflow hazard zone (39.3% of the region's area) occupies the basin of the Altyn-Dara, Shibee, Achyk-Suu, Min-Zhar rivers and the upper reaches of the Tarasha and Sypar-Dzhar rivers on the left side of the valley and the basins of the Kyzyl-Unkur, Daraut, Kashka-Suu rivers and the Tekelik river (right tributary of the Kek-Suu river); the fourth-degree mudflow hazard zone occupies the rest of the mountainous and foothill parts of the region.

Legend

- Mudflows, Floods
- High-mountains lakes with outburst flood potential
- Administrative boundaries
- Primary roads
- Local roads
- Major rivers
- Rivers
- Contours
- Lakes, reservoirs
- Mudflows prone area
- Graciers
- Settlements

MUDFLOW SUSCEPTIBILITY MAP
TALAS OBLAST



Talas oblast with an area of 13406 km^2 occupies the northwestern part of the Kyrgyz Republic and borders on the west and north with the Republic of Kazakhstan, on the east - with Chui oblast , in the south – with Jalal-Abad oblast of the Kyrgyz Republic. The territory of the region is divided into 4 administrative regions: Talas, Bakai-Ata, Aitmatov (Kara-Buura), Manas.

Talas town is a town of regional subordination, 16 rural districts, 93 rural settlements. The total permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 277.1 thousand people (urban population 42.6 thousand people, rural - 234.5 thousand people), including: Bakai-Ata region 55.3, Aitmatov (Kara-Buura) district 72.4, Manas region 36.2, Talas region 70.1 thousand people. The average population density is 20.6 people per 1 km^2 . The administrative center of the region is Talas, as of January 1, 2024, the permanent population is 42.6 thousand people.

In Talas oblast, the areas of glacial mudflow formation include territories occupied by modern glaciation and moraines. In relief, they are expressed by rocky mountain ridges, cirques, and corries. In this area, there are powerful layers of watered moraines, mudflow centers, the territory is characterized by large surface slopes. The lower boundary of the zone passes at an altitude of 3-3.5 thousand meters. In this area, favorable conditions are created for the formation of large volumes of melted snow and glacial waters, the formation of high-mountain outburst-hazardous lakes. The most dangerous in this zone is the Chirkanak Valley.

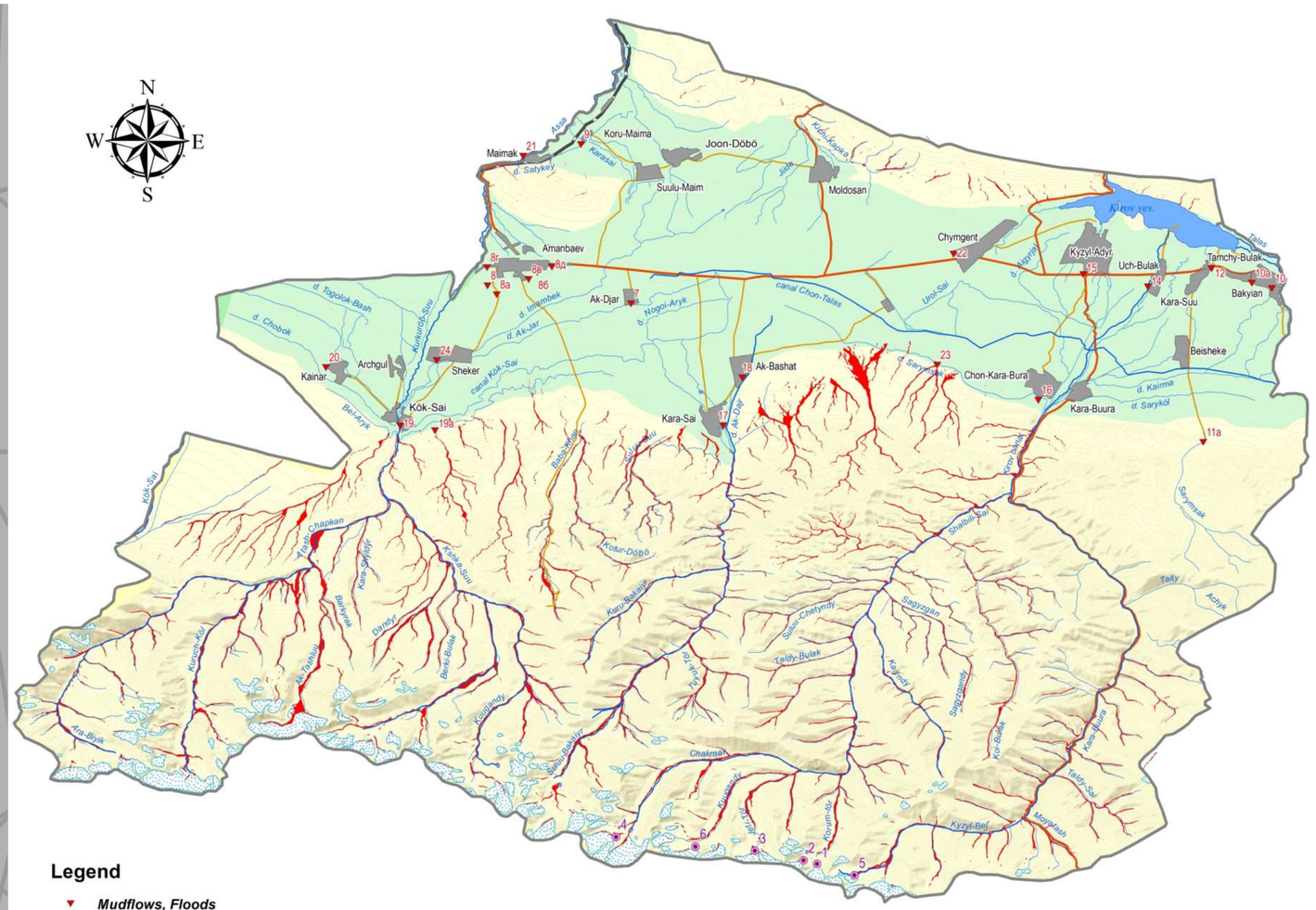
The area of formation of snow-rain mudflows occupies the territories of mid-mountains, partly highlands, which do not have modern glaciation, with remnants of ancient moraines, a large accumulation of mudflow-forming deposits, and the development of permafrost processes on the slopes. The cause of the formation of mudflows is the melting of seasonal snow, heavy rains, and the presence of moist mudflow-forming deposits.

The most dangerous valleys are Kara-Buura-Shilbili-Sai, Beshtash, Kyurkyureo-Suu, Suluu-Bakayir, Kyumyushtak, Kolba, Chon-Chychkan, Bala-Chychkan.

The area of formation of torrential mudflows is foothills, low mountains, alluvial fans, dissected by the channels of temporary and permanent watercourses, composed of modern loose debris deposits. The main reason for the formation of mudflows in this zone is the fallout of intense atmospheric precipitation, often on moistened mudflow-forming deposits.

Flooding on the rivers of the Talas Valley begins in April-May, with maximum discharges observed in July-August, and on the right tributaries of the Talas River in May-June. The formation of liquid runoff of most rivers occurs in the mountainous part due to the melting of seasonal snow, glaciers and snowfields. In the middle reaches of the Talas River, groundwater has a significant impact on the runoff. The danger of flooding of territories can be represented by ice phenomena on the rivers, which continue from December to February. Mudflows and floods cause flooding of territories, destruction of residential and public buildings, engineering structures and communications, irrigation systems, intensify channel processes, leading to the reshaping of the channels and banks of watercourses.

REGIONS OF TALAS OBLAST
AITMATOV REGION



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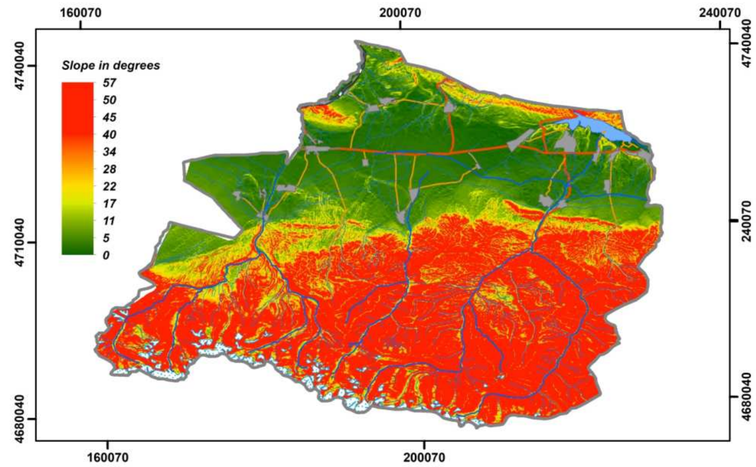
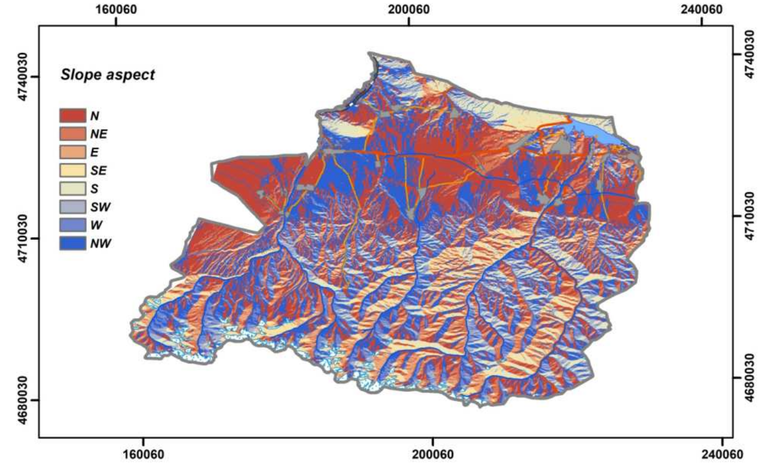




The Aitmatov Region (Kara- Buura) was formed in 1930 (renamed according to the Law of the Kyrgyz Republic No. 82 dated 10.04.2023). The region covers an area of 4216 km^2 . On the territory of the region there are 24 rural settlements belonging to 4 rural regions: Kara- Buura (association of the rural districts of Kara - Buura , Bakiyan , Beysheken) (9 settlements); Cholponbay (association of the rural districts of Cholponbay , Ak-Chii) (4); Amanbayev (association of the rural districts of Amanbayev , Bakayir , Maimak) (7); Sheker (association of the rural districts of Sheker and Kök -Sai) (4). Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

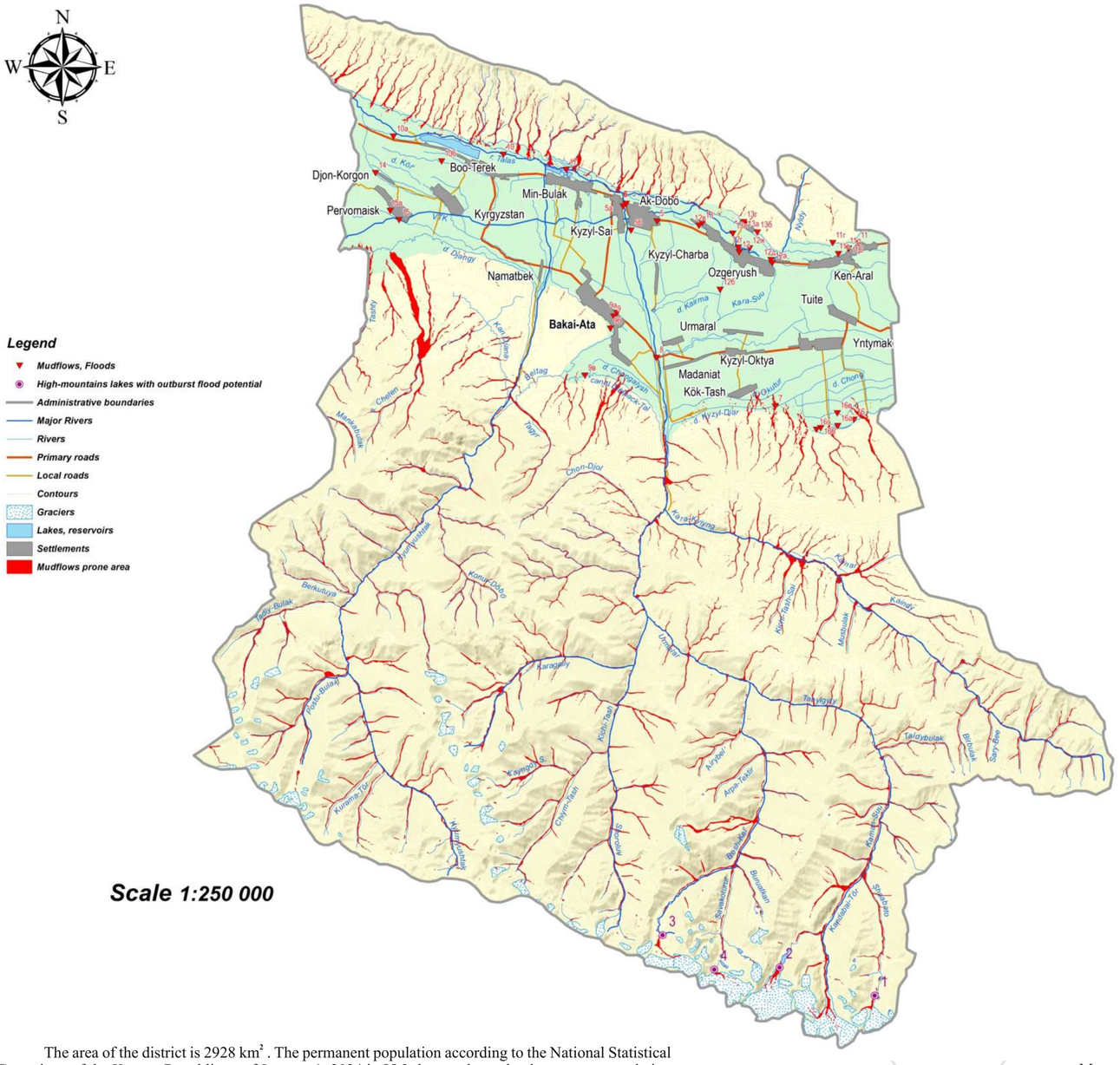
The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 72.4 thousand people. The average population density is 17.2 people per 1 km^2 .

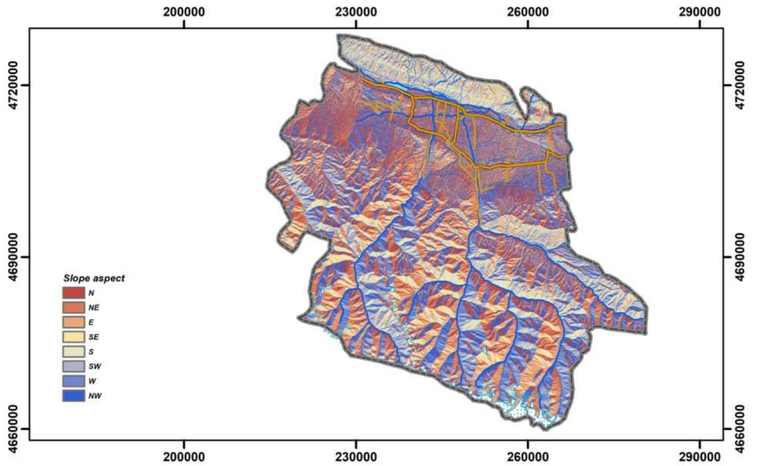
The administrative center of the region is the village of Kyzyl-Adyr with a permanent population of 13.8 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

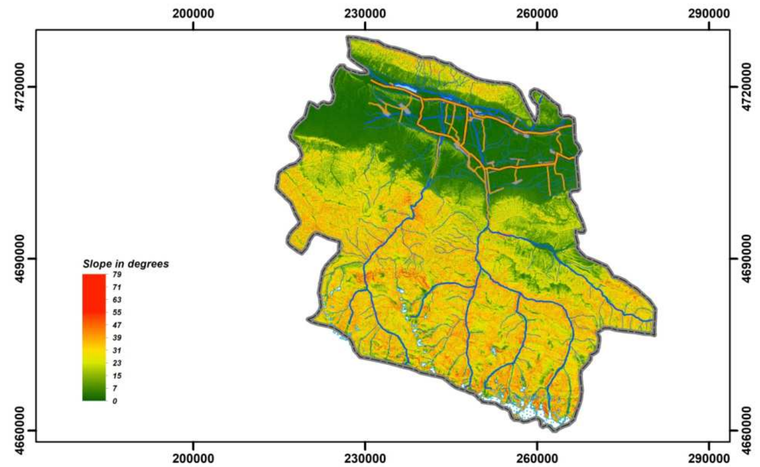
The hydrographic network is represented by the left-bank tributaries of the Talas River, which have the following maximum discharges: the Kyurkyureo River of the Assa River basin - 40 m^3 /sec, Kara- Buura - 52 m^3 / sec, Suluu-Bakayir - 3.5 m^3 / sec. On the territory of the region, the Kirov reservoir with a volume of 550 million m^3 , with a dam height of 83.7 m, is located on the Talas River . It has been in operation since March 1975.

1.3% of the region's area in the upper reaches of the Kyurkyureo River is classified as a territory with the second degree of mudflow hazard . About 50% of the region's area, covering the mid- and high-mountain zones of the northern spurs of the Talas Ala- Too ridge, is classified as a territory with the third degree of mudflow hazard . About 10% of the region's area, covering the lowlands and near- valley areas, is classified as a territory with the fourth degree of mudflow hazard . The remaining area of the region (38.7%) is mainly not mudflow hazard, with the exception of low riverbed terraces and irrigation canals.

REGIONS OF TALAS OBLAST
BAKAI-ATA REGION







The area of the district is 2928 km^2 . The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 55.3 thousand people, the average population density is 19.0 people per 1 km^2 .

There are 19 rural settlements in the region, belonging to 4 rural regions: Bakai-Ata (unification of Bakai-Ata and Min- Bulak rural districts) (3 settlements); Aknazarov (unification of Aknazarov and Shadykan rural districts) (7); Birimdik (unification of Ak- Dobon , Ozgorush , Ken-Aral rural districts) (5); Kumushtak (unification of Boo -Terek and Oro rural districts) (4). Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

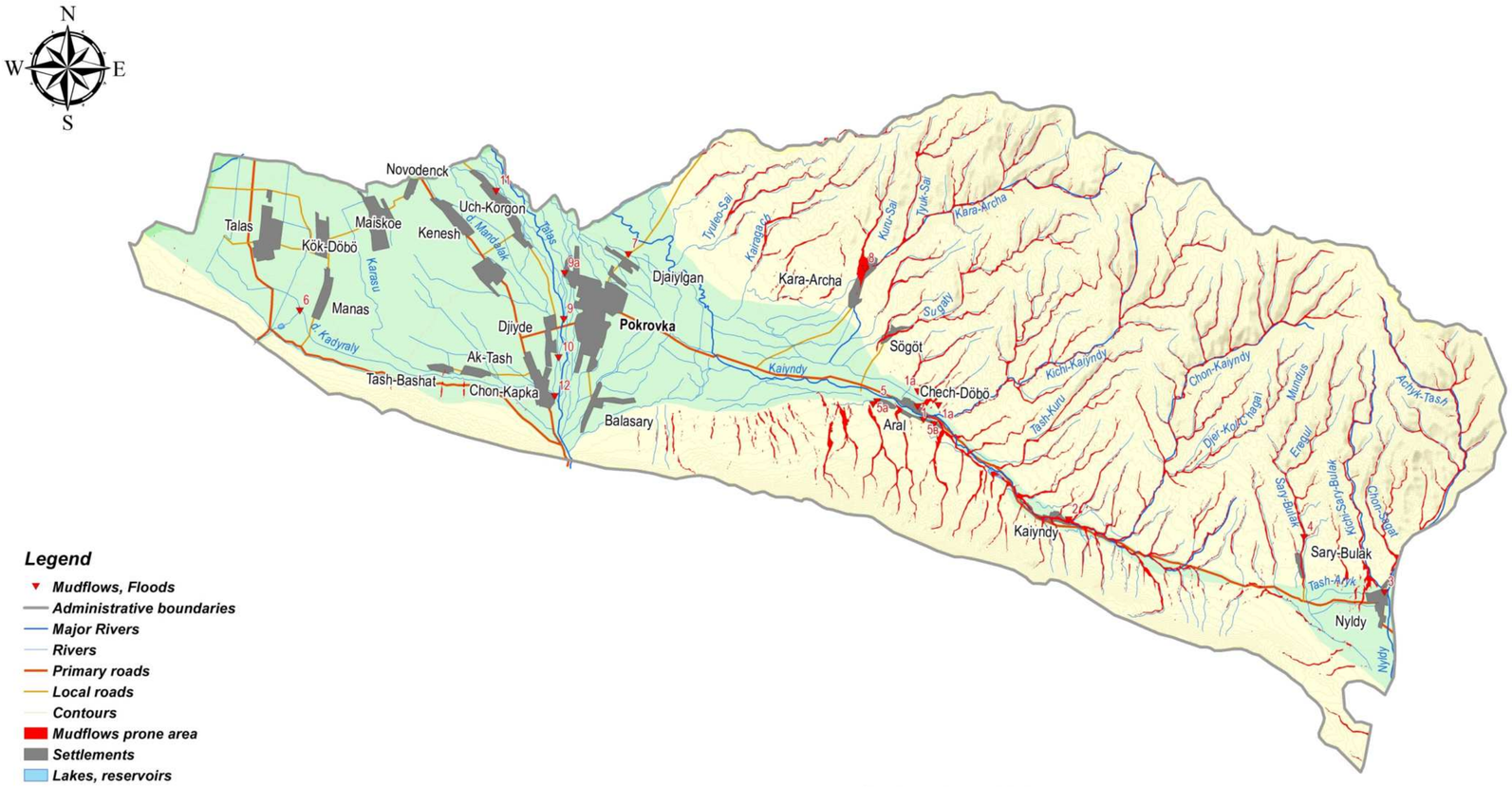
The administrative center is the village of Bakai-Ata with a permanent population of 8.2 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

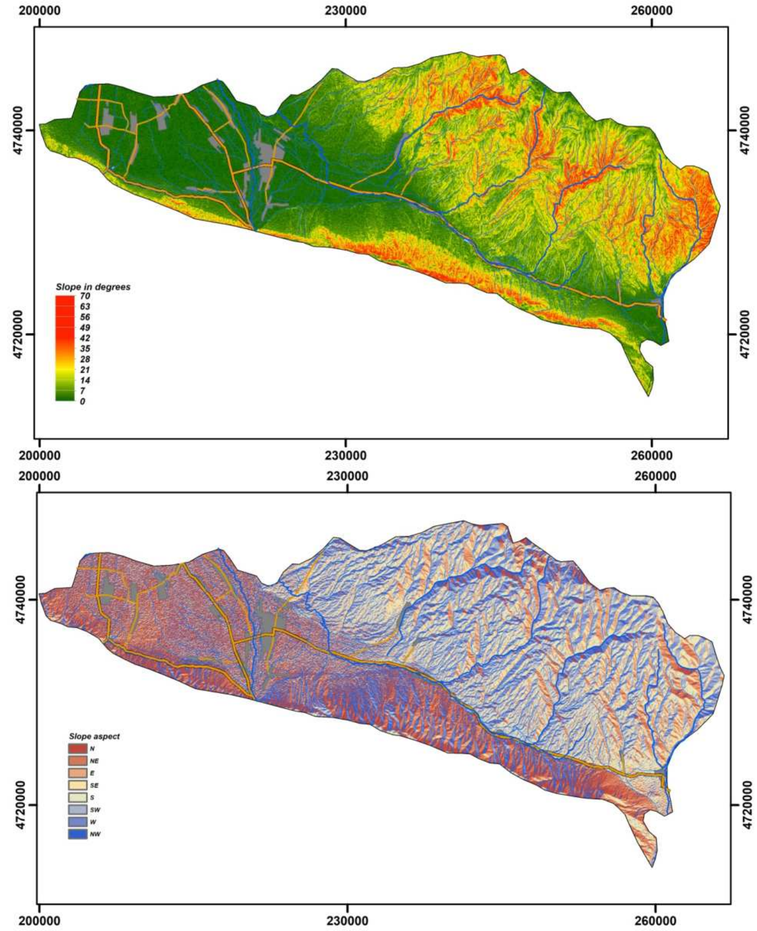
Bakai-Ata region occupies the central part of the Talas intermountain depression, bounded by the Echkili-Too Mountains to the north and the Talas Range to the south. The valley part between the mountainous framing is represented by river terraces, a foothill train and occupies about 20% of the region's territory, absolute marks vary from 950 to 1500 m. Height marks in the Echkili-Too Mountains reach 2160 m, and in the Talas Range - 4000 m.

The main rivers of the region are the Talas River (maximum flow rate 153 m^3 / sec), its left tributaries Urmaral (102 m^3 / sec), Kyumushtak (28 m^3 / sec), Kara- Buura (52 m^3 / sec). The Great Talas Canal, used for irrigation, runs through the region.

The territory of the second degree of mudflow hazard , occupying 8% of the area of the study region, is located in the upper reaches of the Urmaral River and its tributary Tabylgyty on the northern slope of the highlands of the Talas Ala- Too ridge . Sublatitudinal elongated high-, mid- and partially low-mountain tiers of the relief of the northern slope and spurs of the Talas Ala- Too ridge belong to the territory with the third degree of hazard and occupy up to 70% of the area of the study region. Low-mountain tiers of the relief, occupying 19% of the area, are characterized by the fourth degree of mudflow hazard . The remaining 3% of the region's area, excluding river beds and canals, are not mudflow hazardous.

REGIONS OF TALAS OBLAST
MANAS REGION





The Manas region was formed in 1980. The region covers an area of 1198 km^2 . The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 36.2 thousand people. The average population density is 30.2 people per 1 km^2 .

There are 20 rural settlements on the territory, belonging to 3 rural regions: Semetey (unification of the rural districts of Pokrovka and Kaindindy except for the villages of Bulak and Nyldy) (8 settlements); Kyrgyzstan (unification of the rural districts of Kyrgyzstan and May) (5); leave the rural district of Uch-Korgon without changing the administrative borders and the center (7). Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023.

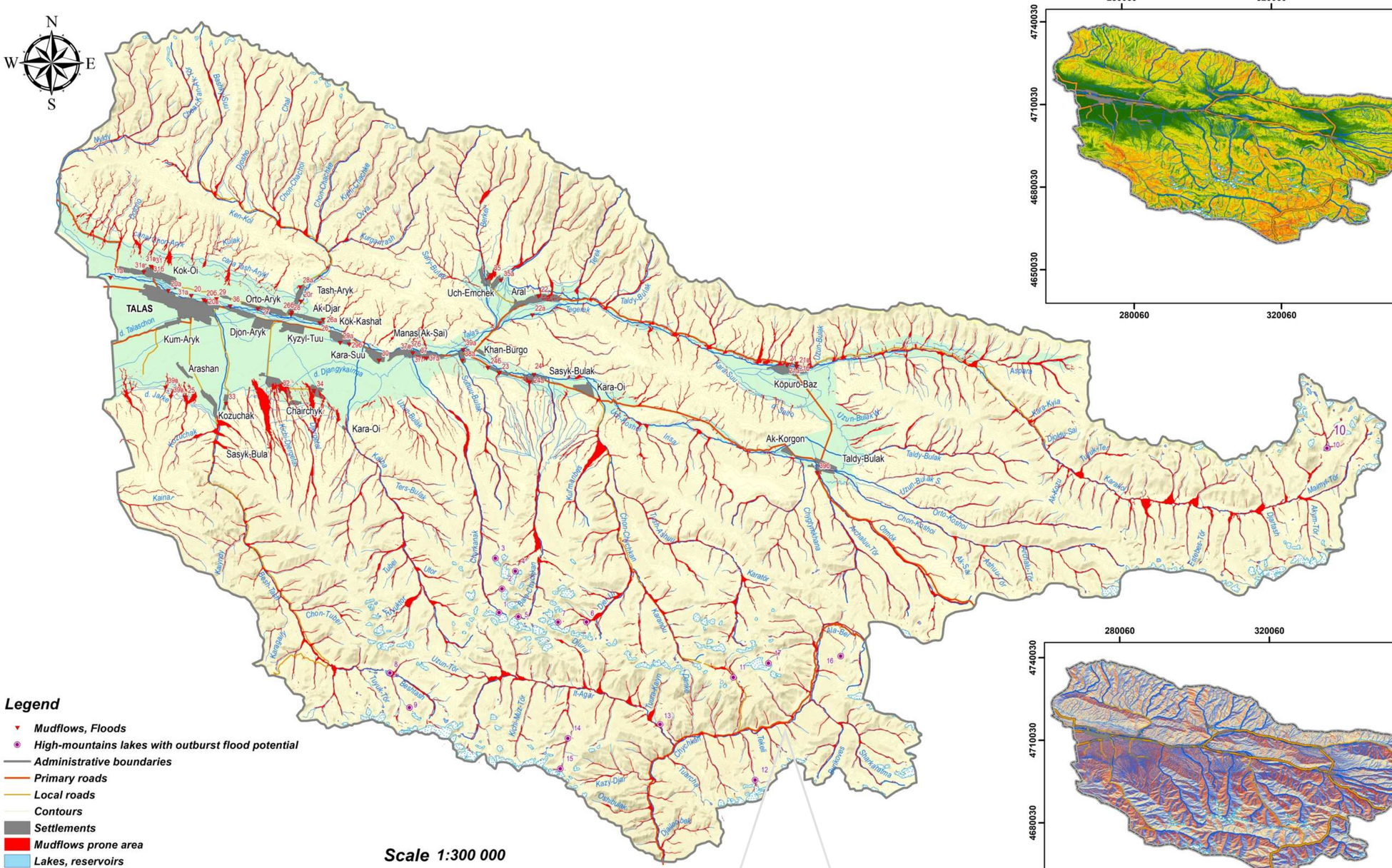
The administrative center of the region is the village of Pokrovka with a permanent population of 9.0 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

The Manas region occupies the lower part of the Talas intermountain depression, from the south its border runs along the Ak- Tash mountains (height 1288 m) and Echkili-Too (2160 m) from the northeast along the slopes of the Kyrgyz ridge (1913 m). The valley part, occupying up to 29% of the region's area, is represented by an alluvial plain and a foothill train. Absolute marks in the flat part vary from 750 to 1150 m.

The main river is the Talas River (below the Kirov reservoir) to the border with Kazakhstan.

29% of the region's area in the upper reaches of the right-bank tributaries of the Talas River have the third degree of mudflow hazard . About 53% of the region's area is characterized by the fourth degree of mudflow hazard . The remaining 18% of the region's studied territory, with the exception of river beds and irrigation canals, are not mudflow hazard.

REGIONS OF TALAS OBLAST
TALAS REGION


N
W
E
S
TALAS
Kok-Oi
Orto-Aryk
Tash-Aryk
Ak-Djar
Kok-Kashat
Djon-Aryk
Kyzyl-Tuu
Manas(Ak-Sai)
Kara-Suu
Khan-Burgo
Sasyk-Bulak
Kara-Oi
Köpürö-Baz
Uch-Emchek
Aral
Kum-Aryk
Arashan
Kozuchak
Chairchyk
Sasyk-Bula
Ak-Korgon
Taldy-Bulak
Uzun-Bulak
Aspara
Kara-Kyia
Dieldu-Sai
Karakol
Maimyl-Tor
Ken-Kol
Kulak
Chon-Chechkan
Kyrk-Tchelmke
Ovuz
Kurgaraish
Tegenek
Terek
Kara-Suu
Sarybulak
Kara-Oi
Ak-Sai
Kaindy
Besh-Tash
Chon-Tuuby
Karagaiy
Uzun-Tor
Tuyuk-Tor
Beshmail
Chyrkanak
Kara-Chechkan
Dzhuluk
Karatör
Kuranbu
Tumurkhan
Chyrchkar
Tokel
Kazy-Djar
Ak-Agar
Ala-Bel
Jeruses
Slankarkina
Kara-Kyia
Taldy-Bulak
Uzun-Bulak S.
Orto-Koshoi
Chon-Koshoi
Ak-Sai
Ashuu-Tor
Kerege-Tor
Kara-Suu
Kara-Oi
Kara-Kyia
Dieldu-Sai
Tuyuk-Tor
Karakol
Maimyl-Tor
Diurbek
Ak-Sai
Achaluu-Tor
Omsk
Chon-Kyzyltuuna
Kara-Kyia
Uzun-Bulak N
Taldy-Bulak
Uch-Koshoi
Irsai
Kurmantas
Chon-Chichkan
Tyrsk-Alhuri
Kara-Suu
Sasyk-Bulak
Uzun-Bulak
Aspara
Sarybulak
Terek
Tegenek
Kyrk-Tchelmke
Ovuz
Kurgaraish
Chon-Chechkan
Chon-Chechkan
Ken-Kol
Kulak
Chon-Aryk
Kaindy
Besh-Tash
Chon-Tuuby
Karagaiy
Uzun-Tor
Tuyuk-Tor
Beshmail
Kok-Moz-Tor
Chyrkanak
Kara-Chechkan
Dzhuluk
Karatör
Kuranbu
Tumurkhan
Chyrchkar
Tokel
Kazy-Djar
Ak-Agar
Ala-Bel
Jeruses
Slankarkina
Kara-Oi
Kara-Suu
Kozuchak
Sasyk-Bula
Kaindy
Besh-Tash
Chon-Tuuby
Karagaiy
Uzun-Tor
Tuyuk-Tor
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Kok-Moz-Tor
Chyrkanak
Kara-Chechkan
Dzhuluk
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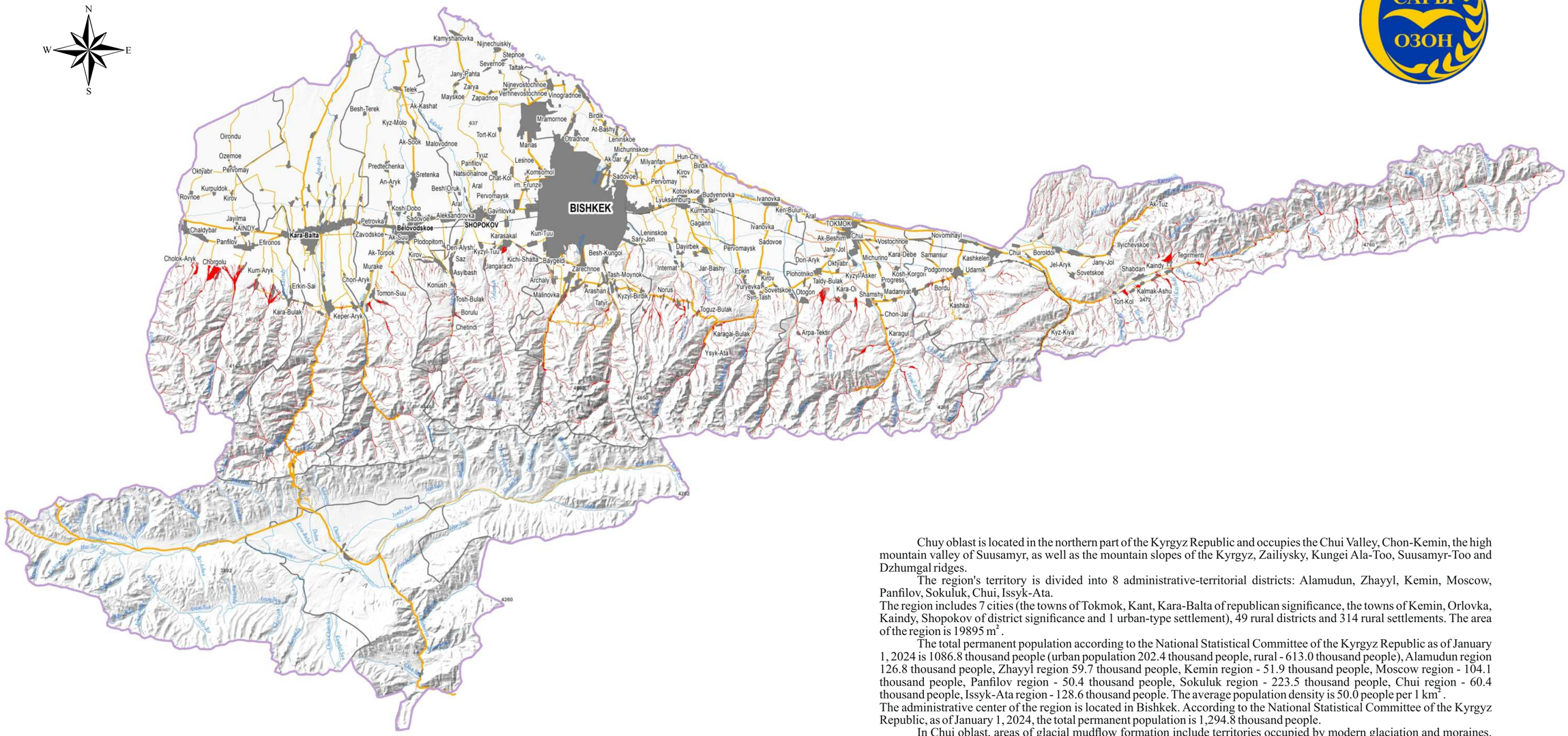
Maimyl-Tor
Ken-Kol
Kulak
Chon-Chechkan
Chon-Chechkan
Kyrk-Tchelmke
Ovuz
Kurgaraish
Tegenek
Terek
Kara-Suu
Sarybulak
Kara-Oi
Ak-Sai

MUDFLOW SUSCEPTIBILITY MAP FOR CHUI OBLAST



Legend

- Mudflows prone area
- Кара-Токой — Settlements
- Tributaries
- Rivers
- Boundaries

Chuy oblast is located in the northern part of the Kyrgyz Republic and occupies the Chui Valley, Chon-Kemin, the high mountain valley of Suusamyr, as well as the mountain slopes of the Kyrgyz, Zailiysky, Kungei Ala-Too, Suusamyr-Too and Dzhumgal ridges.

The region's territory is divided into 8 administrative-territorial districts: Alamudun, Zhayyl, Kemin, Moscow, Panfilov, Sokuluk, Chui, Issyk-Ata.

The region includes 7 cities (the towns of Tokmok, Kant, Kara-Balta of republican significance, the towns of Kemin, Orlovka, Kaindy, Shopokov of district significance and 1 urban-type settlement), 49 rural districts and 314 rural settlements. The area of the region is 19895 m^2.

The total permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 1086.8 thousand people (urban population 202.4 thousand people, rural - 613.0 thousand people), Alamudun region 126.8 thousand people, Zhayyl region 59.7 thousand people, Kemin region - 51.9 thousand people, Moscow region - 104.1 thousand people, Panfilov region - 50.4 thousand people, Sokuluk region - 223.5 thousand people, Chui region - 60.4 thousand people, Issyk-Ata region - 128.6 thousand people. The average population density is 50.0 people per 1 km^2.

The administrative center of the region is located in Bishkek. According to the National Statistical Committee of the Kyrgyz Republic, as of January 1, 2024, the total permanent population is 1,294.8 thousand people.

In Chui oblast, areas of glacial mudflow formation include territories occupied by modern glaciation and moraines. The lower boundary of the zone is at an altitude of 3-3.5 thousand meters. In this area, there are powerful layers of watered moraines, the territory is characterized by large surface slopes. In large valleys of this area, favorable conditions are created for the formation of large volumes of melted snow and glacial waters, the formation of high-mountain breakthrough lakes. The cause of mudflow formation here is the breakthrough of mountain lakes, heavy rains, snowmelt, and the moistening of the sediments that form mudflows with melt water. In July-August, large floods caused by breakthroughs of high-mountain lakes can occur in the valleys of this group. They are most likely to pass in the valleys of Kyzyl-Suu, Tuyuk-Isyk-Ata, Isyk-Ata, Shamshy, Kegeti, Nooruz, Ala-Archa, Sokuluk, Dzhardy-Kaindy, Konorchek, Zhylamysh, Chon-Kemin, Suusamyr.

The area of formation of snow-rain mudflows occupies the territories of mid-mountains, partly highlands, which do not have modern glaciation, with remnants of ancient moraines, a large accumulation of mudflow-forming deposits, and the development of permafrost processes. The cause of the formation of mudflows is the melting of seasonal snow, heavy rains, and the presence of moist mudflow-forming deposits. The most likely time for the passage of mudflows and floods (April-June) is associated with periods of snowmelt and rainfall in the valleys of the northern slope of the Kungey Ala-Too (left tributaries of the Chon-Kemin), Kyrty-Tabylga, Beishek, Jel-Aryk, Taldy-Bulak, Burkut, Bordu, Chon-Almaly, Kichi-Almaly, Taldy-Bulak shamsi, Burana, Taldy-Bulak Kegeti, Arpa-Tektir, Alamedin, Konok, Zhylamysh, Kara-Suu, Chon-Temen-Suu, Dzhardy-Suu, Kara-Balta, Chon-Kayyndy, Cholok-Kayyndy, Koktu-Bulak, Taldy-Bulak, Aspara.

The area of formation of torrential mudflows is the foothills, low mountains, alluvial fans, dissected by the channels of temporary and permanent watercourses, composed of modern loose debris deposits, which are developed within the low-mountain zones of the Kyrgyz ridge, the Zailiysky Ala-Too and Kungei Ala-Too, in the Boom gorge, as well as in the intermountain depression of Suusamyr.

REGIONS OF CHUI OBLAST
ALAMUDUN REGION

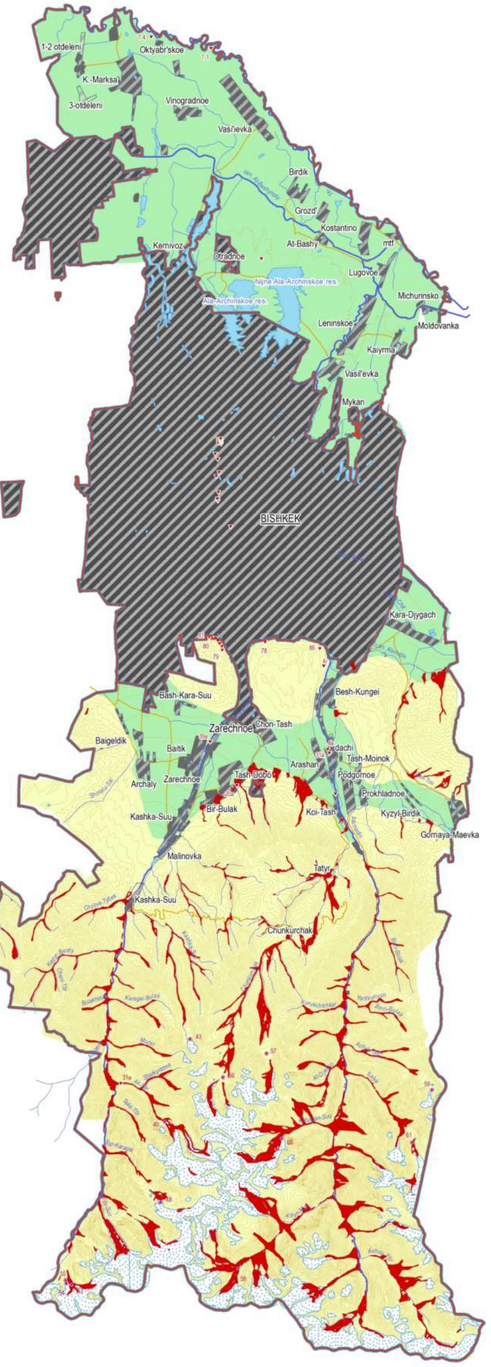
Alamudun region was formed in 1936, the area of the region is 1503 km² , in the area there are 7 rural districts and 38 settlements: Dostuk (the association of the rural districts of Lenin (except for the village of Mykan and the residential areas of Nurkozho-Ata , Ak-Zhar and Adilet), Ak-Debe (except for the residential area of Altyn-Kazy), Grozd) (9 settlements), Suimonkul Chokmorov (unification of the rural district of Ala-Archa and Oktiabr) (5); Arashan (unification of the rural district of Arashan and Tash-Dobo (except for the village of Orto-Sai) (6); leave the rural district of Kara- Zhygach without changing the administrative borders and the center (except for contours No. 544, 545 and 552 and the residential area of Anar-Bak) (2); rename the rural district of Vasilyevka into the rural district of Abdykerim without changing the administrative borders and the center Sydykov (4); Baitik rural district to Baitik-Baatyr rural district (5); leave Tash-Moinok rural district without changing the administrative borders and center (7). Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 126.8 thousand people, the average population density is 84.3 people per 1 km² of area.

The administrative center of the region is the village of Lenin with a permanent population of 13.9 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

Alamudun region is located in the central part of the region and is bounded: from the north by the Chu River and the territory of the Republic of Kazakhstan; from the west by the territory of the city of Bishkek and the Sokuluk region ; from the south by the watershed of the Kyrgyz ridge; from the east by the territory of the Issyk-Ata region .

The region's territory extends from north to south along a slope in the northern direction of 0.5-3.5 degrees, in the valley and foothill parts. The area extends 79 km from north to south, and 18 km from east to west. The absolute marks of the region vary from 625 meters near the Chu River to 4856 m on the crest of the Kyrgyz Range.



Legend

- High-mountains lakes with outburst flood potential
- Mudflows, Floods
- Major Rivers
- Rivers
- Primary roads
- Railways
- Local roads
- Contours
- Administrative boundaries
- Mudflows prone area
- Graciers
- Lakes, reservoirs
- Settlements

Scale 1:270 000

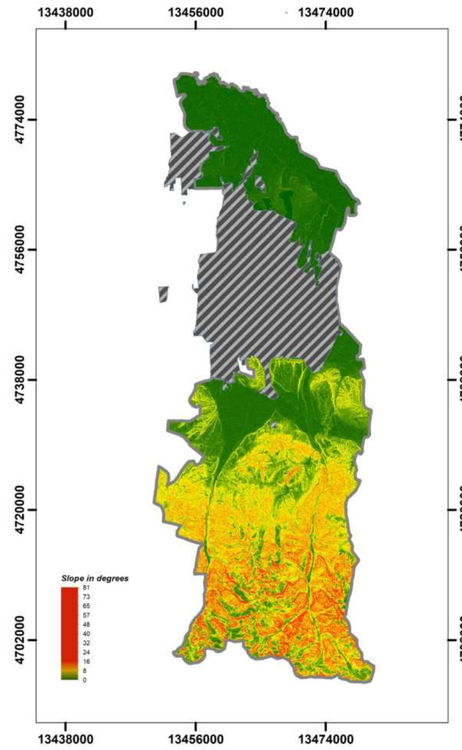
In the southern third of the region there is the Orto- Alysh depression , stretched in the sublatitudinal direction with absolute marks from 1060 m to 1400 m. The climatic characteristics of the central part of the region do not differ from the characteristics of the region. Small differences due to the increase in absolute marks are noted for the Orto- Alysh depression . Thus, the average annual precipitation for the valley part is 400 mm, for the Orto- Alysh depression about 500 mm. The height of the snow cover is within 50 cm, although there are also winters with little snow. There are on average 52 snowy days per year. The winds are predominantly westerly.

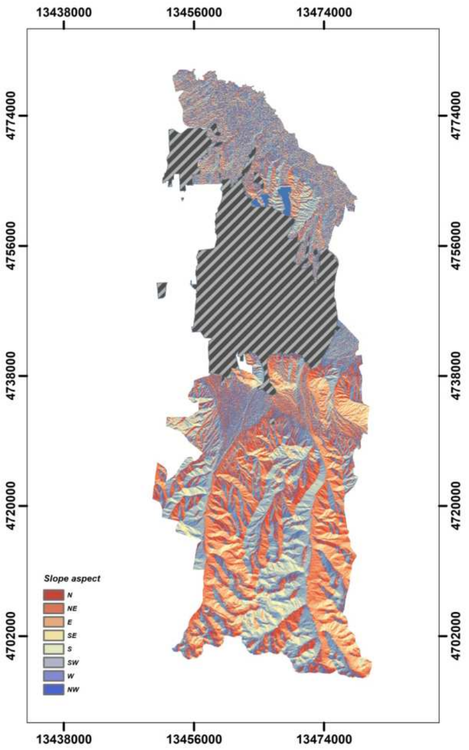
In the mountains, with increasing altitude, an increase in annual precipitation and a decrease in air temperature are observed everywhere. The northern slopes of the Kyrgyz Range are characterized by the following features: slope altitude 1000 m - snow depth 25 cm, the number of days per year with snow cover is 68, 1500 m - 26 cm - 91 days ; 2000 m - 46 cm - 118 days ; 2500 m - 66 cm - 146 days ; 3000 m - 84 cm - 183 days ; 3500 m - 115 cm - 243 days . The main amount of precipitation falls in the spring.

All the rivers in the region are mainly fed by glaciers, snow and rain with the highest total discharges in the second half of summer. The largest watercourses in the area are: the Ala-Archa River (the mouth of the Kashka- Suu) - 56.6 m³ /s; 1% discharge: Alamedin - 70 m³ / s; Orok - 15.7 m³ / s; Baygeldy - 28.3 m³ / s; Shoroly -Sai - 39.4 m³ / s; Chon- Shoroly - 41.0 m³ / s. A significant part of the runoff is used for irrigation and filling artificial reservoirs. The irrigation network is developed everywhere and is represented by numerous ditches and canals. Numerous spillway collectors are located north of the Bolshoi Chuisky Canal.

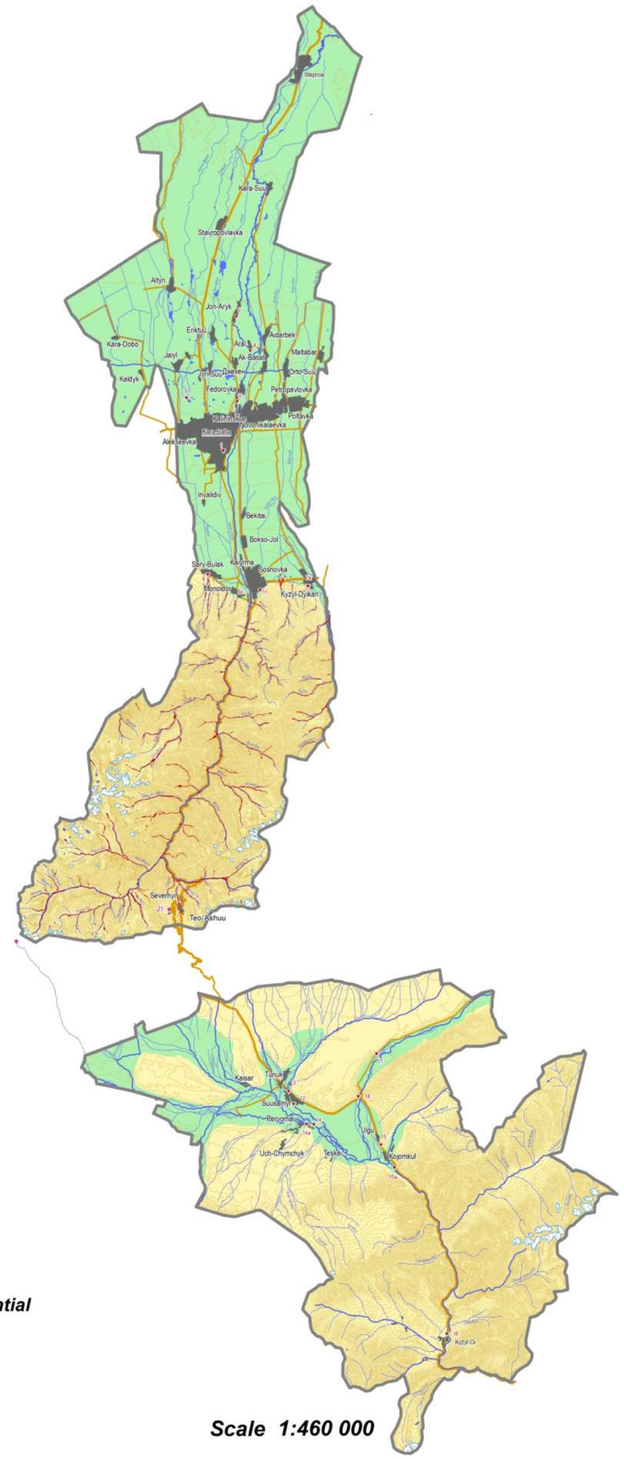
21.6% of the region's area in the upper reaches of the Alamedin River valley and the middle reaches of the Ala-Archa River (in the valleys of its side tributaries Ak-Sai, Adygene , Teke -Ter, Tez-Ter, Top-Karagay, Djeldi-Suu) is classified as a second-degree mudflow hazard. 17.7% of the region's area is classified as a third-degree hazard and occupies the valleys of the Kashka- Suu , Chon - Kurchak and other rivers in the mid-mountain zone of the Kyrgyz Range.

The fourth degree of mudflow hazard includes 12% of the region's area in the foothill zone and the slopes of the Pospeldek and Chon-Aryk uplifts. The remaining territory (48.7% of the area), mainly, with the exception of low terraces, river beds and irrigation canals, is not mudflow hazardous.





REGIONS OF CHUI OBLAST
ZHAYIL REGION



Scale 1:460 000

Legend

- *Mudflows, Floods*
- *Administrative boundaries*
- *Major Rivers*
- *Rivers*
- *Primary roads*
- *Local roads*
- *Contours*
- *High-mountains lakes with outburst flood potential*
- *Settlements*
- *Graciers*
- *Mudflows prone area*

The region was formed in 1927. The area of the region is 3435 km² , includes 6 rural districts, 35 settlements: Yntymak (union of rural areas of Kyzyl- Dyikan and Poltavka) (5 settlements); Taldy-Bulak (union of rural areas of Taldy-Bulak, Sary-Bulak and Sosnovka) (6); Sary- Koo , (association of the rural district of Sary -Koo , Stepnoye, Kara- Suu, annexing the MTF-1 section of the rural district of Krasny Vostok) (9); Zhayyl (union of the rural district of Zhayyl and the villages of Kyldyk and Kara-Dobo of the rural district of the Red East and the sections of Toktosh Sad-Verkha, Ilyich, Verkhniy villages of Kalinin, the rural district of the Red East) (4), leave the rural areas of Suusamyr (7) and Ak -Bashat (4) without changing administrative boundaries and centers. Grant the status of a city of regional significance to the town of Kara-Balta, annexing the village of Kalinin (except for the Toktomush , Sad-Verkha, Verkhniy and Ilyich sections) and the Gidropartiya and Indom sections of the Krasny Vostok rural district). Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

The administrative center of the region is the town of Kara-Balta with a permanent population of 57.8 thousand people, according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

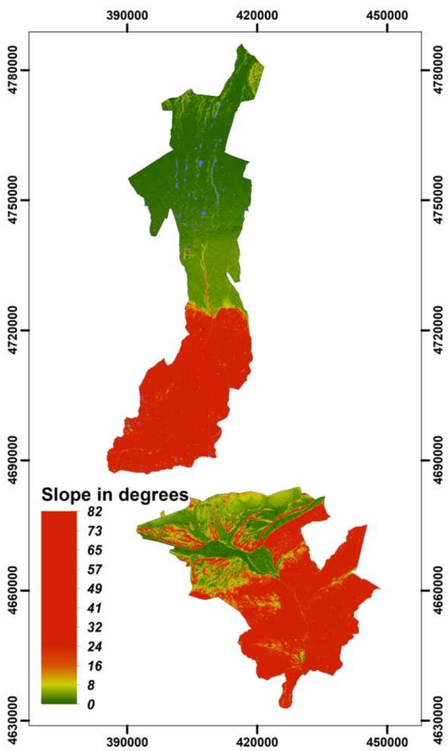
Zhayyl region is located in the western part of the region and is bounded: from the north by the state border with the Republic of Kazakhstan; from the west by the territory of the Panfilov region; from the south by the watershed of the Kyrgyz ridge; from the east by the territory of the Moscow region . The region includes part of the Suusamyr valley, where the rural district of Suusamyr is located .

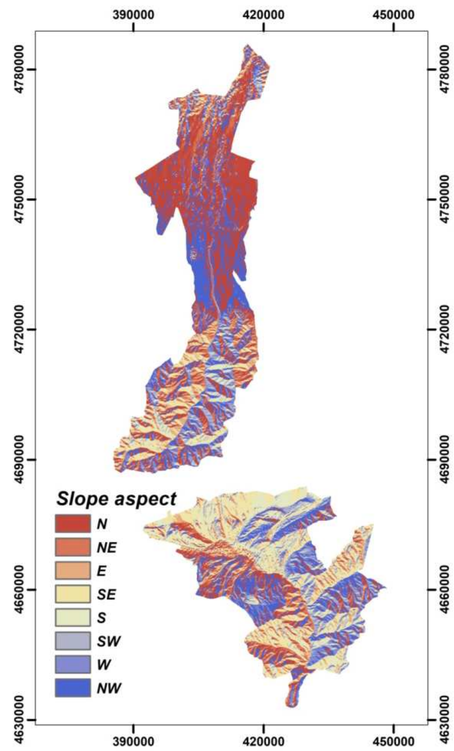
The main part of the region's territory is located in the Chui Valley , stretching along a slope from south to north and covering an alluvial-proluvial plain in its central and northern parts, foothills represented by merged alluvial fans, and the northern slopes of the Kyrgyz Range.

Absolute altitude marks (from the northern to the southern border of the region) increase from 560 m to 1200-1300 m, in the valley and foothill parts with slopes of 1-2 o , on the crest of the ridge - up to 4369 m.

The hydrographic network of the region belongs to the Chu River basin in the Chui Valley and to the Naryn River basin in the Suusamyr Valley . The largest of them in the Chui Valley are represented by the left tributaries of the Chu River, originating on the northern slopes of the Kyrgyz Range with discharges of 1% of provision: the Mintukum River 30.5 m^3 / s, Taldy-Bulak 16.0 m^3 / s, Kara-Balta 69.5 m^3 / s, Sukhoi Log 4.2 m^3 / s, Yablonevy Log 7.1 m^3 / s. The total average annual discharge of the Suusamyr River and the Western Karakol River does not exceed 70 m^3 /s. The type of feeding of the rivers is glacial-snow with additional rain feeding. In the flat part of the Chui Valley , an irrigation network with a large number of canals and artificial reservoirs and a collector and drainage network are widely developed.

In the Suusamyr Valley , the irrigation network is poorly developed and consists only of irrigation ditches and tray canals.



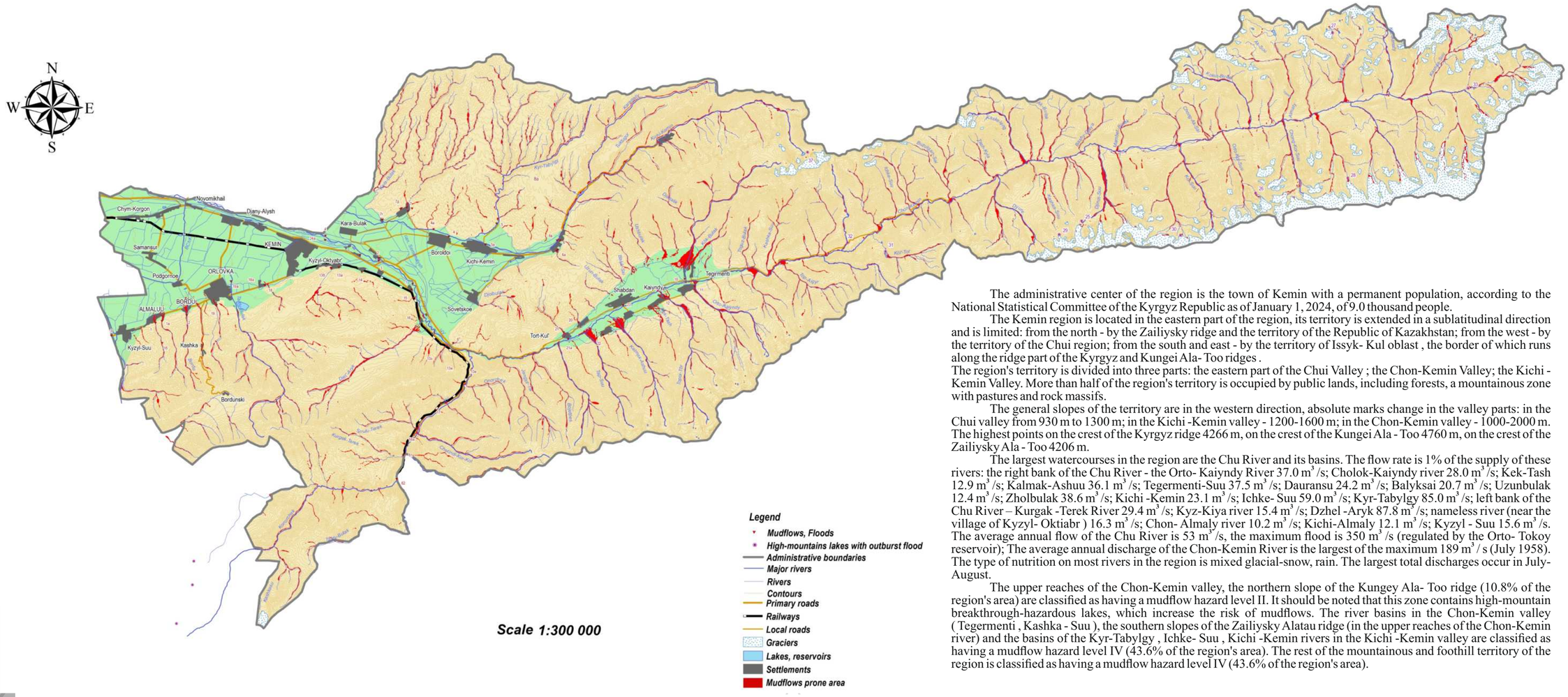


REGIONS OF CHUI OBLAST
KEMIN REGION

The district was formed in 1936. Area of the region is 3533 km², 4 rural districts 34 rural settlements: Kichi - Kemin (union of rural areas Ak-Tuz, Boroldoy , Ilyich, Kara- Bulak Kichi -Kemin) (10 settlements); Kyzyl- Oktiabr (association, rural areas of Zhany -Alysh and Kyzyl- Oktiabr (10); Chym-Korgon (association, rural areas of Chym-Korgon and Almalu) (6); Chon-Kemin (association, rural areas of Chon-Kemin and Kok - Oyrok) (8). Data according to Decree of the President of the Kyrgyz Republic No. 370 from December 29, 2023 .

The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 51.9 thousand people, the urban population is 16.4 thousand people (Kemin - 9.0 thousand people, Orlovka - 7.4 thousand people, Bordunsky - 0.03 thousand people), rural - 35.5 thousand people.

The average population density is one of the lowest in the region and is 14.6 people per 1 km² of area.



The administrative center of the region is the town of Kemin with a permanent population, according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024, of 9.0 thousand people.

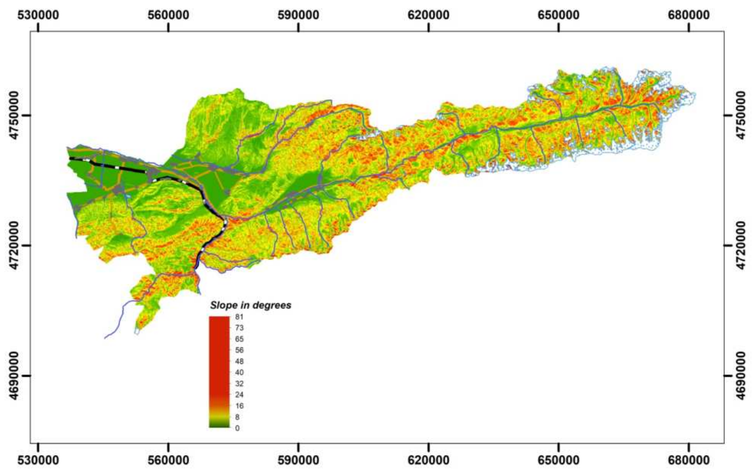
The Kemin region is located in the eastern part of the region, its territory is extended in a sublatitudinal direction and is limited: from the north - by the Zailiysky ridge and the territory of the Republic of Kazakhstan; from the west - by the territory of the Chui region; from the south and east - by the territory of Issyk- Kul oblast , the border of which runs along the ridge part of the Kyrgyz and Kungei Ala- Too ridges .

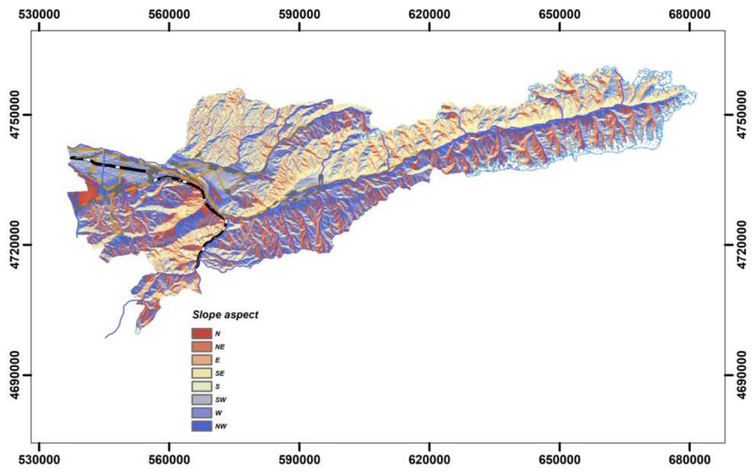
The region's territory is divided into three parts: the eastern part of the Chui Valley ; the Chon-Kemin Valley; the Kichi - Kemin Valley. More than half of the region's territory is occupied by public lands, including forests, a mountainous zone with pastures and rock massifs.

The general slopes of the territory are in the western direction, absolute marks change in the valley parts: in the Chui valley from 930 m to 1300 m; in the Kichi -Kemin valley - 1200-1600 m; in the Chon-Kemin valley - 1000-2000 m. The highest points on the crest of the Kyrgyz ridge 4266 m, on the crest of the Kungei Ala - Too 4760 m, on the crest of the Zailiysky Ala - Too 4206 m.

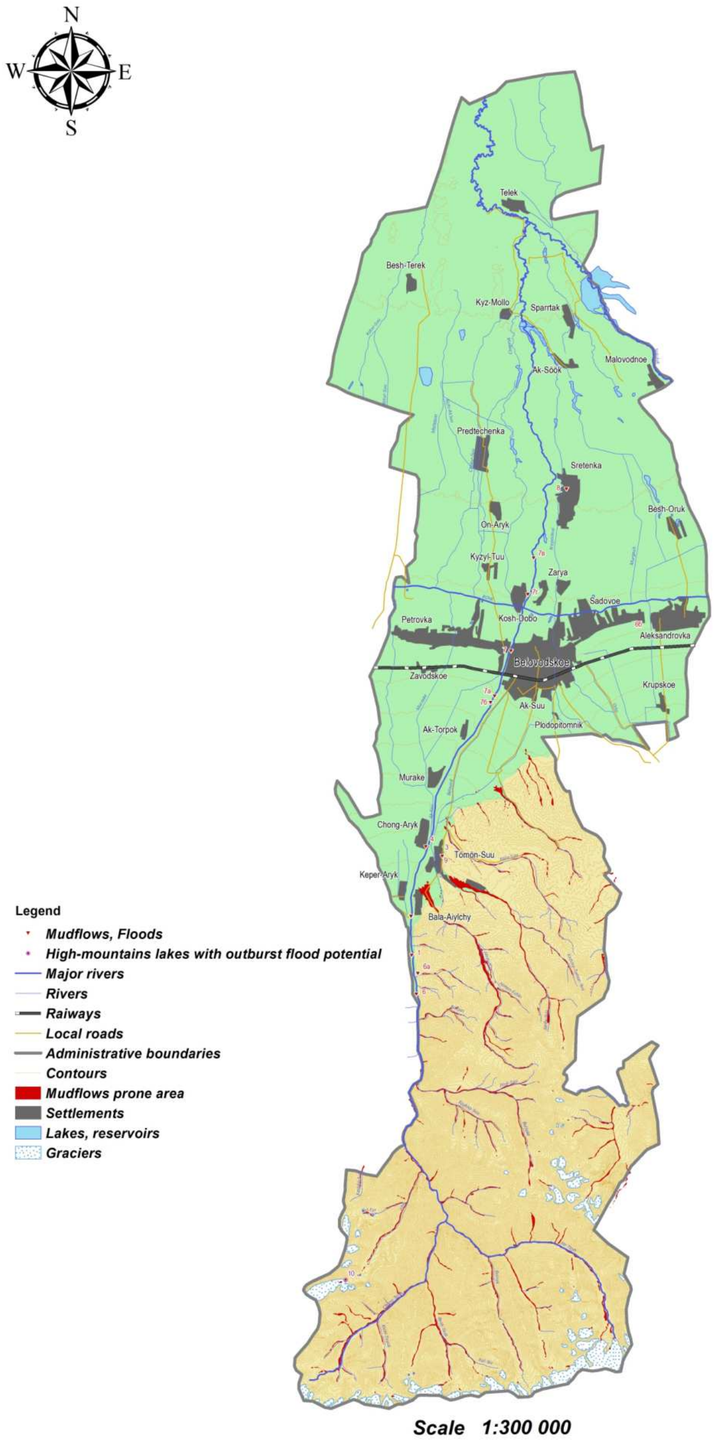
The largest watercourses in the region are the Chu River and its basins. The flow rate is 1% of the supply of these rivers: the right bank of the Chu River - the Orto- Kaiyndy River 37.0 m³ /s; Cholok-Kaiyndy river 28.0 m³ /s; Kek-Tash 12.9 m³ /s; Kalmak-Ashuu 36.1 m³ /s; Tegermenti-Suu 37.5 m³ /s; Dauransu 24.2 m³ /s; Balyksai 20.7 m³ /s; Uzunbulak 12.4 m³ /s; Zholbulak 38.6 m³ /s; Kichi -Kemin 23.1 m³ /s; Ichke- Suu 59.0 m³ /s; Kyr-Tabylgy 85.0 m³ /s; left bank of the Chu River – Kurgak -Terek River 29.4 m³ /s; Kyz-Kiya river 15.4 m³ /s; Dzhel -Aryk 87.8 m³ /s; nameless river (near the village of Kyzyl- Oktiabr) 16.3 m³ /s; Chon- Almaly river 10.2 m³ /s; Kichi-Almaly 12.1 m³ /s; Kyzyl - Suu 15.6 m³ /s. The average annual flow of the Chu River is 53 m³ /s, the maximum flood is 350 m³ /s (regulated by the Orto- Tokoy reservoir); The average annual discharge of the Chon-Kemin River is the largest of the maximum 189 m³ / s (July 1958). The type of nutrition on most rivers in the region is mixed glacial-snow, rain. The largest total discharges occur in July-August.

The upper reaches of the Chon-Kemin valley, the northern slope of the Kungey Ala- Too ridge (10.8% of the region's area) are classified as having a mudflow hazard level II. It should be noted that this zone contains high-mountain breakthrough-hazardous lakes, which increase the risk of mudflows. The river basins in the Chon-Kemin valley (Tegermenti , Kashka - Suu), the southern slopes of the Zailiysky Alatau ridge (in the upper reaches of the Chon-Kemin river) and the basins of the Kyr-Tabylgy , Ichke- Suu , Kichi -Kemin rivers in the Kichi -Kemin valley are classified as having a mudflow hazard level IV (43.6% of the region's area). The rest of the mountainous and foothill territory of the region is classified as having a mudflow hazard level IV (43.6% of the region's area).





REGIONS OF CHUI OBLAST
MOSCOW REGION



The district was formed in 1965. The area of the region is 2056 km^2 , 5 rural districts 33 settlements: Narzan (association of the rural districts Belovodskoye and Pervomaysky) (3 settlements); Tort-Gul (association, rural district Petrovka, Predtechenka and Besh -Terek) (6); Min-Bulak (association, rural district Sadovoye, Sretenka and Aleksandrovka) (7); Tolok (association, rural district Chapayev, Tselinny and Tolok) (5); leave the rural district Ak- Suu without changing the administrative borders and the center (7). Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 104.1 thousand people. The average population density is 50.6 people per 1 km^2 of area.

The administrative center of the region is the village of Belovodskoye with a permanent population of 23.9 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

The Moscow region is located in the western part of the region and is bounded: from the north by the state border with the Republic of Kazakhstan; from the west by the territory of the Zhayyl region ; from the south by the watershed of the Kyrgyz ridge; from the east by the territory of the Sokuluk region .

The territory of the region is located in the Chui Valley , stretches along the slope in the meridional direction and covers an alluvial-proluvial plain, represented by Neogene-Quaternary sandy-clayey deposits; a foothill trail, represented by proluvial-alluvial coarse-grained and sandy-clayey deposits of the Neogene-Quaternary age; the northern slopes of the Kyrgyz ridge, represented by Paleozoic rocks.

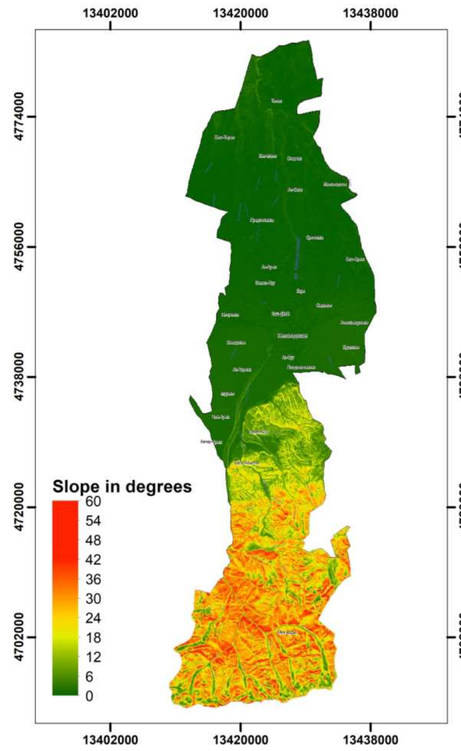
Absolute altitude marks range from 520 m to 1200-1260 m in the foothills and up to 4200 m in the ridge part of the Kyrgyz Range.

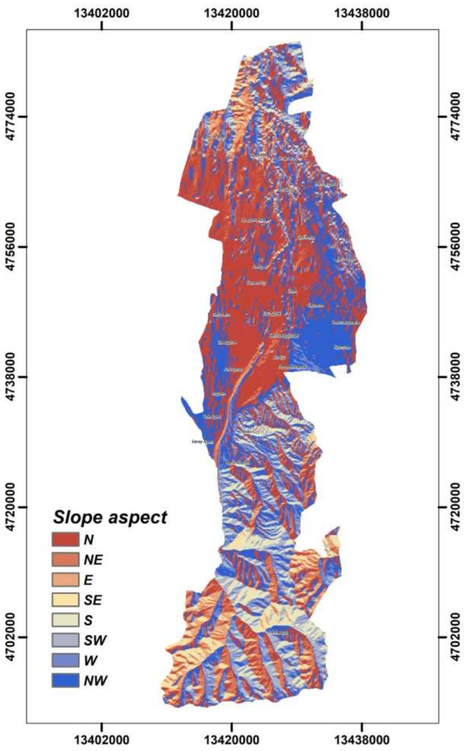
The hydrographic network of the region belongs to the Chu River basin and is represented by its left tributaries originating on the northern slopes of the Kyrgyz ridge. The largest rivers are: Ak- Suu, flow rate 47.7 m^3/s; estimated flow rates of 1% provision: Jardy-Suu – 89.1 m^3 / s; Ak- Bashat – 85.8 m^3 / s; Kara- Suu – 46.5 m^3 / s; Kurgandy – 20.3 m^3 / s; Urubash – 17.7 m^3 / s; Bolshoy and Maly Kashkalot – 14.6 m^3 / s; Sukhoi Log – 13.4 m^3 / s. The rivers are fed by glaciers and snow with additional water from rainfall and springs. The river waters are completely used for irrigation and only during significant floods can they reach the bed of the Chu River.

Region has a well-developed irrigation network, and to the north of the Bolshoi Chuisky Canal, a drainage and collector network.

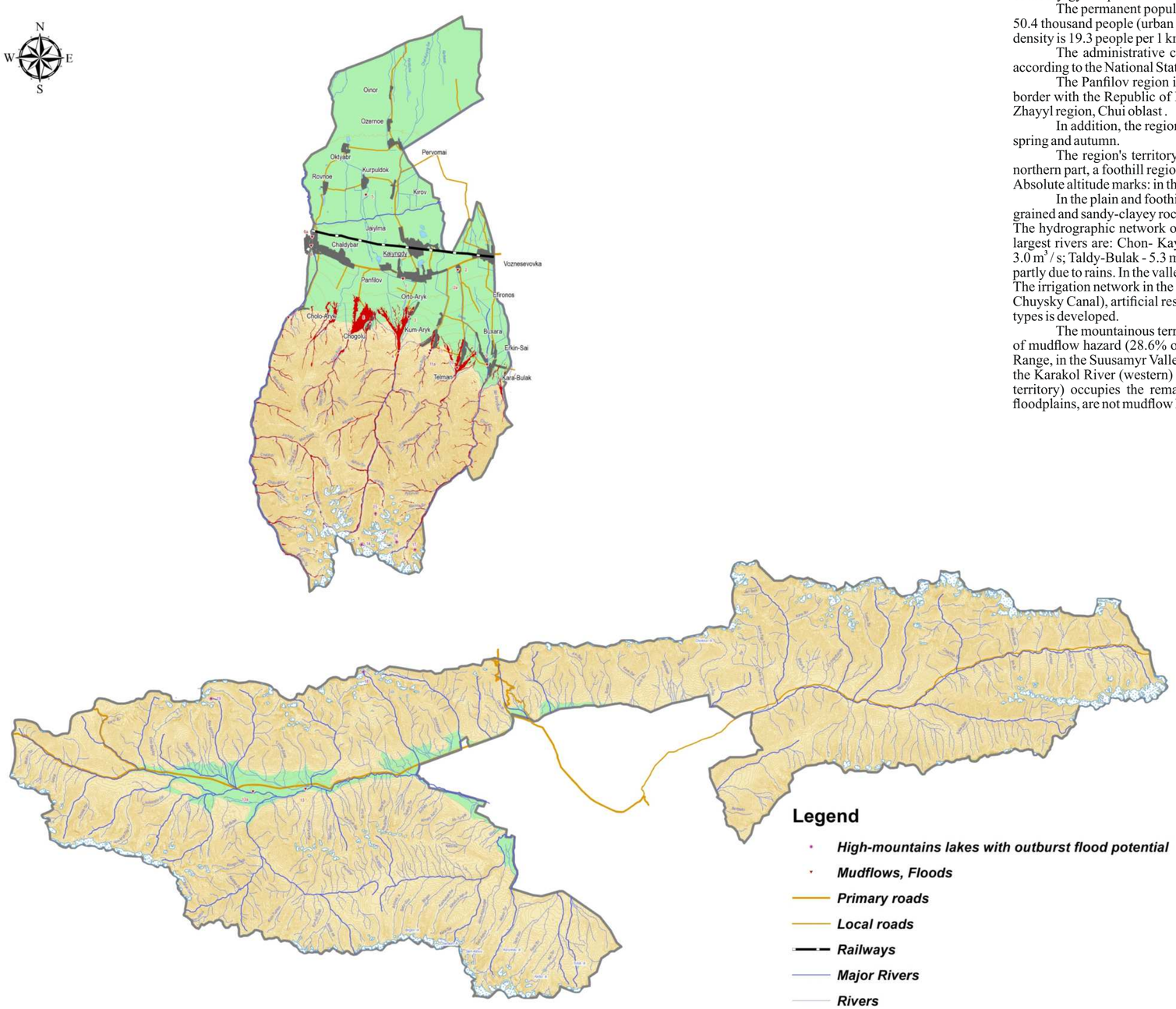
The Bishkek-Osh national highway and the Lugovaya-Bishkek railway pass through the district.

Based on hydrological data, 17 of the total number of permanent and temporary watercourses in the region have been identified, on which mudflows may form in certain periods of the year. These watercourses are the Ak- Suu, Jardy-Suu, Ak -Bashat, Kara- Suu, B. and M. Aylampa, Cholok-Bulak, Kurgandy, Saryjaik, Karakatyn, B. and M. Kashkolot, Urubash rivers, as well as 4 unnamed ravines.





REGIONS OF CHUI OBLAST
PANFILOV REGION



Zhayyl region in 1977 and was a region of republican subordination until 1990. The area of the region is 2,606 km², including 4 rural districts and 20 populated areas: Orto- Kayindy (an association of the rural districts of Voznesenovka and Orto) (6 populated areas); Kurpuldok (an association, the rural district of Kurpuldok and Chaldybar) (7); leaving the rural districts of Kurama (4) and Frunze (3) without changing the administrative borders and centers. Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 50.4 thousand people (urban population - 10.5 thousand people, rural population - 39.9 thousand people). The average population density is 19.3 people per 1 km² .

The administrative center of the region is the town of Kaindy with a permanent population of 10.5 thousand people, according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

The Panfilov region is the westernmost region of the oblast. Its territory is limited: from the north and west – by the state border with the Republic of Kazakhstan; from the south – by the territory of Talas oblast ; from the east – by the territory of the Zhayyl region, Chui oblast .

In addition, the region's territory includes public lands of the Suusamyr Valley without settlements, used as pastures in the spring and autumn.

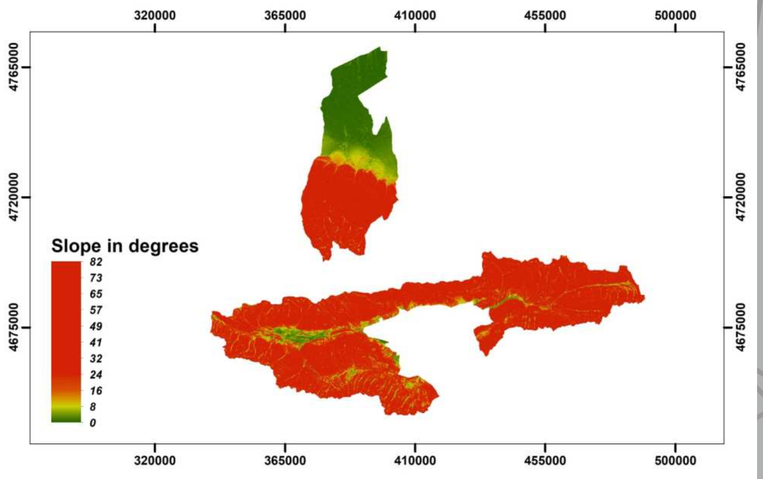
The region's territory is extended along a slope in the meridional direction and covers an alluvial-proluvial plain in its northern part, a foothill region represented by merged alluvial fans, and a mountainous region up to the crest of the Kyrgyz Range. Absolute altitude marks: in the plain 550-750 m; in the foothill - 750-1200 m; in the mountainous part from 1200 to 4380 m.

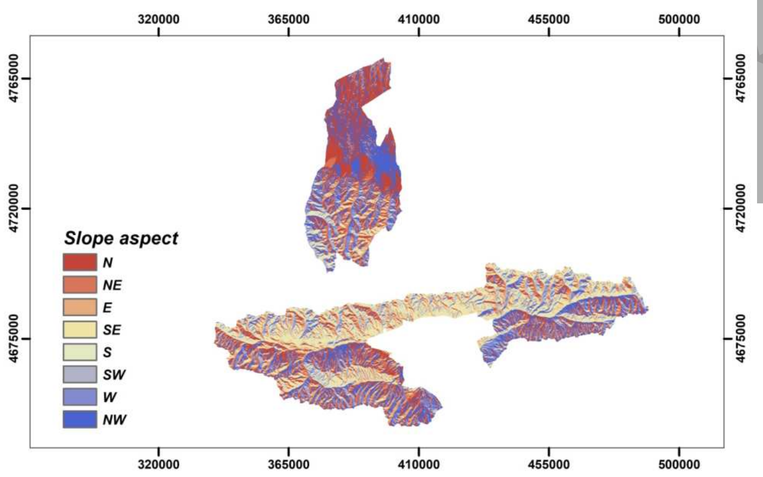
In the plain and foothill areas, the composition and age of rocks varies from alluvial-proluvial Neogene-Quaternary coarse-grained and sandy-clayey rocks to Paleozoic rocks that make up the northern slopes of the Kyrgyz Range.

The hydrographic network of the region belongs to the Chu River basin and is represented by its numerous left tributaries. The largest rivers are: Chon- Kayindy - flow rate of 26.9 m³ / s; Cholok-Kayindy 5.9 m³ /s; Jardy-Kayindy - 31.7 m³ / s; Chorgol - 3.0 m³ / s; Taldy-Bulak - 5.3 m³ / s; Kara-Bulak ravine - 3.0 m³ / s; Chorgol ravine - 1.0 m³ / s. The rivers are fed by glaciers and snow, partly due to rains. In the valley part, a ravine-gully network with permanent and temporary watercourses is widespread.

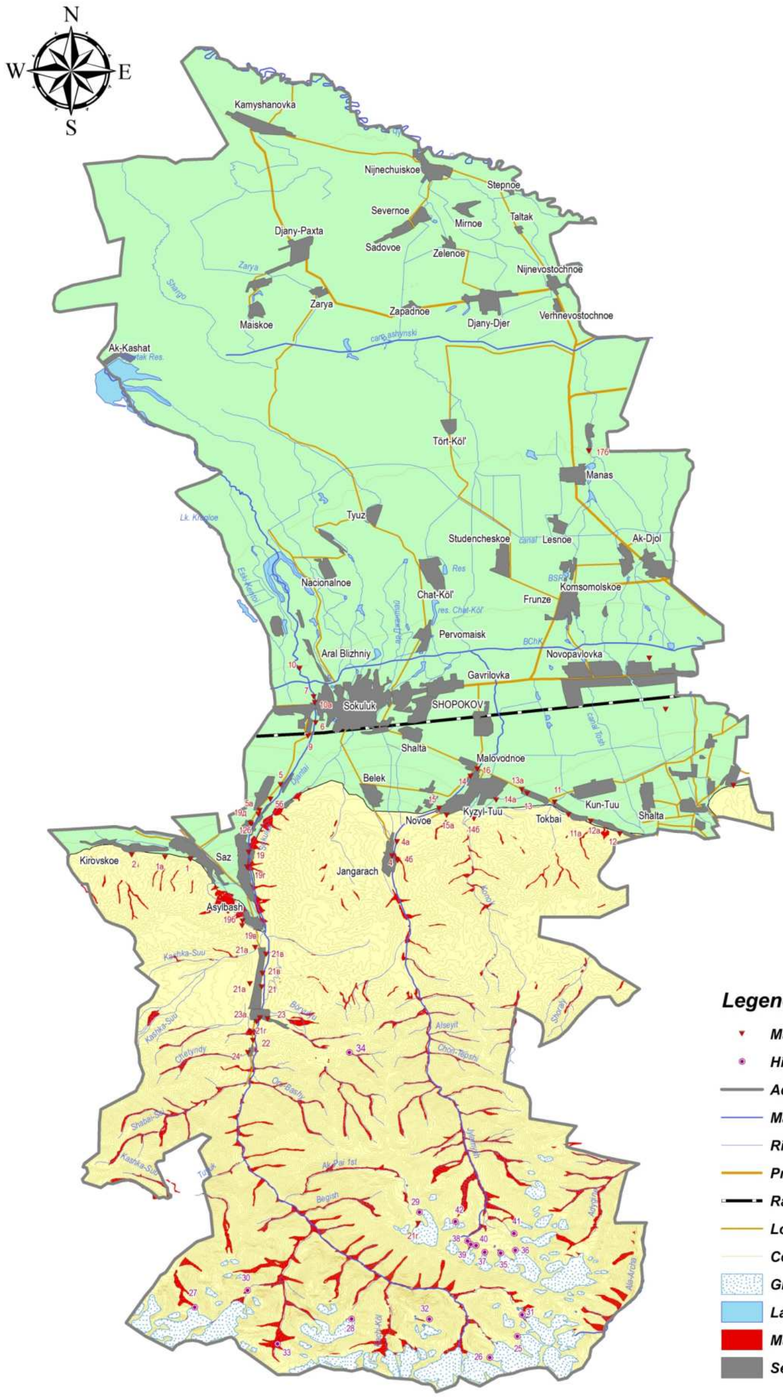
The irrigation network in the valley part is developed everywhere and is represented by numerous canals (the largest is the Bolshoy Chuysky Canal), artificial reservoirs. To the north of the Bolshoy Chuysky Canal, a collector-drainage network of open and closed types is developed.

The mountainous territory of the region is divided into the following mudflow hazard zones: the zone with the third degree of mudflow hazard (28.6% of the region's area) occupies the mid- and high-mountain areas of the northern slope of the Kyrgyz Range, in the Suusamyr Valley, the basins of the Korumdu , Tokoyluu , Chon- Korumdu , Iyri-Suu rivers and the right tributaries of the Karakol River (western) in its upper reaches; the zone with the fourth degree of mudflow hazard (area 48.4% of the region's territory) occupies the remaining mountainous part of the region. Flat areas, with the exception of low terraces and river floodplains, are not mudflow hazardous.





REGIONS OF CHUI OBLAST
SOKULUK REGION



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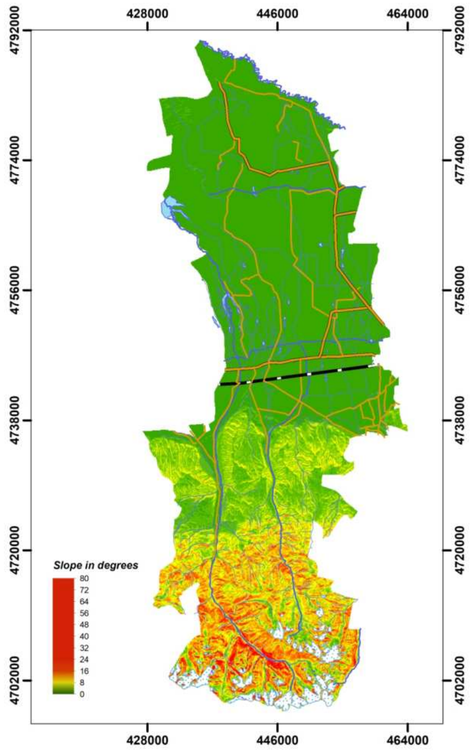
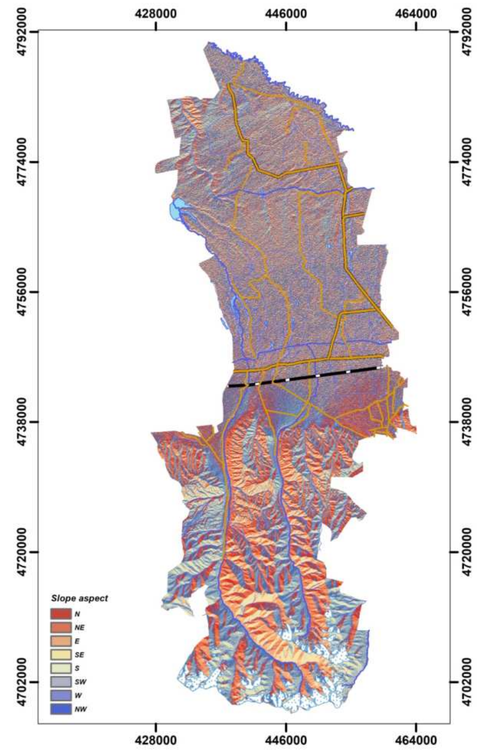




The district was formed in 1953. Area of the region - 2550 km², 1 city, 9 rural districts, 58 settlements: rural district of Sary-Ozon (union of rural districts Asylbash , Tosh- Bulak , named after Krupskaya) (9 settlements); Sokuluk (union of rural areas Sokuluk and Saz) (3); Z. Kainazarova (union of the rural district of Z. Kainazarova and Pervomai) (6); Kuntuu (union of the rural district of Kuntuu and Kyzyl- Tuu) (10); Manas (union of the rural district of At-Bashi (with the exception of contour No. 177) and Frunze) (8); Zhany-Pakhta (union of the rural district of Zhany-Pakhta and Zhany- Zher) (10); Nizhniy-Chui (unification of the rural district of Nizhniy-Chui and Kamyshanovka) (7); leave the rural districts of Gavrilovka (4) and Voenno-Antonovka (1) without changing the administrative borders and centers. Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023

Of Shopokov is located on the territory of the region, with a permanent population of 10.8 thousand people, according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 223.5 thousand people (urban population 10.8 thousand people, rural population 212.7 thousand people). The average population density is 87.6 people per 1 km² of area. On the territory of the region there is a town of Shopokov with a permanent population of 10.3 thousand people.

The administrative center of the region is the village of Sokuluk with a permanent population of 15.2 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

Sokuluk region is located in the central part of the Chui Valley and is bounded: from the north by the territory of the Republic of Kazakhstan; from the west by the territory of the Moscow region; from the south by the ridge of the Kyrgyz Range; from the east by the territory of the Alamudun region .

Territory extends along a slope from south to north, including the northern slopes of the Kyrgyz Range, which occupy the southern third of the region's area, a foothill zone with a slope of up to 2°, and a flat part with slopes of less than 0.5° in the northern direction.

The mountainous part is represented by rocky rocks of Paleozoic age, the valley part is represented by alluvial-proluvial, sandy-clayey and coarse-grained rocks of Neogene-Quaternary age.

Absolute relief elevations increase from the northern borders of the region from 580 to 1100 m in the valley part to 4400 m on the crest of the Kyrgyz ridge.

Mountain rivers originating on the northern slopes of the Kyrgyz Range are predominantly of mixed glacial-snow and rain feeding with the highest total flow occurring in July-August.

The largest watercourses in the region are the following rivers: Konok - 1% flow rate 20.8 m³/s; Zhylamysh – 29.0 cm³/s; Sazbulak - 25.1 m³/s; Burley – 131.0 m³/s; Chetendi - 39.2 m³/s; Sarymsakty - 45.4 m³/s; Kashka- Suu – 89.0 m³/s; Sokuluk – 61.5 m³/s.

Mountain rivers have very deep channels with numerous branches wandering in the floodplain depressions. At the entrance to the valleys, a significant part of the river flow is used for irrigation.

In the valley part, a gully-ravine network with permanent and temporary watercourses fed by rain and groundwater is widespread.

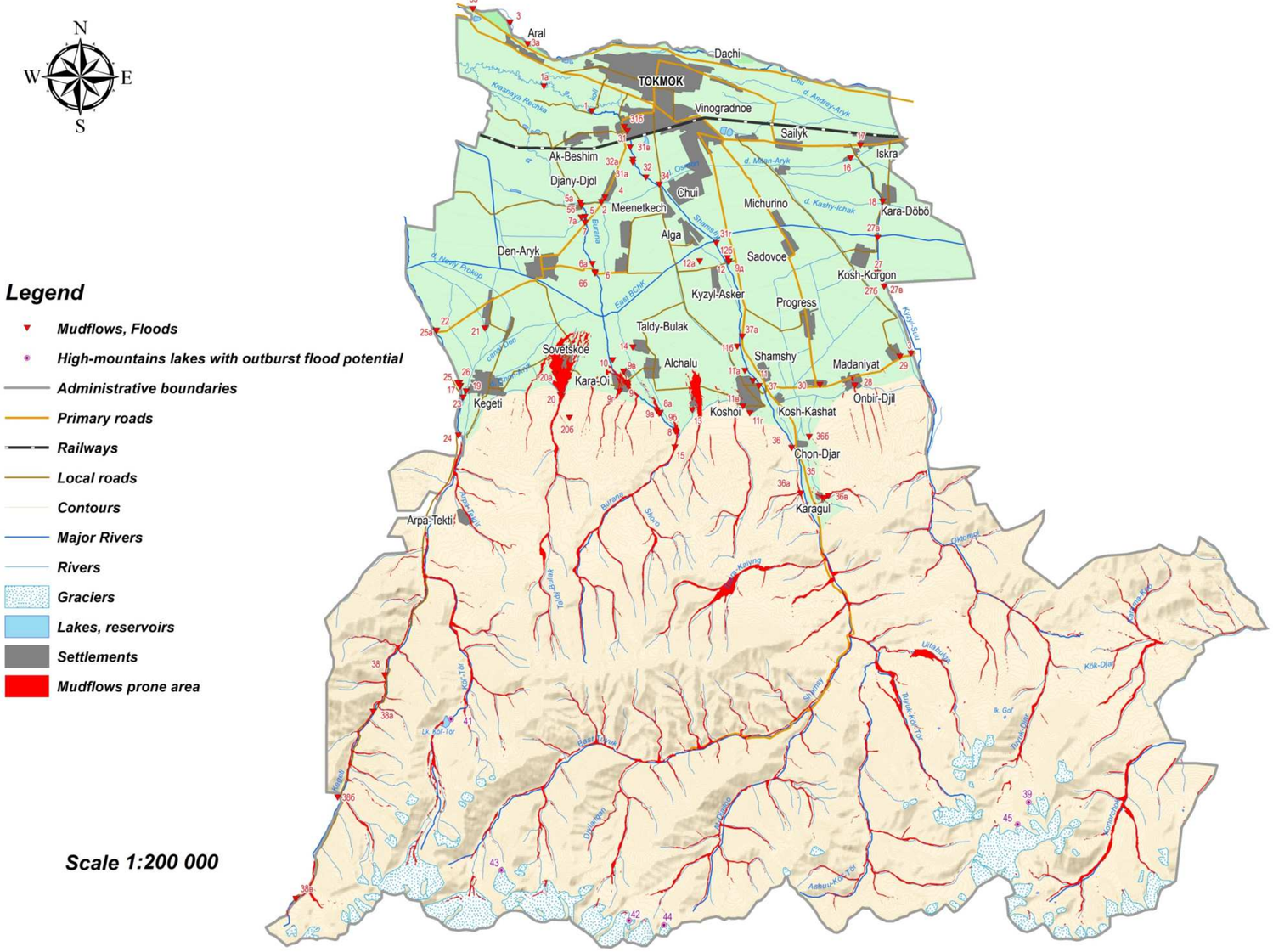
The irrigation network is developed throughout the central and northern parts of the region and is represented by numerous canals and artificial reservoirs. In the middle part of the region there are swampy areas and a developed collector-drainage network.

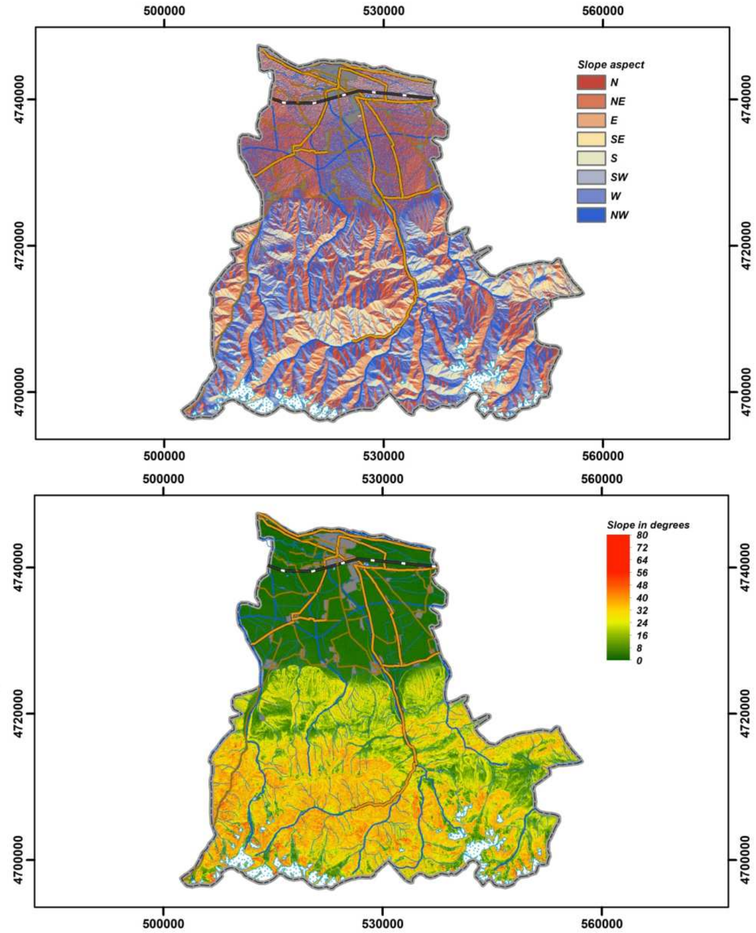
The Lugovaya-Bishkek-Balykchy railway and the Bishkek-Osh highway pass through the region.

The mountainous territory of the region is divided into the following mudflow hazard zones: the second degree (15.4% of the region's area) is distributed in the upper reaches of the Zhylamysh and Sokuluk rivers (as well as in the floodplain and low terraces of the Sokuluk river); the zone with the third degree (17.2% of the region's area) occupies the mid-mountain areas of the region; the zone with the fourth degree (area 8% of the region's area) is distributed in the foothills and low mountains.

In the upper reaches of the Sokuluk and Zhylamysh rivers there are high- mountain lakes with a risk of outbursts, which increase the risk of mudflows and floods.

REGIONS OF CHUI OBLAST
CHUI REGION





Region was formed in 1924. The area of the region is 1756 km^2 , 5 rural districts and 42 settlements: rural district of Burana (union of rural districts of Burana and Ak- Beshim) (7 settlements); Sultan Ibraimov (union, rural area of Kegeti and Ibraimov (11); Onbir Zhylga (association, rural district Onbir Zhylga and Shamshy) (12): Birimdik (unification, rural district Kosh- Korgon , Iskra and Sailyk) (9); leave the rural district Chui without changing the administrative borders and center (3). Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated 29 December 2023 .

The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 60.4 thousand people. The average population density is 34.4 people per 1 km^2 of area (excluding the town of Tokmok). The city of Tokmok with a population of 75.2 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is located on the territory of the region.

The administrative center of the region is the village of Chui with a permanent population of 12.9 thousand people according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024.

In relation to the territory of the region, the territory of the region is 8.4%, the population is 12.5% of the total number of residents of the region (taking into account the population of the town of Tokmok).

The region is located in the eastern part of the Chui Valley and is bounded: from the north by the territory of the Republic of Kazakhstan (the border runs along the Chu River); from the west by the territory of the Issyk-Ata region ; from the south by the ridge of the Kyrgyz Range; from the east by the territory of the Kemin region.

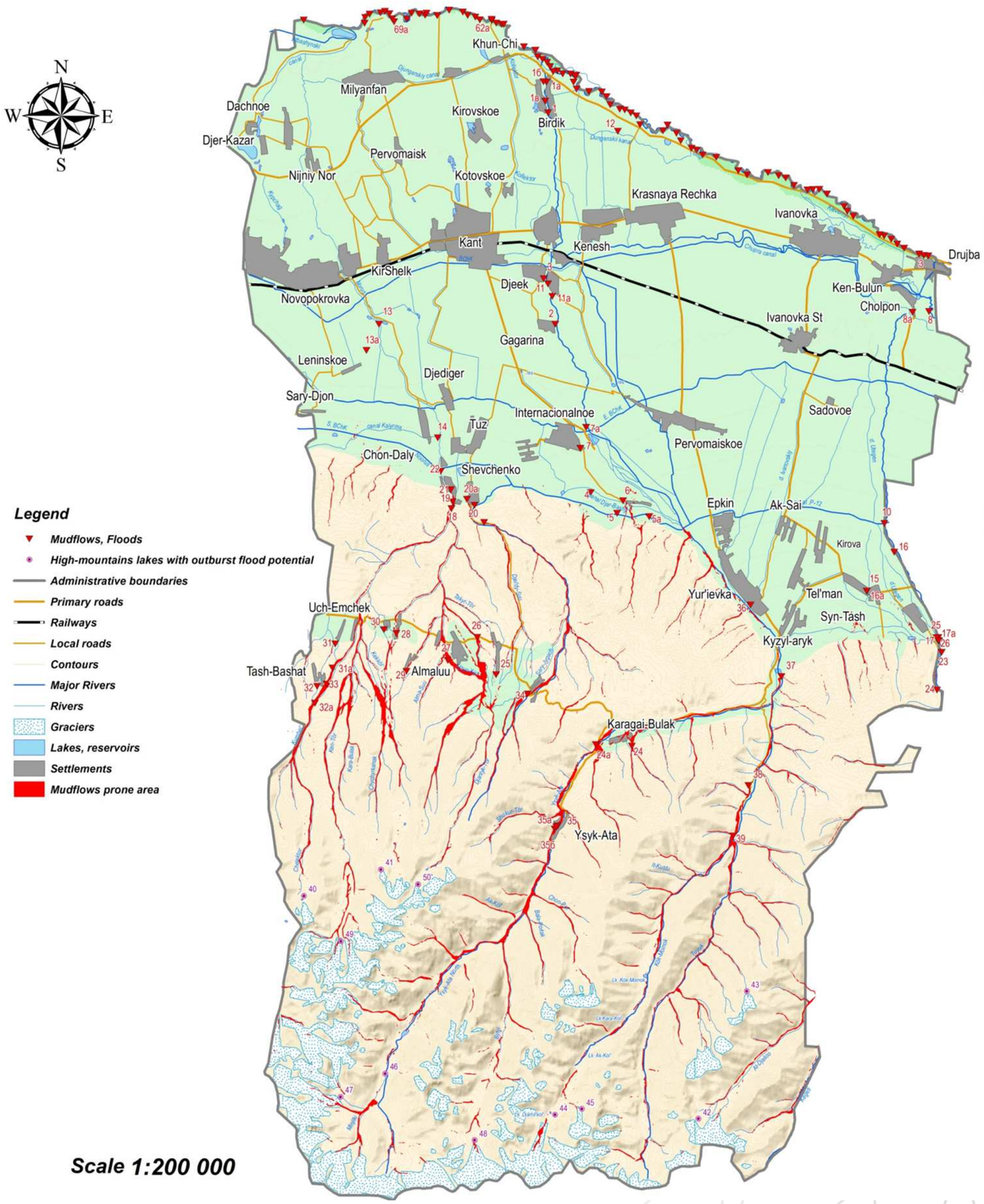
The region's territory extends along a slope from south to north and is made up of a valley part, occupying the northern half of the region's area, and a mountainous part, occupying the southern half of the region's area.
In the valley part the slope of the terrain does not exceed 30. Absolute marks from 778 m to 4388 m.

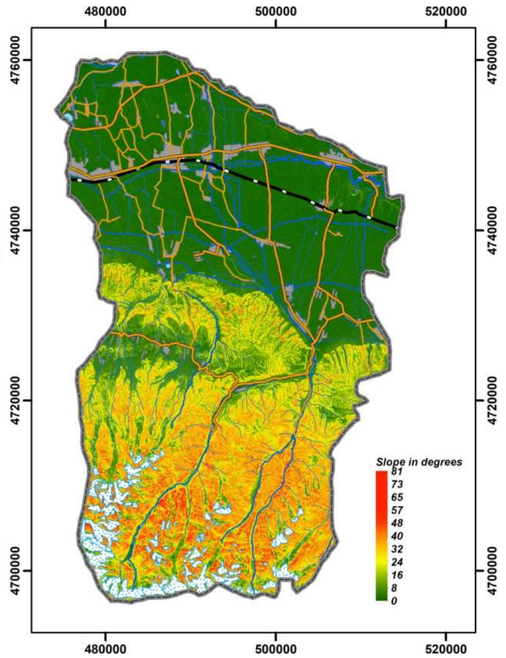
The hydrographic network of the region is represented by both natural and artificial watercourses. Of the natural watercourses, the largest are the left tributaries of the Chu River.

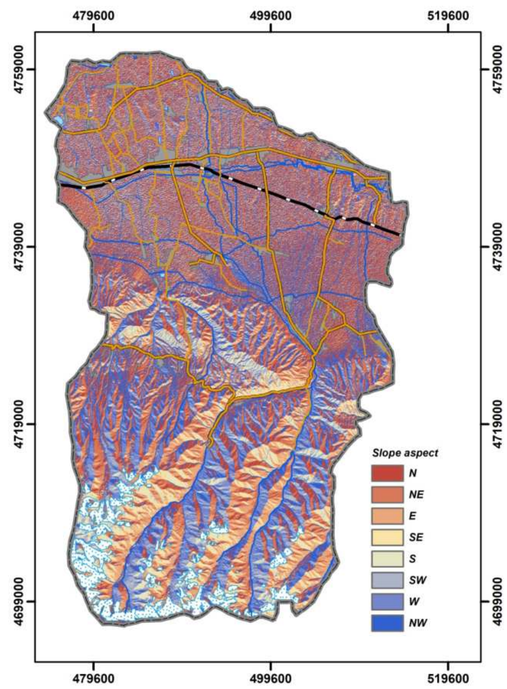
The following rivers fed by glaciers and snow are characterized by a flow rate of 1%: Kyzyl- Suu – 15.6 m^3 / s; Karagul – 13.9 m^3 / s; Shamshy (near the village of Koshoy) – 55.4 m^3 / s; Taldy-Bulak – 15.2 m^3 / s; Burana – 23.5 m^3 / s, Arpa-Tektir – 16.3 m^3 / s, Kegeti – 31.5 m^3 / s. The period of maximum floods is July-August. The irrigation network is developed throughout the entire territory of the valley part.

In the mountainous part of the region the following are distinguished: the territory with the second degree of mudflow hazard (12.3% of the region's area) is located in the upper reaches of the Kegety and Vostochny Tuyuk Rivers (the left tributary of the Shamshy River); the territory with the third degree (13.5% of the region's area) includes the Shamshy River basin (except for the Tuyuk Vostochny tributary) and the Kyzyl- Suu River basin ; the territory of the fourth degree is located in the Burana River basin and in the foothill areas of the region, occupying 14.7% of the region's territory. The remaining territory, with the exception of low terraces, river floodplains and irrigation canals, is not mudflow hazardous.

REGIONS OF CHUI OBLAST
ISSYK-ATA REGION







The area of the region is 2415 km² . There are 54 settlements in the district, which belong to 9 rural regions: Zhayilma (unification of the rural districts of Logvinenko and Tuz) (6 settlements); Zheek (3) (unification of the rural district Zheek and Internatsional) (5); Ken Bulun (unification of the rural district Ivanovka and Ken- Bulun) (5); Nurmanbet (unification of the rural district Nurmanbet and Krasnaya Rechka) (4); Uzungur (unification of the rural district of Novopokrovka and Uzungur) (6); Ak-Kuduk (unification of the rural district of Ak- Kuduk and Milyanfan) (5); Kochkorbayev (unification of the rural district of Kochkorbayev and Birdik) (5); Syn-Tash (unification of the rural district of Syn-Tash and Yuryevka) (10); Leave the rural district of Ysyk-Ata without changing the administrative borders and the center) (9). Grant the town of Kant the status of a city of regional significance, annexing the rural district of Luxembourg to the town of Kant. Data according to the Decree of the President of the Kyrgyz Republic No. 370 dated December 29, 2023 .

The permanent population according to the National Statistical Committee of the Kyrgyz Republic as of January 1, 2024 is 128.6 thousand people (urban population 31.7 thousand people, rural 128.6 thousand people). The average population density per 1 km2 of area is 53.2 people. The administrative center of the region is the town of Kant with a permanent population of 31.7 thousand people as of January 1, 2024.

The district occupies an area located in the central part of the valley, bounded: from the north by the Chu River and the territory of the Republic of Kazakhstan; from the west by the territory of the Alamudun region ; from the south by the watershed of the Kyrgyz ridge; from the east by the territory of the Chui region.

Most of the region's territory is located in the Chui Valley and covers its flat part and, stretching in the meridional direction to the south, occupies the northern slopes of the Kyrgyz Range. Absolute marks vary from 650 m at the northern edge of the region to 950-1000 m at the foot of the ridge's ramparts and 4500 m on the ridge's crest.

The main territory of the region is located on the surface of an alluvial-proluvial plain, represented by Neogene-Quaternary coarse-grained and sandy-clay soils.

The mountainous part of the region is represented by rock formations of the Paleozoic age. The different structure and composition of the rocks determine the general engineering and geodynamic situation of the region.

The hydrographic network of the region belongs to the Chu River basin and is represented by its largest left tributaries: the Kegety River (forest cordon area) - discharge of 1% of provision 31.5 m^3 / s; 4 dry channels without names - 11.6-14.2 m^3 / s; the Issyk-Ata River (near the village of Yuryevka) - 53.6 m^3 / s; the Saryzhygach River (near the village of Nizhnyaya Serafimovka) - 24.9 m^3 / s; the Nooruz River - 36.0 m^3 / s; the Takyr-Ter, Uzun- Kyr River (near the village of Gornaya Serafimovka) - 48.6 m^3 / s; the Dzhantyk -Ter River - 26.3 m^3 / s; The Ichke- Suu River (near the village of Ysyk-Ata) – 17.8 m^3 / s; the Chychyrkanak River , the Kek -Kel River – 50.6 m^3 / s; the Kurgundey River – 20.9 m^3 / s. The sources of all the rivers are on the northern slopes of the Kyrgyz Range. The rivers are of mixed glacier-snow and rain feeding with the highest total discharges in July-August. Most of the water from the rivers is used for irrigation, therefore only a few of the streams reach the Chu River bed during significant floods.

The irrigation network is widely developed in the valley part of the region. To the north of the Great Chui Canal, in the floodplains of large watercourses, there are swampy areas, a collector-drainage network is developed with water discharge into existing canals and the Chu River.

The following areas are identified in the region: a zone with the second degree of mudflow hazard (18.6% of the region's territory) is distributed in the upper reaches of the Issyk-Ata and Nooruz river basins ; a zone with the third degree occupies mid-mountain areas and the Tuyuk River basin (the right tributary of the Issyk-Ata River), an area of 20.6% of the region's territory; a zone of the fourth degree (18.3% of the region's area) is distributed in the foothill zone. The remaining area of the region, with the exception of floodplains and low river terraces, irrigation canals, is not mudflow hazardous.

The most catastrophic mudflows of glacial genesis

No.	Name of the lake	River basin	Breakthrough year	Consumption breakthrough flow, m3 / sec	Mudflow flow rate, m3 / sec	Type of lake	
1	**Selector (Ch-53)**	-	2017	20	200	moraine-glacial stationary	**Northern slope of the Kyrgyz ridge**
2	**Teketor (Ch-12)**	Tuyuk- Issyk - Ata	16.08.1953 08.1978	40-50 30	- 300	moraine-glacial stationary	
3	**Takyrtor (Ch-55)**	Noorus	4.06.1991 4.06.2009	15 25	- 300	moraine-glacial non-stationary	
4	**Teztor (Ч-8)**	Ala-Archa	22.06.1953 June 1988 July 2004 31.07.2012	50 - 6-8 10-15	250 - - 300	moraine-glacial non-stationary	
5	**Top-Karagay (Ch-10)**	Ala-Archa	1974 1993	6	-	moraine-glacial stationary	
6	**Aksai (Ch-40)**	Ala-Archa	50.07.1960 26.07.1961 21.08.1965 18.06.1968 24.07.1969 18.07.1970 04.08.1975 18.07.1980	- - - 30-40 30-40 10-20 - -	- - - 800 900 150 - -	intraglacial capacity non-stationary	
7	**Isha (Ч-3)**	Aksuu	06.1968	20	100	moraine-glacial non-stationary	
8	**Keys-Kuchkach (Ч-4)**	Aksuu	07.1980 12.08.1983	40 40-50	- 500	moraine-glacial stationary	
9	**At-Jailoo (Ч-13)**	Kegets	13.07.1968 1997	- 10	- 60	moraine-glacial stationary	
10	**Jardy -Kaindy (Ch-26)**	Sokuluk	1995	-	-	moraine-glacial	
11	**Akpai (Ch-19)**	Sokuluk	01.08.2021	30	350	moraine-glacial non-stationary	
12	**Jalpaktor (T-2)**	Chirkanak Talas	20.06.1969 14.07.1976 07.1993 07.1997	- - 5-8 35	- - 150 300	moraine-glacial non-stationary	**Southern slope of the Kyrgyz ridge**
13	**Kyzylzhar (I-72)**	Chon -Aksuu	15.07.1958	50	-	moraine-glacial	**Issyk-Kul Lake Basin**
14	**Chon -Kyzylsuu (I-29)**	Chon - Kyzylsuu	5.06.1959 October 1966 11.07.1968	- 60 50	- - -	moraine-glacial stationary	
15	**Kichi-Kyzylsu (I-53)**	Kichi-Kyzylsu	August 1952	45	-	moraine-glacial stationary	
16	**Tamga (I-6)**	Tamga	12.08.1964	30	-	moraine-glacial stationary	
17	**Tosor (I-176)**	Tosor	9.07.1995	60	-	moraine-glacial	
18	**Angysay**	Tone	17.06.1975 24.07.1978	- 15	- 300	intraglacial capacity non-stationary	
19	**Choktal-1 (I-1)**	Choktal	27.09.1978	30	300	moraine-glacial stationary	
20	**Choktal-2 (I-2)**	Choktal	09.1999	11	-	moraine-glacial non-stationary	
21	**Chonkoysuu (I-13)**	Chonkoysuu	14.06.1994	20	-	moraine-glacial	
22	**Suyuktor (I-10)**	Jerooy	1985	-	300	moraine-glacial	
23	**Koltor (I-35) (I-35)**	Tone	July 2003	-	-	moraine-glacial	
24	**Kurumdy (I-172)**		July 2015	-	-	moraine-glacial	
25	**Chetyndy (I-181)**	Jerooy -Aksai-Ton	15.08.2013	15	300	moraine-glacial	
26	**Zyndan (I-167)**		July 2008 August 2024	25 -	250 200	moraine-glacial	
27	**Buzulgansuu (H-14)**	Shamsi - Kochkorskoe	July 1987	20	100	glacial	**Naryn**
28	**Allaudin (O-20)**	Shakhimardan	July 1998	30	300	moraine-glacial non-stationary	**South of Kyrgyzstan**
29	**Tegermach - southern (O-16)**	Isfayramsay	July 1999	-	-	moraine-glacial stationary	
30	**Tegermach - northern (O-15)**	Isfayramsay	July 1978	30	600	moraine-glacial stationary	
31	**Yashilkel**	Isfayramsay	18.06.1966	1000	2000	Landslide-landfall	

CATALOGUE OF MUDFLOW-PRONE RIVERS IN KYRGYZSTAN

Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse, km	Mudflow catchment area, square km	Absolute height, m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods		Mudflow type	Possible causes of mudflows	Mudflow activity
			Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
Southern slope of Kungey-Alatoo	Shyrgyl	r. Chu (right)	23	64.2	3460	1575	82	05.1958, 05.1960	1	Mudstone	Rainfall, Glacial	low
Northern slope of the Kyrgyz ridge	Konorchek	r. Chu (left)	33	265	3690	1140	64	6.07.1960, 27.071968, 29.06.1974, 2000, 2012	2	Nanowater , Mudstone	Rainfall, Glacial	high
	Kyz-Kuye	r. Chu (left)	2.9	9	1884	1458	147	14.08.2016, 30.07.2022, 08.08.2022	2A	Mudstone	Rainwater	high
	Kurgakterek	r. Chu (left)	7.8	21.6	2620	1471	147	VII 1960, 2000, 2012	3	Mudstone	Rainwater	high
	Kok-Moinok	r. Chu (left)	-	-	-	-	-	19.06.1967	3A	Mudstone	Rainwater	average
	Suluterek	r. Chu (left)	6	20.4	2100	1437	110	07.1958, 27.06.1968, 2000, 2012	4	Mudstone	Rainwater	high
	Creek #1	r. Chu (left)	1.9	1.7	2060	1540	274	-	5	Nanowater	Rainwater	average
	Kyzylsu	It's getting lost	32	240.3	3600	1190	75	04.1950, 8.06.1959, 20.04.1987, 1998, 20.06.2016, 18.05.2016, 7.05.2011, 27.02.2004	6	Mudstone	Rainwater	average
	Taldybulak	R. Chu (left)	20.3	97.8	2280	1950	16		7	Mudstone	Rainwater	average
	Shamsi	Krasnaya Rechka (left)	12	38	3180	1532	137	15.08.1955, 8.04.1959, 17.06.1966, 28.05.1969, 7.07.1981, 07.1987, 25.06.2010, 29.06.2013,, 22.10.2013, 11.04.2013, 14.03.2016	8	Water-stone , Mud-stone	Rainwater	high
	Turagenen	r. Shamsi (left)	12	38	3180	1532	137	5.07.1957, 15.04.1958, 8.04.1959, 01.06, 10.07.1963, 28.05.1969	9	Nanowater	Rainfall, snowmelt	average
	Sai Kyzkiya	r. Chu (left)	3.5	6.9	1880	1435	127	27.06.1968, 07.1998,5-10.10.1998	10	Nanowater	Rainwater	average
	Burana	It's getting lost	22	91.3	3390	1040	107	11.05.1964, 22.10.2013, 9.04.2013, 18.05.2016,2019, 21.01.2020, 04.2024	11	Nanowater , Mudstone	Rainwater	high
	Sai Cholok	r.M.Kemin (left)	3.5	9.5	2930	2180	214	15.07.1958	12	Mudstone	Rainwater	average
	Issykata	r. Chu (left)	81	-	3600	675	36	31.05.1957, 4.08.1975, 9.08.1979, 2.07.1983, 06-07.1993, 19.08.2004, 19.03.2006, 28.08.2013	13	Mudstone	Rainfall, Glacial	average
	Nowruz	It's getting lost	26	-	3160	740	93	III-VII 1964, 1993, 2009, 2017, 14.03.2018	14	Mudstone	Rainfall, Glacial	high
	Alamedin	R. Chu (left)	82.5	-	3720	620	38	14.07.1956, 1.07.1959, 15.07.1964, 2.08.2013	15	Nanowater , Mudstone	Rainfall, Glacial	average
	Salyk	r.Alamedin (right)	7.9	36.3	3507	1991	192	VI-VIII	15A	Mudstone	Rainfall, Glacial	average
	Achyk-tash	r.Alamedin (right)	4.5	8.6	3460	2000	210	VI-VIII	15B	Mudstone	Rainfall, Glacial	low
	Kuturgan-Suu	r.Alamedin (left)	5	21.6	3244	2160	275	VI-VIII	15B	Mudstone	Rainwater	high
	Yantkunush	r.Alamedin (right)	5.2	9.8	3186	1779	272	2000	15G	Nanowater , Mudstone	Rainwater	average
	Berli-Bulak	r.Alamedin (right)	7	7	2885	1537	187	VI-VIII	15D	Nanowater , Mudstone	Rainwater	average
	Joon-Karatma	-	-	-	-	-	-	VI-VIII	15E	Nanowater	Rainwater	average
	Bek- Too	-	-	-	-	-	-	VI-VIII	15F	Nanowater	Rainwater	average
	can.Alamidin	-	-	-	-	-	-	-	15Z	Nanowater	storm	-
	Altyn-Tor	r.Alamedin (left)	7	45	3200	2300	129	VI-VIII	15I	Mudstone	Rainfall, Glacial	average
	Ashuu -Thor	r.Alamedin (right)	5.5	23.8	3320	2780	98	VI-VIII	15K	Mudstone	Rainfall, Glacial	low
	Chonkurchak	r.Alamedin (left)	19	98.9	3290	1280	106	16.05.1949,15.07.1964, 21.07.1970	16	Water-stone , Mud-stone	Rainwater	average
	Alaarcha	R. Chu (left)	78	270	3340	620	35	22.07.1953,07.1961, 4.08.1975, 26.05.1986,8.1988, 08.1993, 21.07.2003, 16.07.2004,, 28.06.2005, 20.03.2006, 30.03.2007, 27.10.2009, 7.03.2015, 24.07.2015, 16.05.2018,	17	Water-stone , Mud-stone	Rainfall, Glacial	high
	Muratsai	r.Ala-Archa (right)	5.7	5.5	3715	2034	295	1993, 21.07.2003, 2005, 27.10.2009, 07.2015, 26.07.2015	17A	Water-stone , Mud-stone	Rainwater	high
	Karagai- Bulak	r.Ala-Archa (right)	4.3	7.4	3140	1879	297	16.07.1966, 21.07.2003, 20.07.2004, 27.10.2009	17B	Water-stone , Mud-stone	Rainwater	average
	Kadir-Berdy	r.Ala-Archa (left)	19.9	19.9	3246	1700	180	14.07.1966,13.04.2005	17B	Nanowater	Rainwater	low
	Kashka- Suu	r.Ala-Archa (right)	4.8	8.05	3246	1700	188	21.07.2003	17G	Water-stone , Mud-stone	Rainfall, Glacial	average
	Adygine	r.Ala-Archa (left)	9	38	3550	2050	184	22.06.1953, 18.06.1966	18	Mudstone	Rainwater	average

CATALOGUE OF MUDFLOW-PRONE RIVERS IN KYRGYZSTAN

No.	Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse, km	Mudflow catchment area, square km	Absolute height, m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods	Map-scheme	Mudflow type	Possible causes of mudflows	Mudflow activity
				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
35	Northern slope of the Kyrgyz ridge	Aksai	r.Ala-Archa (right)	5.7	30	3440	2240	256	8.07.1960, 07.1961, 21.07.1965, 18.08.1966, 24.07.1968, 25.07.1969, 18.07.1970, 2.08.1970, 4.08.1975, 27.10.2009, 07.2015, 1.06.2016	19	Mudstone	Rainfall, Glacial, melting of snowfields	high
36		Sharkratma	r.Aksai (right)	1.6	4.25	3060	2560	312	VI 1961, 20.07.2004	20	Mudstone	Rainfall, snowmelt	high
37		Sai Lagernyi	r. Ala-Archa (right)	2	3	1580	1340	120	VIII 1964	21	Nanowater	Rainwater	low
38		Sai Shurales	Can.Tush	13	19.6	2800	1270	118	1.14.2010	22	Nanowater	Rainwater	low
39		Chon-Sharalo	Same	13	24	2320	1250	82	-	23	Nanowater	Rainwater	low
40		Sai Baygeldy	[illegible]	6.5	7.7	1600	1160	68	-	24	Nanowater	Rainwater	low
41		Jelamysh	It's getting lost	28	186	3680	1000	96	4.05.1958, 4.07.1971, 15.06.1972, 15.06.1975, 4.08.1975, 13.06.1980, 29.06.1981,27.02.2017,20 .03.2002.29.08.2016,20.0 5.2016, 21.05.2015,22.05.2009, 28.05.2005	25	Mudstone	Rainwater	high
42		Chon-Tepshi	Jelamysh (right)	3.4	5.36	3033	2497	158	VI-VIII	25A	Mudstone	Rainwater	low
43		Abseyt	Jelamysh (right)	2.5	3.1	2140	1730	164	VI-VIII	25B	Mudstone	Rainwater	low
44		Shorals	It's getting lost	13	19.6	2800	1270	118	-	22	Nanowater	Rainwater	low
45		Kosh- Bulak	Jelamysh (left)	1.8	2.5	2420	2030	217	VI-VIII	25G	Nanowater	Rainwater	low
46		Altmyshbay	Jelamysh (left)	2.6	1.87	2572	1850	278	VI-VIII	25D	Nanowater	Rainwater	low
47		Kichine- Tepshi	Jelamysh (left)	2.9	4.13	2381	1696	236	VI-VIII	25F	Nanowater	Rainwater	low
48		Kuldzha -Ter	Jelamysh (left)	3	5.8	3532	2845	229	VI-VIII	25E	Nanowater	Rainwater	low
49		Tuyuk- Bulak	Jelamysh (right)	2.45	4.5	3232	2523	289	VI-VIII	25Z	Nanowater	Rainwater	low
50		Ak- Paltargan	Jelamysh (right)	2.5	3.6	2800	2380	168	VI-VIII	25I	Nanowater	Rainwater	low
51		Chon-koshbulak	Jelamysh (left)	2,2	7.62	2660	2087	260	VI-VIII	25K	Nanowater	Rainwater	low
52		Ak-Pai1	Sokuluk (right)	9.7	22.5	3508	1820	174	02..08.2021	25th	mudstone	Glacial	average
53		Ak-Pai2	Jelamysh	2.4	4	3450	2750	292	VI-VIII	25th	Nanowater	Rainwater	low
54		Horse	[illegible]	24	63.8	3090	800	95	IV-VIII 1964, 18.05.1968, 19.05.2015	26	Mudstone	Rainwater	low
55		Aksu	r.Chu (left)	155	1530	3270	515	18	15.07.1964, 06.1968, 22.06.1975	27	Mudstone	Rainwater	average
56		Jar-Tash	r.Aksu (right)	6.3	21.7	3180	2300	140	VI-VIII	27A	Mudstone	Rainwater	average
57		Chon-Tash	r.Aksu (right)	6.7	38.8	2900	2232	100	VI-VIII	27B	Mudstone	Rainwater	average
58		Kichi - Tuyuk	r.Aksu (right)	4.15	15	3106	2680	103	VI-VIII	27B	Mudstone	Rainwater	average
59		Boyrek	r.Aksu (right)	7.79	25	3180	2260	118	VI-VIII	27G	Mudstone	Rainwater	average
60		Isha	r.Aksu (left)	8.8	32.7	3466	1964	169	13.07.1968	27D	Mudstone	Rainfall, Glacial	low
61		Jindy-Suu	r.Aksu (right)	5.34	17.8	3006	2091	171	VI-VIII	27E	Nanowater	Rainwater	average
62		Bultuke	r.Aksu (right)	4.63	21	2934	1765	252	VI-VIII	27F	Nanowater	Rainwater	average
63		Bakpai	r.Aksu (right)	5.1	7.5	1923	1357	111	VI-VIII	27Z	Nanowater	Rainwater	average
64		Sokuluk	r.Aksu (right)	87	563.5	3180	730	28	4.05.1958, 29.05.1969, 1980, 12.08.1983,1996, 21.05.2015, 19.02.2015	28	Mudstone	Rainfall, Glacial	average
65		Kachy -Ter	r.Sokuluk (left)	3.9	17.8	3038	2428	156	VI-VIII	28A	Nanowater	Rainwater	low
66		Chon -Ter	r.Sokuluk (left)	3.4	14.2	3470	2957	151	VI-VIII	28B	Mudstone	Glacial	average
67		Ashu-Tor	r.Sokuluk	9.9	43.8	3420	1960	147	VI-VIII	28B	Mudstone	Rainwater	average
68		Begish	r.Sokuluk	4.9	7.5	3350	2050	265	VI-VIII	28G	Mudstone	Rainwater	average
69		Tuyuk	r.Sokuluk (left)	7.55	69	2636	1720	121	VI-VIII	28D	Mudstone	Rainwater	average
70		Shabai-Sai	r.Sokuluk (left)	5.35	21.5	2400	1500	168	VI-VIII	28E	Nanowater	Rainwater	average
71		Kashkasu	r.Sokuluk (left)	4.9	5.4	1490	1210	57	-	29	Nanowater	Rainwater	average

No.	Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse, km	Mudflow catchment area, square km	Absolute height, m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods	Map-scheme	Mudflow type	Possible causes of mudflows	Mudflow activity
				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
72	Northern slope of the Kyrgyz ridge	Chetendy	[illegible]	4.8	4.7	2080	1360	150	3.06.1963, 8.06.1963 , 03.07.1963, 15.07.1964, 22.07.1970, 8.08.1970, 12.07.1974, 10.06.1978	30	Mudstone	Rainwater	average
73		Oro-Bashy	r.Sokuluk (right)	4.9	12.3	2493	1480	207	VI-VIII	30A			
74		Berlului	r. Sokuluk (left)	3.9	7	2266	1550	184	01.06.2011	30B	Nanowater	Rainwater	average
75		Mintukum	r.Aksu (left)	6.3	10	1700	1100	95	16.07.1955, 27.05.1963, 3.06.1963, 7.07.1964, 15.07.1964, 18.09.2003, 27.12.2012	31	Mudstone	Rainwater	average
76		Sukhoi log	[illegible]	1.5	1	2000	1330	447	27.05.1963, 3.06.1963	32	Mudstone	Rainwater	low
77		Jardysu	It's getting lost	19	44.5	3160	940	117	15.07.1964	33	Mudstone	Rainwater	low
78		Darkness	[illegible]	18	77.4	3150	1030	118	15.07.1964, 20.05.2016, 23.10.2006	34	Mudstone	Rainwater	low
79		Karasu	r.Temene (right)	11	22.5	1680	1040	58	15.07.1964	35	Mudstone	Rainwater	low
80		Kichine Temen-Suu	r.Temene (right)	5.05	8.63	2270	1515	150	V-VII	35A		Rainwater	low
81		Kotur-Suu	-	-	-	-	-	-	-	35B		Rainwater	low
82		Sai Yablonevy	r.Karabalty (right)	2.5	3.6	1400	1160	96	4.06.1954, 9.07.1955	36	Mudstone	Rainwater	average
83		Karabalty	r.Aksu (left)	133	668	3450	530	44	20.07.1958,15.07.1964, 18.09.2003, 27.12.2012	37	Mudstone	Rainwater	average
84		Kel -ter Vost	r.Karabalty (left)	7.92	43	3033	2321	90	V-VIII	37A	Mudstone	Rainwater	average
85		Toguz -Ter	r.Karabalty (left)	6.53	28.3	3351	2195	177	V-VIII	37B	Mudstone	Rainwater	average
86		Yesen-Sai	r.Karabalty (right)	6.71	23.9	2926	1593	199	V-VIII	37B	Mudstone	Rainwater	average
87		Jacken	It's getting lost	-	-	-	-	-	-	37G	Nanowater	Rainwater	average
88		Ashuu-Bulak	It's getting lost	-	-	-	-	-	-	37D	Nanowater	Rainwater	average
89		Sargau	It's getting lost	-	-	-	-	-	-	37E	Nanowater	Rainwater	average
90		Saryjagach	r . Nouruz (right)	13	29.6	2010	1080	72	III-VII 1964	38	Mudstone	Rainwater	average
91		Taldybulak	It's getting lost	6	12.2	1880	1060	137	13.07.1964, 17.07.1964	39	Mudstone	Rainwater	average
92	Southern slope of the Kyrgyz ridge	Keldy	r.Talas (right)	35	281	3360	1220	61	30.04.1956, 1.06.2005, 24.12.2002,16.08.2004, 1.06.2006, 9.10.2007, 19.02.2015	1	Mudstone	Rainwater	low
93		Beshbulak	r.Talas (right)	-	-	-	-	-	2.06.1972, 20.02.1973,16.08.2004, 29.10.2007	1A	Mudstone	Rainwater	average
94		Chirkanak	r.Talas (right)	-	-	-	-	-	20.06.1969, 14.07.1976, 07.1991, 07.1997	1B	Mudstone	Rainfall, Glacial	high
95		Kenkol	r. Talas	-	-	-	-	-	12.07.1974, 2.05.2002,29.12.2014, 17.05.2016	1B	Mudstone	Rainwater	high
96		Karabura	r. Talas	-	-	-	-	-	11.06.1962, 18.06.1975, 30.05.1977, 30.05.1980, 2.07.1981, 7.05.1986,25.08.2000, 02.04.2001	1G	Nanowater	Rainwater	average
97		Achyktash	R. Keldy (right)	14	44.4	2900	1460	103	30.04.1956	2	Mudstone	Rainwater	average
98		Sugaty	It's getting lost	15.5	30.2	2280	890	90	30.04.1956	3	Mudstone	Rainwater	average
99		Karagash	It's getting lost	11	16.5	1660	828	76	IV-VI 1964	4	Mudstone	Rainwater	average
100		Tuleusai	It's getting lost	9.7	14.1	1360	800	58	IV-VI 1964	5	Mudstone	Rainwater	average
101		Kurusai	It's getting lost	5.8	9.6	1700	1052	112	IV-VI 1964,11.03.2005, 1.09.2006, 26.06.2007, 27.08.2008, 26.06.2015	6	Mudstone	Rainwater	average
102		Karaarcha	It's getting lost	14	59.7	2360	940	101	IV-VI 1964, 14.03.196626.06.2015 , 27.08.2008, 26.06.2007, 1.09.2006, 11.03.2005	7	Mudstone	Rainwater	average
103	Northern slope of Talas Alatau	Kaindy	r.Beshtash (left)	5.2	16.8	3200	1843	261	IV-VI 1964, 29.04.1967	1	Mudstone	Rainwater	average
104		Creek #1	Can.Yarke	2,2	2.1	1600	1480	54	16.06.2005, 1.11.2018	2	Nanowater	Rainwater	low
105		Creek #2	Same	1.9	1.4	1600	1460	74	16.06.2005, 1.11.2019	3	Nanowater	Rainwater	low
106		Creek #3	It's getting lost	6.4	9	2180	1380	125	16.06.2005, 1.11.2020	4	Nanowater	Rainwater	low

CATALOGUE OF MUDFLOW-PRONE RIVERS IN KYRGYZSTAN

No.	Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse, km	Mudflow catchment area, square km	Absolute height, m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods	Map-scheme	Mudflow type	Possible causes of mudflows	Mudflow activity
				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
107	Northern slope of Talas Alatau	Creek #4	It's getting lost	2.6	3.3	1580	1390	73	16.06.2005, 1.11.2021	5	Nanowater	Rainwater	low
108		Tutusu	It's getting lost	4.8	10.7	1840	1390	94	16.06.2005, 1.11.2022	6	Mudstone	Rainwater	low
109		Uluvashat	It's getting lost	6.6	20.5	1860	1390	71	16.06.2005, 1.11.2023	7	Mudstone	Rainwater	low
110		Kortu- Uluvashat	It's getting lost	5.4	13.9	1800	1360	81	16.06.2005, 1.11.2024	9	Mudstone	Rainwater	low
111		Kurusai	It's getting lost	1.8	1	1620	1300	178	IV-VI 1964, 14.03.1966	9	Mudstone	Rainwater	average
112		Creek #5	Can. Zhalpaktin	1.8	1	1620	1300	178	IV-VI 1964	10	Nanowater	Rainwater	average
113		Creek #6	Same	3.2	3.4	1720	1300	131	IV-VI 1964	11	Nanowater	Rainwater	average
114		Creek #7	[illegible]	1,1	0.8	1540	1300	218	IV-VI 1964	12	Nanowater	Rainwater	average
115		Creek #8	[illegible]	1.4	0.8	1580	1290	207	IV-VI 1964	13	Nanowater	Rainwater	average
116		Creek #9	[illegible]	2	1,1	1640	1285	178	IV-VI 1964	14	Nanowater	Rainwater	average
117		Creek #10	[illegible]	2.8	1,1	1700	1285	148	IV-VI 1964	15	Nanowater	Rainwater	average
118		Creek #11	It's getting lost	2,2	1.6	1500	1280	100	IV-VI 1964	16	Nanowater	Rainwater	average
119		Creek #12	It's getting lost	4.8	5.4	1840	1300	112	IV-VI 1964	17	Nanowater	Rainwater	average
120		Creek #13	It's getting lost	6.6	7.3	2360	1330	156	IV-VI 1964	18	Nanowater	Rainwater	average
121		Creek #14	Can.Zhalpaktin	3.5	3.1	1580	1260	91	IV-VI 1964	19	Nanowater	Rainwater	average
122		Creek #15	Can. Baltag	4.05	6.6	1700	1285	102	IV-VI 1964	20	Nanowater	Rainwater	average
123		Creek #16	Same	1.6	1,2	1420	1305	72	IV-VI 1964	21	Nanowater	Rainwater	average
124		Tatyr	[illegible]	8	15.2	2840	1305	192	IV-VI 1964	22	Nanowater	Rainwater	low
125		Creek #17	Can.Jana	2.8	2	1840	1300	193	IV-VI 1964	23	Nanowater	Rainwater	low
126		Creek #18	Same	3.2	4.5	1820	1300	162	IV-VI 1964	24	Nanowater	Rainwater	low
127		Creek #19	[illegible]	5.4	6.8	2000	129	132	IV-VII 1964	25	Nanowater	Rainwater	low
128		Creek #20	It's getting lost	3.8	1,2	1500	1260	63	IV-VII 1964	26	Nanowater	Rainwater	low
129		Cheten	It's getting lost	12.8	28.1	2800	1225	123	IV-VII 1964	27	Nanowater	Rainwater	low
130		Creek #21	Channel untitled	5	9	1760	1220	108	IV-VII 1965	28	Nanowater	Rainwater	low
131		Tights	Same	9.4	19.9	2390	1220	124	IV-VII 1966	29	Nanowater	Rainwater	low
132		Creek #22	It's getting lost	4	6.2	1900	1255	161	IV-VII 1967	30	Mudstone	Rainwater	low
133		Sarybulak	It's getting lost	3.7	2.5	1760	1240	140	IV-VII 1968	31	Mudstone	Rainwater	low
134		Sarymsak	It's getting lost	15.8	58.5	3200	1280	121	15.06.1964, 24.06.1964	32	Mudstone	Rainwater	low
135		Creek #23	Channel Sarykul	11.2	30.7	2060	1120	84	IV-VII 1964, 25.08.2000, 27.07.2010	33	Mudstone	Rainwater	low
136		Creek #24	Same	6	6.5	1920	1110	135	IV-VII 1964, 25.08.2000, 27.07.2011	34	Mudstone	Rainwater	low
137		Karasai	Can. Yul-Yakshi	8	11.9	1640	1018	78	17.05.1963	35	Mudstone	Rainwater	low
138		Kokjar	r. Karabura (left)	5	3.2	1900	1180	144	30.07.1957, 19.07.1957, 02.06.1962, 8.05.1963, 16.05.1964, 25.08.2000, 27.07.2010	36	Mudstone	Rainwater	average
139		Ashme	R. Karabura (left)	5	4.2	1500	1200	60	19.07.1957, 30.07.1973 02.05.1961, 8.05.1963, 15.06.1964, 24.06.1964, 25.08.2000, 27.07.2010, 22.06.2016	37	Nanowater , Mudstone	Rainwater	average
140		Karasu	r. Tala s(left)	10.4	-	970	839	13	V-VIII 1912, 4.06.1957, 13.06.1957, 23.05.1958, V-VIII 1959, 7.07.1964	38	Mudstone	Rainwater	average
141		Creek #25	It's getting lost	9.4	19.1	2300	1340	102	IV-VII 1964	39	Mudstone	Rainwater	average
142		Creek #26	[illegible]	9	11	2260	1300	107	IV-VII 1964	40	Mudstone	Rainwater	average
143		Sulubakand	r.Talas (left)	21.7	189.7	3720	1400	107	11.08.1962, 23.05.1964, 20.06.1964, 09.06.2002, 1.09.2006, 27.08.2008	41	Mudstone	Rainwater	average
144		Sulunsu	Channel untitled	9.3	18.9	2360	1400	103	19.05.1949, 7.06.1964, 20.06.1964	42	Mudstone	Rainwater	average
145		Creek #27	It's getting lost	9.9	5.6	1900	1260	65	IV-VII 1964	43	Mudstone	Rainwater	average

No.	Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse, km	Mudflow catchment area square km	Absolute height, m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods	Map-scheme	Mudflow type	Possible causes of mudflows	Mudflow activity
				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
146	Northern slope of Talas Alatau	Babahan	Can. Nogai	20.6	64.4	2680	1160	74	I-2/VI 1963	44	Mudstone	Rainwater	average
147		Creek #28	Same	9.8	7.3	1560	1167	40	IV-VII 1964	45	Mudstone	Rainwater	average
148		Tashbashat	Can. Nogai	19.3	24.7	2260	1180	56	19.05.1949, I.06.1963, 2.06.1963	46	Mudstone	Rainwater	average
149		Creek #29	Can. Untitled	6.3	6.2	1540	1255	45	1.06.1963, 2.06.1963	47	Mudstone	Rainwater	average
150		Kurasai	Same	9.4	20.3	1840	1260	62	I.06.1963, 2.06.1963	48	Mudstone	Rainwater	average
151		Kurkursusu	r. Assa (right)	60	612	3700	860	47	19.05.1949, 20.07.1954, 17.05.1960, 03.1966, 28.05.1982, 09.06.2002, 1.06.2005, 12.04.2003, 12.05.2005,1.09.2006, 27.08.2008, ,4.03.2008, 19.11.2013	49	Mudstone	Rainwater	high
152	Issyk Kul Lake Basin	Kalmaks	It's getting lost	18	65	3560	1611	69	18/VI 1955	1	Mudstone	Rainwater	average
153		Iyri-Taldy-Bulak	It's getting lost	7	37.8	2843	1839	143	12.04.2012, 4.04.2018,15.10.2020	1A	Nanowater , Mudstone	Rainwater	average
154		Taldy-Bulak	It's getting lost	12.15	38	2756	1740	84	V-VIII	1B	Nanowater , Mudstone	Rainwater	average
155		Toraigyr (Toruaygyr)	It's getting lost	30	196	3320	1654	67	12.09.1962, 17.07.1964, 5.07.1971, 27.07.1973, 22.07.1979, 24.06.1980, 21.02.2000, 26.10.2005, 16.08.2010, 24.06.2010, 9.08.2018	2	Nanowater , Mudstone	Rainwater	high
156		Kol-Tor	It's getting lost	10	35	2618	1923	70	28.10.2014	2A	Nanowater	Rainwater	average
157		Dure-Suu	It's getting lost	11	44	2821	1893	84	28.10.2015	2B	Nanowater	Rainwater	average
158		Kabyrga	It's getting lost	14.46	55	3242	1905	92	9.08.2018, 28.10.2014	2B	Nanowater	Rainwater	average
159		Chon-Tamchy	It's getting lost	7.2	15.9	2696	1937	105	28.10.2014, 9.08.2018, 7.10.2019	2G	Nanowater	Rainwater	average
160		Chok -Tal	It's getting lost	12	55.5	3102	1852	104	27.09.1978, 20.07.1979 , 09.1999, 24.03.2003,15.08.2007, 2013, 9.08.2018	2D	Mudstone	Rainfall, Glacial	high
161		Chet- Kolsuu	It's getting lost	12	21.7	3400	1908	124	25.06.2010	2E	Mudstone	Rainwater	average
162		Orto-Kolsuu	It's getting lost	14.9	45	3310	1755	104	12.04.2012, 27.12.2010	2G	Nanowater	Rainwater	average
163		Kara-Oy	It's getting lost	-	-	-	-	-	15.09.1970, 23.08.1980	2Z	Mudstone	Rainwater	average
164		Chon-Koysu	Lake Issyk-Kul	25	124	3380	1610	79	19.06.1966, 14.06.1994,8.09.1996	3	Mudstone	Rainfall, Glacial	average
165		Cholponata	Same	22	130	4100	1610	124	10-16.08.1951, 19.06.1966, 1978, 5.4.2005, 10.06.2005, 6.03.2007, 15.08.2013, 24.01.2012, 20.04.2010, 7.10.2008, 225.04.2017, 24.08.2019	4	Mudstone	Rainwater	high
166		Baktuu Dolon-Ata	It's getting lost						22.08.2016, 15.08.13,24.01.12,20.04.10,7.10.08,26.03.07,10.06.05,22.08.2016, 12.08.13, 12.04.12,25.06.10, 23.05.09, 26.03.07, 10.06.05,8,2024	4A	Mudstone	Rainwater	high
167		Toguzbulak	It's getting lost	9.2	15.5	2680	1640	26	4.08.1954, 19.07.1954, 28.07.1976, 7.10.2008,26.03.2007,10.06.2005, 20.04.2010, 24.01.2012, 15.08.2013, 22.08.2016, 08.2024,	5	Nanowater , Mudstone	Rainwater	high
168		Judemish (untitled)	[illegible]	6.8	10	2180	1640	88	08.1961,22.08.2016, 12.08.13, 12.04.12,25.06.10, 23.05.09, 26.03.07, 10.06.05	6	Mudstone	Rainwater	high
169		Rosary - Dolonata	Lake Issyk-Kul	16	48	3640	1610	127	-	7	Mudstone	Rainwater	average
170		Karajilga (untitled)	is lost	5.5	5.9	2580	1670	165	-	8	Mudstone	Rainwater	average
171		Tuyukjar (untitled)	It's getting lost	10	12.7	2520	1630	94	26/VIII 1962	9	Mudstone	Rainwater	average
172		Ketsenir (untitled)	[illegible]	4.2	5	2100	1740	86	VIII 1962	10	Mudstone	Rainwater	average
173		Korumdu	Lake Issyk-Kul	14	38.8	3200	1610	114	12.04.2012,28.10.2014, 12.04.2012, 26.03.2007, 26.10.2005	11	Mudstone	Rainwater	average

CATALOGUE OF MUDFLOW-PRONE RIVERS IN KYRGYZSTAN

No.	Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse, km	Mudflow catchment area, square km	Absolute height, m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods	Map-scheme	Mudflow type	Possible causes of mudflows	Mudflow activity
				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
174	Issyk-Kul Lake Basin	Kumbel	Lake Issyk-Kul	13	30.7	3190	1610	122	-	12	Mudstone	Rainwater	average
175		Karachan (West)	It's getting lost	13	14.1	3640	1620	155	-	13	Mudstone	Rainwater	average
176		Karachan (East)	В	10.5	22	3460	1740	176	-	14	Mudstone	Rainwater	average
177		Chon -Aksu	Lake Issyk-Kul	53	362	3840	1610	47	15/VII 1958, 19.06.1966, 7.27.1970, 12.08.1982, 23.07.1986, 10.06.2005,08.2024	15	Nanowater , Mudstone	Rainfall, Glacial	average
178		Kyzyldzhar	r. Chon -Aksu right	8	5.2	3760	2910	106	-	16	Nanowater , Mudstone	Rainfall, Glacial	average
179		M.Aksu	Lake Issyk-Kul	34	200	3660	1610	84	4.04.2018	17	Nanowater , Mudstone	Rainwater	average
180		Chet- Baysoorun	Lake Issyk-Kul	12.1	52.8	3090	1802	106	IV-VIII	17A	Nanowater , Mudstone	Rainwater	average
181		Burgan-Suu	Lake Issyk-Kul	16.5	85	2865	1670	72	IV-VIII	17B	Nanowater , Mudstone	Rainwater	average
182		Kamennaya	Same	24	122	3450	1610	66	6,1951	18	Nanowater , Mudstone	Rainwater	average
183		Kichi-Uryukty	В	16	55.4	3300	1610	93	28.10.2014, 2.10.2013	19	Nanowater , Mudstone	Rainwater	average
184		Chon-Uryukty	В	20	106	3890	1610	115	-	20	Nanowater , Mudstone	Rainwater	average
185		Orto-Oryuktu							-	20A	Nanowater , Mudstone	Rainwater	average
186		Uital (Oital)	В	19	53.9	3400	1610	82	22.07.1949, 15.07.1957, 19.06.1966,06.1975,28.10.2014, 2.10.2013	21	Nanowater , Mudstone	Rainwater	average
187		Curmenty	В	15	59	3340	1610	103	15.07.1957,28.10.2014, 2.10.2013	22	Nanowater , Mudstone	Rainwater	average
188		Tyup	В	120	1180	3900	1610	19	21.08.2009	23	Nanowater , Mudstone	Rainwater	average
189		Shaty	It's getting lost	7.53	35.7	2760	1760	133		23A	Nanowater , Mudstone	Rainwater	average
190		Taldy-Suu	It's getting lost	2,2	0.5	2458	1945	233	12.08.2023 7.08.2023	23B	Nanowater , Mudstone	Rainwater	average
191		Koochu	It's getting lost	1	0.42	2188	1920	268	12.08.2023 7.08.2023	23B	Nanowater , Mudstone	Rainwater	average
192		Balbay	It's getting lost	3.8	3.7	2426	1741	180	31.07.2023 30.06.2023 29.07.2022 28.05.2022 24.08.2021	22A	Nanowater , Mudstone	Rainwater	average
193		Corumdy	It's getting lost	1.4	0.73	2015	1815	143	07.10.2019,12.08.2023	22B	Nanowater , Mudstone	Rainwater	average
194		Kainar	It's getting lost	1.7	0.63	2375	1903	278	12.08.2023	22B	Nanowater , Mudstone	Rainwater	average
195		Ken- Suu	It's getting lost	3.1	1.83	2591	1940	210	07.10.2019,2.08.2023 7.08.2023	23G	Nanowater , Mudstone	Rainwater	average
196		Tabylgyty	It's getting lost	4.64	9	2282	1920	78		23D	Nanowater , Mudstone	Rainwater	average
197		Chonbet	It's getting lost	4.31	12.8	2361	1890	109		23E	Nanowater , Mudstone	Rainwater	average
198		Karkyra	It's getting lost	-	-	-	-	-	-	23F	Nanowater , Mudstone	Rainwater	average
199		Uch -Kashka	Karkyra	9.14	43.8	2983	2356	69	-	23Z	Nanowater , Mudstone	Rainwater	average
200		Kichine-Dzhanalach	Karkyra	7.25	45	3132	2710	58	-	23I	Nanowater , Mudstone	Rainwater	average
201		Tuyuk	It's getting lost	4.5	6.52	3454	2711	165	-	23K	Nanowater , Mudstone	Rainwater	average
202		Jirgalan	В	95	2070	3860	1610	24	28.10.2014, 27.12.2010, 29.05.2020, 25.04.2017,	24	Nanowater , Mudstone	Rainwater	average
203		Aksu- Arasan	r.Dzhirgalan (left)	45	513	4010	1653	52	30.06.1957, 01.07.1957, 1958, 05.1963,12.04.2012, 28.10.2014, 17.06.2016, 6.09.2017, 25.04.2017	25	Nanowater , Mudstone	Rainwater	high
204		Jetyoguz	Lake Issyk-Kul	55	387	3400	1610	33	10.08.2000 , 10-14.05.2001,14.11.2016, 28.10.2014,16.10.2020	26	Nanowater , Mudstone	Rainwater	high

No.	Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse, km	Mudflow catchment area, square km	Absolute height, m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods	Map-scheme	Mudflow type	Possible causes of mudflows	Mudflow activity
				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
205	Issyk-Kul Lake Basin	Chon-Kyzylsu	Lake Issyk-Kul	48	340	3200	1610	33	IV 1951,IV 1952, 8.07.1953, 14.07.1953,VI 1956, 14.07.1956, VI 1957, 5.06.1959, 10.1966, 11.07.1968, 12.04.2012, 6.08.2013, 17.06.2016, 23.05.2016, 17.06.2016, 16.09.2015, 23.05.2016	27	Nanowater , Mudstone	Rainwater	high
206		Kichi Kyzyl- suu	It's getting lost	15	105	2920	1900	68	08.1952,4.10.2010	27A	Water-stone , Mud-stone	Glacial	low
207		Irdyk	Same	33	100	3840	1610	68	28.07.1964, 12-15.08.1997, 10.08.2000, 10-14.05.2001, 11.03.2019	28	Nanowater	Rainwater	average
208		Juuku	В	68	590	4060	1610	36	26.10.2005	29	Nanowater	Rainwater	average
209		Chychkan	Lake Issyk-Kul	8.58	97.7	2118	1697	49	IV-VII	29A	Nanowater	Rainwater	average
210		Chon Dzhargylchak	Lake Issyk-Kul	16.65	145	3130	1639	90	IV-VII	29B	Nanowater	Rainwater	average
211		Barskaun	В	45	352	3900	1610	51	07.1956, 27.07.1964, 22.05.1975,23.05.2016,16.10.2020 г.	30	Nanowater	Rainwater	high
212		Tamga	В	27	162	4000	1610	88	21.07.1963, 30.07.1963, 16.07.1964, 12.08.1964,12.07.1966	31	Nanowater	Rainwater	average
213		Ubulak	r.Tamga	11	15	2440	1620	74	30.07.1963	32	Nanowater	Rainwater	average
214		Chegedek	r.Tamga (right)	15	37.8	3520	1960	104	-	33	Nanowater	Rainwater	average
215		Jolbarsty	Same	18	31.6	3760	1830	106	30.07.1963	34	Nanowater	Rainwater	average
216		Zhilbulak	Lake Issyk-Kul	1.9	7.6	1660	1610	27	8,1963	35	Nanowater	Rainwater	average
217		Tosor	Same	30	304	3810	1610	73	11.08.1963, 26.07.1965, 12.07.1966, 9.07.1995	36	Mudstone	Rainfall, Glacial	average
218		Chetendy	r.Tosor (right)	13	36.1	4065	2147	147	02.07.1963	37	Mudstone	Rainfall, Glacial	average
219		Toguz-Bulak	r.Tosor (left)	1.9	1.58	2463	1927	282	IV-VII	37A	Mudstone	Rainwater	average
220		Jer-Uy	r.Ton	7.09	11.4	3388	2135	177	1985, 16.10.2012, 9.09.2013, 19.07.2014, 17.06.2016	37B	Mudstone	Rainfall, Glacial	average
221		Kek-Sal	r.Ton	8.7	45.6	3045	2172	100	16.10.2012, 07.10.2019	37B	Mudstone	Rainwater	average
222		Kodol	В	3.7	6.6	2380	1810	157	02.07.1963, 6.08.2013, 14.11.2016	38	Mudstone	Rainwater	average
223		Tegerek	r.Tosor (left)	3.2	6.3	2420	1915	158	02.07.1963	39	Mudstone	Rainwater	average
224		Sugety	Lake Issyk-Kul	5.8	20.7	2040	1610	74.3	-	40	Mudstone	Rainwater	average
225		Kazhy	Lake Issyk-Kul	14	59.1	2560	1610	68	26.04.2002, 9.10.2008, 10.08.2009, 14-15.09.2015, 6.09.2017	41	Mudstone	Rainwater	average
226		Tone	Lake Issyk-Kul	36	742	3920	1610	64	24.07.1978, 16.07.1980, 2003-2004, 24.07.2008, 9.10.2008, 16.08.2010, 15.10.2012, 15.10.2012,12.08.2013, 09.09.2013, 08.2024	42	Mudstone	Rainfall, Glacial	high
227		Aksal	Lake Issyk-Kul	11	34.9	1940	1610	29	2.07.1958, 16.10.2012, 23.06.2016, 17.06.2016,	43	Mudstone	Rainfall, Glacial	high
228		Ak-terek	Lake Issyk-Kul	15	72.2	2070	1610	31	15.07.1958, 27.07.1973, 2.09.1977, 11.08.1982,28.05.2020	44	Nanowater , Mudstone	Rainwater	average
229		Tuura-Suu	Lake Issyk-Kul	11.3	80.2	3277	2197	96	16.08.2010, 6.04.2018	44A	Nanowater , Mudstone	Rainfall, Glacial	high
230		Kashka- Suu	Lake Issyk-Kul	12.6	52	3463	2337	89	IV-VII	44B	Nanowater , Mudstone	Rainwater	average
231		Ulahol	Lake Issyk-Kul	8.77	26.5	3470	2473	114	IV-VII	44B	Nanowater , Mudstone	Rainwater	average
232		Log Eshimdin	В	2.5	1.67	1800	1670	52	-	45	Nanowater , Mudstone	Rainwater	average
233		Gilginda Log	В	4	2.95	1690	1610	20	-	46	Nanowater , Mudstone	Rainwater	average
234		Kuturga	В	14	70.2	3120	1610	108		47	Nanowater , Mudstone	Rainwater	average
235		Curmenty	В	15	53.2	3340	1610	115	15.07.1957	48	Nanowater , Mudstone	Rainwater	average

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No.	Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse, km	Mudflow catchment area, square km	Absolute height, m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods	Map-scheme	Mudflow type	Possible causes of mudflows	Mudflow activity
				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
236	Issyk-Kul Lake Basin	Chon-Sarybulak	-	16	29.6	3080	1610	91	-	49	Alluvial, Mud-stone	Rainwater	average
237		Chon-Sugety	-	17	32.1	3330	1610	101	-	50	Alluvial, Mud-stone	Rainwater	average
238		Karasu	-	9.8	66	2090	1610	49	29.07.1952	51	Alluvial, Mud-stone	Rainwater	average
239		Turgen-Aksu	r. Jirgalan (left)	50	412	3340	1760	32	17.06.2016, 23.06.2016, 22.09.2015	52	Alluvial, Mud-stone	Rainwater	average
240		Kudyur	Turgen-Aksuu river (left)	2.51	10	2735	2197	214	IV-VII	52A	Alluvial, Mud-stone	Rainwater	average
241		Boz-Uchuk	-	14.24	73.8	3141	1912	86	27.06.2011, 10.11.2016	52B	Alluvial, Mud-stone	Rainwater	average
242		Jergez	Aksuu	26	191	3029	1903	43	22.09.2015	52B	Alluvial, Mud-stone	Rainwater	average
243		Karakol	-	50	394			49	17.07.2012, 12.04.2012,16.10.2020, 29.05.2020	52D	Alluvial, Mud-stone	Rainwater	high
244		Creek between the Turasu-Akterek rivers	Can. Chon-Aryk	-	75	-	-	-	28.07.1964	53	Nanowater	Rainwater	average
245	South eastern slope of the Chatkal ridge	Sumsar	Fan of canals, Syrdarya river	32.5	-	3340	1270	64	27.07. 1964, 29.01.2010, 17.11.2016, 8.08.2017	1	Nanowater	Rainwater	average
246		Terek	Kassansay	34	282	2760	1500	37	01.06.1958	2	Nanowater	Rainwater	average
247		Uryukty	-	28	121	3520	1114	86	27.07.1964, 24.03.2001, 28.11.2003,7.10.2005, 24.05.2008, 29.01.2010, 13.05.2016, 6.06.2017	3	Nanowater	Rainwater	high
248		Adabuka	-	40	318	3300	1040	56	27.07.1964, 26.10.1998, 10.07.2002, 18.08.2004, 2.04.2004, 22.07.2004, 14.06.2011, 24.05.2008,11.06.2020	4	Nanowater	Rainwater	high
249		Padshaata	It's getting lost	117	-	3500	668	24	27.07.1964, 16.06.2003, 3.08.2007, 15.05.2010	5	Nanowater	Rainwater	average
250		Aksai	r.Padshaata (left)	4	3.8	2000	1640	90	-	6	Nanowater	Rainwater	average
251		Karabasatsai	-	6.2	9.4	2160	1540	100	28.06.2016	7	Nanowater	Rainwater	average
252		Togoloksai	r.Padshaata (left)	6.3	8.4	2240	1949	118	29.04.2002, 3.08.2007, 25.05.2017, 9.06.2017, 12.08.2017	8	Nanowater	Rainwater	average
253	The Naryn River basin	Jergetal	It's getting lost	20	31.4	2800	1040	88	-	1	Nanowater	Rainwater	average
254		Tytysay	-	15	21.4	2700	1090	107	-	2	Nanowater	Rainwater	average
255		Tereksai	r.Uzunakhmat (left)	18.5	41	2800	920	102	-	3	Nanowater	Rainwater	average
256		Sugutsai	-	18	22	2900	950	108	-	4	Nanowater	Rainwater	average
257		Mazarsu	Fan of channels	13	33.2	3100	1400	131	-	5	Nanowater	Rainwater	average
258		Kuchusu	It's getting lost	17	39.6	2850	1440	83	27.03.2008	6	Nanowater	Rainwater	average
259		Sarybulak	r. Uzunakhmat (right)	12	24	2800	940	155	-	7	Nanowater	Rainwater	average
260		Nameless creek	-	5	4.47	1460	900	112	9.09.2011	8	Nanowater	Rainwater	average
261		Jenaryksay	-	16	33.9	1480	860	39	-	9	Nanowater	Rainwater	average
262		Nameless creek	It's getting lost	7.7	9.9	1380	940	57	-	10	Nanowater	Rainwater	average
263		Nameless creek	It's getting lost	11.6	16.5	2040	990	91	9.09.2011	11	Nanowater	Rainwater	average
264		Tuarcha	r.Chichkan (left)	6.8	13.2	3440	1770	245	-	12	Nanowater	Rainwater	average
265		Kichkine-Tuarcha	-	4.5	7.7	2100	1620	107	-	13	Nanowater	Rainwater	average
267		Nameless creek	r.Chichkan (right)	7.3	11.9	2100	1030	147	-	14	Nanowater	Rainwater	average
268		Kashkasu (Kodul)	r.Naryn (right)	38	186	3480	810	70	-	16	Nanowater	Rainwater	average
269		Nichkesai	-	24	69.1	2582	810	73	03.11.2017	17	Nanowater	Rainwater	average
270		Torkent	-	46	678	3810	850	64	02.05.2009, 10.06.2010, 14.04.2011	18	Nanowater	Rainwater	average
271		Burlykiya	r. Torkent (left)	26	162	2780	1060	66	-	19	Nanowater	Rainwater	average
272		Belaldy	-	30	149	3600	1060	85	-	20	Nanowater	Rainwater	average
273		Oital	r.Naryn (right)	10	22.8	1880	900	98	4.07.1964, 02.05.2009	21	Nanowater	Rainwater	average
274		Chichenhana	-	17	49.5	2400	900	88	-	22	Nanowater	Rainwater	average
275		Kambarata	r.Naryn (left)	34	367	3510	900	77	4.07.1964,3.08.2010, 3.04.2010,10.06.2015	23	Nanowater	Rainwater	average
276		Nichkesai	r.Kambarata (right)	24	126	3500	1300	92	27.03.2008,3.08.2010,	24	Nanowater	Rainwater	average
277		Saragata	r.Naryn (left)	31	246	3000	880	70	15.06.2020, 23.11.2020	25	Nanowater	Rainwater	average
278		Untitled	r. Saragata (left)	4.5	19.8	1550	1360	42	4.07.1964, 3.04.2010, 3.08.2010, 12.04.2012, 10.08.2013	26	Nanowater	Rainwater	average

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				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
279	The Naryn River basin	Untitled	r. Saragata (left)	12	28.8	3200	1300	158	4.07.1964 ,25.12.2016	27	Nanowater	Rainwater	average
280		Untitled	-	6	4.86	1700	1360	57	4.07.1964 ,25.12.2016	28	Nanowater	Rainwater	average
281		Uravaly	It's getting lost	12	42.5	2540	1680	70	25.05.1960, 15.06.1960, 16.06.2003, 15.04.2005, 26.07.2007, 13.05.2009 , 19.04.2010, 22.04.201	29	Nanowater	Rainwater	high
282		Untitled	-	10.5	10.9	2320	1660	63	25.05.1961, 15.06.1961	30	Nanowater	Rainwater	average
283		Jumatały	-	12	27.4	2140	1675	39	25.05.1961, 15.06.1961	31	Nanowater	Rainwater	average
284		Untitled	-	6	8.5	1950	1600	59	25.05.1961, 15.06.1961	32	Nanowater	Rainwater	average
285		Kokyr	r.Naryn (right)	14	28.8	2160	1570	41	25.05.1960, 15.05.1960,25.05.1964, 15.06.1964	33	Nanowater	Rainwater	average
286		Aflatun	r. Karasu (right)	50	928	3080	870	44	V-VI 1955, V-VI 1956, 27.07.1964, 1-4.08.2001, 19.04.2002, 10.04.2004, 12.06.2009, 07.04.2010, 5.07.2013, 25.05.2017, 18.04.2020	34	Nanowater	Rainwater	high
287		Itokar	r. Aflatun (right)	40	310	3200	990	55	V-VI 1955, V-VI 1956, 27.07.1965, 10.04.2004, 12.06.2009, 21.05.2012, 5.07.2013, 14.12.2015, 16.11.2016, 9.06.2017, 25.05.2017, 27.11.2018	35	Nanowater	Rainwater	high
288		Sarychelek (Hajaata)	R.Karasu (right)	33	282	2840	880	59	27.07.1964	36	Nanowater	Rainwater	average
289		Teldegach	It getting lost	3.4	3.7	1384	1140	72	28.06.2016,18.04.2020	37	Nanowater	Rainwater	average
290		Karasu	r. Naryn (right)	86	2800	2900	500	27	27.07.1964,14.03.2017,19 .04.2018,07.05.2020	38	Nanowater	Rainwater	high
291		Akjol	r. Karasu (left)	30	254	2680	760	64	27.07.1964, 8.02.2007, 19.04.2009, 15.05.2010, 22.06.2016 , 06.02.2020	39	Nanowater	Rainwater	high
292		Kichikjol	r.Akjol (left)	14	38.8	2400	950	104	27.07.1964, 3.08.2007, 03.05.2010, 21.05.2013, 22.06.2016	40	Nanowater	Rainwater	average
293		Aksai	r.Naryn (right)	25.5	82.8	1120	520	24	2.07.1963	41	Nanowater	Rainwater	average
294		Mailisay	is lost	34	136.4	1140	500	19	2.07.1964	42	Nanowater	Rainfall, snowmelt	high
295		At-Bashi	(mouth of the Achakaindy river)	-	-	-	-	-	29.05.1956,12.05.2009, 4.06.2007 , 25.04.2005,17.04.2012, 30.07.2007,18-19.07.2016	43	Mudstone	Rainwater	high
296		Ak-Kiya	is lost	3	4.63	2340	2169	57	03.08.2015,10.07.2020	44	Nanowater	Rainwater	average
297		Nameless creek	channel	1	0.4	2244	2059	185	03.07.2019	45	Nanowater	Rainwater	average
298		Nameless creek	is lost	1.5	0.47	2451	2041	273	05.08.2021	46	Nanowater	Rainwater	average
299		Nameless creek	is lost	3.47	2.52	2882	2044	241	17.06.2020	47	Nanowater	Rainwater	average
300		Nameless creek	is lost	2.4	1.36	2753	2050	293	03.06.2020	48	Nanowater	Rainwater	average
301		Jergetal	r.Naryn (right)	21	132	2572	1950	30	14.07.2019, 18.12.2020	49	Nanowater	Rainwater	average
302		Nameless creek	is lost	0.71	0.27	2230	2033	277	03.06.2020	50	Nanowater	Rainwater	average
303		Kulanak	is lost	4.8	8	2465	1828	133	19.04.2004,4.06.2007, 19.04.2010, 17.04.2012, 12.11.2014, 20.07.2016, 29.07.2020, 21.07.2023	51	Nanowater	Rainwater	high
304		Ichke	is lost	4.1	7.16	2900	1860	254	10.04.2020,26.04.2024	52	Mudstone	Rainwater	average
305		Baigonchak	-	-	-	-	-	-	16.06.2003, 18.09.2008, 13.06.2011, 17.04.2012, 20.07.2016, 13.06.2021	53	Nanowater	Rainwater	high
306		Ugut-Sai	-	-	-	-	-	-	21.07.2008, 19.04.2010, 10.06.2017, 19.06.2019	54	Nanowater	Rainwater	average
307		Mukhachy	is lost	0.84	0.37	2110	1965	173	12.08.2000, 12.09.2005, 2009 ,21.07.2008, 26.07.2007, 19.04.2006, 12.04.2018, 26.06.2019	55	Nanowater	Rainwater	high
308		Chon-Kadyraaly	is lost	2.27	1.85	2322	2134	83	10.06.2021	56	Nanowater	Rainwater	average
309		Kara-Suu	is lost	5.51	9.91	2520	2081	80	10.07.2019	57	Nanowater	Rainwater	average
310		Taldy-Suu	r.At-Bashi	8.6	26.5	3200	2477	84	22-23.06.2016, 25.04.2005, 01.08.2020	58	Mudstone	Rainwater	average
311		Central	Minkush (right)	5.61	12.6	3200	2159	186	16.05.2005,03.08.2020	59	Nanowater	Rainwater	average
312		Kashbulak	Minkush (right)	9.61	5.61	3508	1922	165	11.08.2004,02.08.2020	60	Nanowater	Rainwater	average
313		Keksu	Kekemeren (left)	13.37	78	3310	1379	144	13.08.2023	61	Nanowater	Rainwater	average
314		Dungerme	Minkush (left)	27.7	215	3352	1429	69	17.07.2003, 19.10.2009, 16.09.2011, 08.06.2021	62	Nanowater	Rainwater	average

CATALOGUE OF MUDFLOW-PRONE RIVERS IN KYRGYZSTAN

No.	Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse, km	Mudflow catchment area, square km	Absolute height, m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods	Map-scheme	Mudflow type	Possible causes of mudflows	Mudflow activity
				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
315	The Naryn River basin	Name + less Creek	Kyzart	4.16	4.6	2496	2226	65	10.07.2017,16.07.2019	63	Nanowater	Rainwater	average
316		Orto-Kuundagi	Jumgal (left)	24.45	164	3444	1674	72	7.06.2000,26.06.2020	64	Mudstone	Rainwater	average
317		Oro-Bashy	is lost	7.3	8.34	3055	2064	136	19.04.2004,11.07.2017	65	Nanowater	Rainwater	average
318		Chatyrkel	is lost	8.8	22	2567	1987	66	24.06.2002	66	Nanowater	Rainwater	average
319		Kek-Tai	Keng-Suu (right)	5	12.5	2670	2340	66	19.04.2006, 26.11.2020,12.06.2022	67	Nanowater	Rainwater	average
320		Ayaky-Belche	Kara-Kulzhur (right)	11.69	37.4	3642	2273	117	18.04.2018, 13.06.2003,31.07.2020	68	Nanowater	Rainwater	average
321		Nameless Creek	Naryn (right)	17.34	64	2598	1280	76	11.04.2018 , 19.04.2010,02.06.2020, 29.07.2020	69	Mudstone	Rainwater	average
322		Nameless Creek	is lost	10.33	20.3	3159	1788	133	19.05..2017	70	Mudstone	Rainwater	average
323		Askali	Naryn (right)	9	104	2220	1736	54	28.04.2017, 29.03.2016,06.06.2020	71	Mudstone	Rainwater	average
324		Creek 1	Aral-Minkush	7	-	-	-	-	17.04.2006, 16.05.2005,17.09.2010, 16.05.2005,02.08.2020	72	Nanowater	Rainwater	average
325		Jumgal		96	3080	-	-	-	23.05.1970, 10.11.2002, 19.04.2004, 19.04.2006, 2.04.2013, 22.05.2019	73	Mudstone	Rainwater	high
326	Kurshab river basin	Creek #1	r.Kurshab (right)	5.5	19.5	1460	1042	76	IV-VII	1	Nanowater	Rainwater	average
327		Creek #2	[illegible]	6	6.3	2480	1250	205	IV-VII	2	Nanowater	Rainwater	average
328		Creek #3	r.Karuly (right)	4.1	3.4	2280	1540	180	IV-VII	3	Nanowater	Rainwater	average
329		Creek #4	r.Karuly (left)	2	1.6	2200	1240	480	IV-VII	4	Nanowater	Rainwater	average
330		Creek #5	r.Karuly (left)	1.9	1	2000	1710	152	IV-VII	5	Nanowater	Rainwater	average
331		Creek #6	[illegible]	1,1	0.6	1920	1700	200	IV-VII	6	Nanowater	Rainwater	average
332		Creek #7	[illegible]	1.9	1	1880	1580	158	IV-VII	7	Nanowater	Rainwater	average
333		Creek #8	[illegible]	1.5	1,2	1980	1560	280	IV-VII	8	Nanowater	Rainwater	average
334		Creek #9	[illegible]	3	2.7	1880	1460	140	IV-VII	9	Nanowater	Rainwater	average
335		Creek #10	r.Kurshab (right)	3.7	3	1760	1480	76	30.04.2011, 30.05.2012	10	Nanowater	Rainwater	average
336		Creek #11	[illegible]	2.4	1.9	1760	1495	110	04.05.2022	11	Nanowater	Rainwater	average
337		Creek #12	r. Dzhusaly (right)	3	2.4	1960	1590	123	04.05.2023	12	Nanowater	Rainwater	average
338		Creek #13	[illegible]	2.6	2.5	1920	1620	115	IV-VII	13	Nanowater	Rainwater	average
339		Creek #14	[illegible]	3.2	3.7	2060	1680	119	IV-VII,	14	Nanowater	Rainwater	average
340		Creek #15	[illegible]	1	0.16	1960	1690	270	2.08.2017, 11.05.2004, 29.06.99, 1.12.2020	15	Nanowater	Rainwater	average
341		Creek #16	[illegible]	2,3	1.3	2040	1720	139	2.08.2017, 11.05.2004, 29.06.99, 1.12.2020	16	Nanowater	Rainwater	average
342		Creek #17	[illegible]	2.8	3.6	2080	1730	125	IV-VII	17	Nanowater	Rainwater	average
343		Creek #18	[illegible]	0.4	0.2	1800	1740	150	IV-VII	18	Nanowater	Rainwater	average
344		Creek #19	[illegible]	1.5	0.52	2560	1750	540	2.08.2017, 29.05.2017	19	Nanowater	Rainwater	average
345		Creek #20	[illegible]	3.7	0.96	1800	1755	12	2.08.2017, 29.05.2017	20	Nanowater	Rainwater	average
346		Creek #21	[illegible]	6	4.72	1960	1760	33	2.08.2017, 29.05.2017	21	Nanowater	Rainwater	average
347		Creek #22	[illegible]	4.7	3.59	2400	1765	133	2.08.2017, 29.05.2017	22	Nanowater	Rainwater	average
348		Kara-Takhta (Creek No. 23)	[illegible]	16	34.8	2600	1770	52	IV-VII	23	Nanowater	Rainwater	average
349		Creek #24	[illegible]	5.5	7.37	2520	1780	133	IV-VII	24	Nanowater	Rainwater	average
350		Creek #25	[illegible]	0.6	0.2	1840	1790	83	IV-VII	25	Nanowater	Rainwater	average
351		Creek #26	[illegible]	1.8	0.6	1880	1800	44	2.08.2017, 23.05.2003	26	Nanowater	Rainwater	average
352		Creek #27	[illegible]	2	0.84	2080	1840	120	2.08.2017, 23.05.2003	27	Nanowater	Rainwater	average
353		Creek #28	[illegible]	4.2	2.85	2200	1860	81	2.08.2017, 23.05.2003	28	Nanowater	Rainwater	average
354		Creek #29	[illegible]	1.3	0.98	2040	1920	92	IV-VII	29	Nanowater	Rainwater	average
355		Kizil-Bulak	[illegible]	10	25.6	2700	1940	76	04.05.2022	30	Nanowater	Rainwater	average
356		Sary-Kungey	r. Dzhusaly (left)	7	9.93	3120	1900	174	IV-VII	31	Nanowater	Rainwater	average
357		Creek #31	[illegible]	0.7	0.85	1880	1820	88	IV-VII	32	Nanowater	Rainwater	average
358		Creek #32	[illegible]	1.7	1.47	2100	1840	153	IV-VII	33	Nanowater	Rainwater	average
359		Creek #33	[illegible]	0.5	0.26	2000	1800	400	30.09.2022	34	Nanowater	Rainwater	average
360	Kurshab river basin	Creek #34	[illegible]	1	0.64	1880	1780	100	IV-VII	35	Nanowater	Rainwater	average
361		Creek #35	[illegible]	2,3	0.98	1960	1775	78	24-28.04.2003, 2-4.05.2003, 11.05.2003, 19.03.2011, 04.05.2022	36	Nanowater	Rainwater	high
362		Creek #36	R. Dzhusaly (left)	0.8	0.16	1960	1760	250	24-28.04.2003, 2-4.05.2003, 11.05.2003, 19.03.2011, 04.05.2022	37	Nanowater	Rainwater	high
363		Creek #37	[illegible]	0.5	0.4	1800	1750	100	30.09.2022	38	Nanowater	Rainwater	average
364		Creek #38	[illegible]	3.5	2.44	2240	1730	146	2.08.2017, 23.05.2003	39	Nanowater	Rainwater	average
365		Creek #39	[illegible]	0.8	0.32	1800	1725	94	IV-VII	40	Nanowater	Rainwater	average
366		Creek #40	R.Gulcha (right)	0.6	0,1	1660	1550	183	IV-VII	41	Nanowater	Rainwater	average
367		Creek #41	[illegible]	3.1	3.5	2000	1560	142	29.09.2022	42	Nanowater	Rainwater	average
368		Creek #42	[illegible]	1.4	0.5	1800	1570	164	IV-VII	43	Nanowater	Rainwater	average
369		Creek #43	[illegible]	1	0.44	1720	1580	140	IV-VII	44	Nanowater	Rainwater	average
370		Creek #44	[illegible]	0.4	0.2	1680	1590	225	IV-VII	45	Nanowater	Rainwater	average
371		Creek #45	[illegible]	0.6	0.2	1820	1595	375	16.03.2001, 12.04.2005, 29.07.2010, 14.04.2017, 8-11.04.2013, 2.08.2017 , 23.04.2014, 1.12.2020	46	Nanowater	Rainwater	high
372		Creek #46	[illegible]	0.5	0.24	1800	1620	360	IV-VII	47	Nanowater	Rainwater	average
373		Creek #47	[illegible]	1.5	0.5	2020	1630	260	12.04.2005, 23.04.2014, 2.08.2017	48	Nanowater	Rainwater	average
374		Creek #48	[illegible]	0.8	0.3	1920	1690	288	IV-VII	49	Nanowater	Rainwater	average
375		Creek #49	[illegible]	1	0.8	1920	1690	230	IV-VII	50	Nanowater	Rainwater	average
376		Creek #50	[illegible]	2.1	0.84	2200	1690	243	IV-VII	51	Nanowater	Rainwater	average
377		Creek #51	[illegible]	0.4	0.06	1860	1690	425	IV-VII	52	Nanowater	Rainwater	average
378		Creek #52	[illegible]	0.2	0.06	1800	1690	550	26.08.2015, 20.08.2018	53	Nanowater	Rainwater	average
379		Creek #53	[illegible]	6.3	9	3480	1970	240	2-4.04.2014, 26.08.2015, 20.08.2018	54	Nanowater	Rainwater	average
380		Creek #54	[illegible]	1,1	0.52	2420	1975	404	IV-VII	55	Nanowater	Rainwater	average
381		Askali	[illegible]	10	32.4	2800	1980	82	19.07.2018, 13.08.2010, 18-22.05.2009, 27.06.2008	56	Nanowater	Rainwater	high
382		Targalak	[illegible]	8.5	23.2	3400	1985	166	12.04.2005, 23.06.2002, 14.05.2001	57	Nanowater	Rainwater	average
383		Angal	[illegible]	5.2	8.7	2600	2050	106	IV-VII	58	Nanowater	Rainwater	average
384		Sugut	[illegible]	15	85.2	4420	2107	154	14.04.2017, 23.06.2011	59	Nanowater	Rainwater	average
385		Creek #55	[illegible]	3.3	2.64	2800	2150	197	IV-VII	60	Nanowater	Rainwater	average
386		Creek #56	[illegible]	1,1	0.36	2320	2160	147	23.06.2011, 14.04.2017,10.08.2020, 04.05.2022	61	Nanowater	Rainwater	high
387		Creek #57	[illegible]	1	0.68	2240	2180	60	23.06.2011, 14.04.2017,10.08.2020, 04.05.2022	62	Nanowater	Rainwater	high
388		Creek #58	[illegible]	0.6	0.24	2240	2185	92	29.09.2022	63	Nanowater	Rainwater	average
389		Creek #59	[illegible]	5.1	11	3400	2190	237	25.12.2020, 29.09.2022	64	Nanowater	Rainwater	average
390		Katta -Karakol	R.Gulcha (left)	14	67	3920	2470	103	IV-VII	65	Nanowater	Rainwater	average
391		Creek #60	[illegible]	0.3	0.08	2530	2445	28	IV-VII	66	Nanowater	Rainwater	average
392		Creek #61	[illegible]	0.3	0.08	2540	2440	333	1.12.2020	67	Nanowater	Rainwater	average
393		Kachik - Karakol	[illegible]	18	49	4240	2300	108	28.05.2017	68	Nanowater	Rainwater	average
394		Kurgatal	[illegible]	14.1	44	4040	2250	127	IV-VII	69	Nanowater	Rainwater	average
395		Creek #62	R. Gulcha (right)	1	0.4	2460	2240	220	29-30.07.2004, 29.07.2010, 08.07.2011, 9.01.2014, 14.04.2017	70	Nanowater	Rainwater	high
396		Creek #63	[illegible]	2.6	1.68	3000	2110	342	29-30.07.2004, 29.07.2010, 08.07.2011, 9.01.2014, 14.04.2017	71	Nanowater	Rainwater	high
397		Jirgital	[illegible]	6	12	3040	2060	163	08.07.2011	72	Nanowater	Rainwater	average
398		Creek #64	[illegible]	3.6	9.7	2400	2010	108	IV-VII	73	Nanowater	Rainwater	average
399		Creek #65	[illegible]	1,2	6.3	2260	1960	250	IV-VII	74	Nanowater	Rainwater	average

CATALOGUE OF MUDFLOW-PRONE RIVERS IN KYRGYZSTAN

No.	Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse, km	Mudflow catchment area, square km	Absolute height, m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods	Map-scheme	Mudflow type	Possible causes of mudflows	Mudflow activity
				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
400	Kurshab river basin	Creek #66	R	8.4	21.6	2560	1820	88	IV-VII	75	Nanowater	Rainwater	average
401		Creek #67	R	0.8	0.28	2200	1700	625	1.12.2020	76	Nanowater	Rainwater	average
402		Creek #68	R	0.5	0.2	2000	1695	610	26.08.2015, 20.08.2018	77	Nanowater	Rainwater	average
403		Creek #69	R	0.7	0.24	2200	1620	829	26.08.2015, 20.08.2018	78	Nanowater	Rainwater	average
404		Creek #70	R	0.3	0,1	1800	1700	333	IV-VII	79	Nanowater	Rainwater	average
405		Creek #71	R	0.6	0.32	1880	1680	333	IV-VII	80	Nanowater	Rainwater	average
406		Creek #72	R	1,2	0.4	2000	1590	341	IV-VII	81	Nanowater	Rainwater	average
407		Creek #73	R	0.8	0.24	2000	1580	252	IV-VII	82	Nanowater	Rainwater	average
408		Creek #74	R	5.4	3	2200	1560	118	IV-VII	83	Nanowater	Rainwater	average
409		Jailisu	R	29	191.4	3080	1670	49	1.04.2002, 14.05.2001,04.05.2022,30.09.2022	84	Nanowater	Rainwater	average
410		Creek #75	R	4.2	3.94	2080	1516	134	16.03.2001, 1.04.2002 , 24.05.2010, 19.05.2016	85	Nanowater	Rainwater	average
411		Creek #76	R	7.8	11.1	2350	1512	107	19.05.2016, 29.07.2010, 24.05.2010, 20.09.2002 , 16.03.2001, 7.03.2000,9.03.2000	86	Nanowater	Rainwater	high
412		Creek #77	R	5	16	2040	1505	107	19.05.2016, 29.07.2010, 24.05.2010,20.09.2002 , 16.03.2001, 7-9.03.2000	87	Nanowater	Rainwater	high
413		Creek #78	R.Kurshab (left)	2.7	2.6	2100	1350	278	31.05.2012	88	Nanowater	Rainwater	average
414		Creek #79	R	1.8	1.6	1720	1310	228	31.05.2012	89	Nanowater	Rainwater	average
415		Creek #80	R. Usazh (right)	1.8	2	2060	1800	144	24.04.2019	90	Nanowater	Rainwater	average
416		Creek #81	R	1.8	1.3	2200	1820	211	24.04.2019	91	Nanowater	Rainwater	average
417		Creek #82	R.Usaz (left)	2.6	2.6	2410	1840	220	31.05.2012	92	Nanowater	Rainwater	average
418		Koynak	R. Tura (left)	4.2	10.3	2100	1690	98	15.04.2006, 30.04.2011, 31.05.2012, 16.07.2017	93	Nanowater	Rainwater	high
419		Creek #83	Lake Kandankol	3.2	3.7	2060	1650	128	15.04.2006, 30.04.2011, 31.05.2012, 16.07.2017	94	Nanowater	Rainwater	high
420		Creek #84	R. Bagarchi (left)	5.5	14.6	2180	1580	109	15.04.2006, 30.04.2011, 31.05.2012, 16.07.2017	95	Nanowater	Rainwater	high
421		Creek #85	R	2,3	1.9	1970	1460	222	15.04.2006, 30.04.2011, 31.05.2012, 16.07.2017	96	Nanowater	Rainwater	high
422		Creek #86	R	5	11.5	2060	1410	130	15.04.2006, 30.04.2011, 31.05.2012, 16.07.2017	97	Nanowater	Rainwater	high
423		Creek #87	R	1.6	1.3	1790	1390	250	15.04.2006, 30.04.2011, 31.05.2012, 16.07.2017	98	Nanowater	Rainwater	high
424		Creek #88	R.Kurshab (left)	4.6	4.6	1800	1215	127	15.04.2006, 30.04.2011, 31.05.2012, 16.07.2017	99	Nanowater	Rainwater	high
425		Creek #89	R	3.1	2,2	1520	1210	100	IV-VII	100	Nanowater	Rainwater	average
426		Creek #90	R	5.5	3.6	2000	1180	149	IV-VII	101	Nanowater	Rainwater	average
427		Creek #91	R	7.7	6.8	2200	1160	135	IV-VII	102	Nanowater	Rainwater	average
428		Creek #92	R.Kurshab (left)	9.2	8.8	2160	1140	111	IV-VII	103	Nanowater	Rainwater	average
429		Creek #93	R	1.4	0.6	1300	1137	116	IV-VII	104	Nanowater	Rainwater	average
430		Kyzylkol	R	6.2	19	1680	1100	94	IV-VII	105	Nanowater	Rainwater	average
431		Creek #94	Lake Kyzylkol (left)	2,2	2.6	1540	1300	109	IV-VII	106	Nanowater	Rainwater	average
432	Basin of the Taldyk river	Creek #1	r. Taldyk	3.2	6.5	1840	1588	79	IV-VII	1	Nanowater	Rainwater	average
433		Creek #2	R	1.6	1	1810	1640	106	IV-VII	2	Nanowater	Rainwater	average
434		Creek #3	R	3	3	1980	1645	III	IV-VII	3	Nanowater	Rainwater	average
435		Creek #4	R	1.7	0.8	1900	1635	156	IV-VII	4	Nanowater	Rainwater	average
436		Karasu	R	9.4	30.6	2480	1650	88	IV-VII	5	Nanowater	Rainwater	average
437		Creek #5	R	2.6	1.8	2380	1860	200	IV-VII	6	Nanowater	Rainwater	average
438		Creek #6	R	2.6	1,2	2400	1870	204	IV-VII	7	Nanowater	Rainwater	average
439		Creek #7	R	2	1.9	2250	1880	185	IV-VII	8	Nanowater	Rainwater	average
440		Creek #8	R	2,2	2	2220	1900	145	IV-VII	9	Nanowater	Rainwater	average
441		Creek #9	R	1.8	4.9	2080	1860	122	IV-VII	10	Nanowater	Rainwater	average
442		Creek #10	R	1,1	0.3	2220	2040	164	IV-VII	11	Nanowater	Rainwater	average
443		Creek #11	R. Taldyk (left)	1,2	0.54	2200	1860	283	19.06.2016	12	Nanowater	Rainwater	average
444		Creek #12	R	1	0.8	2170	1865	245	IV-VII	13	Nanowater	Rainwater	average
445	Basin of the Taldyk river	Creek #13	R	1.3	0.5	2200	1855	265	IV-VII	14	Nanowater	Rainwater	average
446		Creek #14	R	1.3	0.4	2180	1830	270	IV-VII	15	Nanowater	Rainwater	average
447		Creek #15	R	1.9	1,1	2180	1750	225	IV-VII	16	Nanowater	Rainwater	average
448		Creek #16	R	2	1.6	2140	1745	197	IV-VII	17	Nanowater	Rainwater	average
449		Creek #17	R	4.9	7	2260	1690	116	31.02.2011, 24.09.2010, 7.07.2005, 27.07.2004, 13.09.2003	18	Nanowater	Rainwater	high
450		Creek #18	R	1	0.24	2120	1820	300	IV-VII	19	Nanowater	Rainwater	average
451		Creek #19	R	1	0.4	1840	1660	180	31.02.2011, 24.09.2010, 7.07.2005, 27.07.2004, 13.09.2003	20	Nanowater	Rainwater	high
452		Creek #20	R	4.7	10.8	2170	1640	113	31.02.2011, 24.09.2010, 7.07.2005, 27.07.2004, 13.09.2003	21	Nanowater	Rainwater	high
453		Creek #21	R	0.6	0.3	1740	1650	150	3.08.2015	22	Nanowater	Rainwater	average
454		Creek #22	R	0.5	0,1	1700	1635	130	IV-VII	23	Nanowater	Rainwater	average
455		Creek #23	R	1.3	0.4	1900	1630	207	IV-VII	24	Nanowater	Rainwater	average
456		Creek #24	R	4.3	3.6	2060	1595	108	IV-VII	25	Nanowater	Rainwater	average
457		Creek #25	R. Taldyk (left)	3	3.3	1840	1590	83	IV-VII	26	Nanowater	Rainwater	average
458		Creek #26	R	0.9	0.5	1900	1615	319	IV-VII	27	Nanowater	Rainwater	average
459		Creek #27	R	0.8	0.4	1800	1570	288	IV-VII	28	Nanowater	Rainwater	average
460		Creek #28	R	1.7	0.25	1700	1530	110	IV-VII	29	Nanowater	Rainwater	average
461		Creek #29	R	1.5	0.6	1725	1550	150	IV-VII	30	Nanowater	Rainwater	average
462		Creek #30	R	0.6	0.16	1600	1445	258	IV-VII	31	Nanowater	Rainwater	average
463		Creek #31	R	0.6	0,1	1600	1410	316	3.12.2018	32	Nanowater	Rainwater	average
464		Creek #32	R	1.5	0.44	1480	1300	120	3.12.2018	33	Nanowater	Rainwater	average
465		Creek #33	R	6.5	3.4	1520	1300	34	25.06.2016	34	Nanowater	Rainwater	average
466		Creek #34	R	10.8	30.6	1740	1295	41	25.06.2016	35	Nanowater	Rainwater	average
467		Creek #35	R	8.2	6.3	1720	1280	54	IV-VII,	36	Nanowater	Rainwater	average
468		Creek #36	R	2.7	0.9	1410	1240	63	17.07.2017, 11.03.2014	37	Nanowater	Rainwater	average
469		Creek #37	R	3.5	1.7	1390	1230	46	IV-VII	38	Nanowater	Rainwater	average
470		Creek #38	R	2.1	1	1350	1220	62	IV-VII	39	Nanowater	Rainwater	average
471		Creek #39	R	11.6	23.1	1830	1200	54	IV-VII,	40	Nanowater	Rainwater	average
472		Creek #40	R	7.8	3.9	1760	1190	73	IV-VII,	41	Nanowater	Rainwater	average
473		Creek #41	R	4.7	1	1400	1185	46	11.03.2014	42	Nanowater	Rainwater	average
474		Creek #42	R	8.1	6.7	1500	1170	41	11.03.2014	43	Nanowater	Rainwater	average
475		Creek #43	R	5	2,2	1280	1140	28	11.03.2014	44	Nanowater	Rainwater	average
476		Creek #44	Can . Yuzhny	5.1	4.2	1280	1110	33	18.08.2008, 23.06.2008, 26.05.2008, 4.05.2007	45	Nanowater	Rainwater	average
477		Creek #45	Same	13.8	22.6	1600	1060	39	18.08.2008, 23.06.2008, 26.05.2008, 4.05.2007	46	Nanowater	Rainwater	average
478		Creek #46	R	7.6	5.2	1320	1050	36	18.08.2008, 23.06.2008, 26.05.2008, 4.05.2007	47	Nanowater	Rainwater	average
479		Creek #47	R	7.7	5.6	1320	1040	36	18.08.2008, 23.06.2008, 26.05.2008, 4.05.2007	48	Nanowater	Rainwater	average
480		Creek #48	R	3.8	1.8	1180	1030	40	18.08.2008, 23.06.2008, 26.05.2008, 4.05.2007	49	Nanowater	Rainwater	average
481		Creek #49	R	6.2	17.9	1480	1010	76	18.08.2008, 23.06.2008, 26.05.2008, 4.05.2007	50	Nanowater	Rainwater	average
482	Akbura River Basin	Creek #1	r. Akbura	2.1	0.8	1220	1080	67	IV-VII	1	Nanowater	Rainwater	average
483		Creek #2	R	2,2	0.8	1290	1085	93	24.04.2019	2	Nanowater	Rainwater	average
484		Creek #3	R	3.6	2.7	1370	1100	75	IV-VII	3	Nanowater	Rainwater	average
485		Creek #4	R	4	1.8	1440	1115	81	3.12.2018 11.05.2017, 27.05.2014, 27.07.2012, 18.06.2009,14.05.2009, 23.06.2005, 17.08.2007	4	Nanowater	Rainwater	high

CATALOGUE OF MUDFLOW-PRONE RIVERS IN KYRGYZSTAN

No.	Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse , km	Mudflow catchment area, square km	Absolute height , m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods	Map-scheme	Mudflow type	Possible causes of mudflows	Mudflow activity
				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
486	Akbura River Basin	Creek No. 5	r. Akbura	3	1.9	1360	1130	77	3.12.2018 11.05.2017, 27.05.2014, 27.07.2012, 18.06.2009,14.05.2009, 23.06.2005, 17.08.2007	5	Nanowater	Rainwater	high
487		Creek No. 6	[illegible]	6.5	21.1	1560	1115	68	18.06.2012,14.05.2009, 26.04.2008, 2.06.2006, 30.03.2005, 7.06.2005, 16.08.2005 , 18.03.2004, 18.04.2004 , 28.05.2004 , 28.10.2003, 2.12.2003, 24.04.2000	6	Nanowater	Rainwater	high
488		Karasugat Sai	[illegible]	12.8	46.8	2160	1240	72	18.06.12,14.05.2009, 26.04.2008, 2.06.2006, 30.03.2005, 7.06.2005, 16.08.2005 , 18.03.2004, 18.04.2004 , 28.05.2004 , 28.10.2003, 2.12.2003, 24.04.2000	7	Nanowater	Rainwater	high
489		Creek No. 7	[illegible]	2.8	1.8	1640	1265	134	18.06.12,14.05.2009, 26.04.2008, 2.06.2006, 30.03.2005, 7.06.2005, 16.08.2005 , 18.03.2004, 18.04.2004 , 28.05.2004 , 28.10.2003, 2.12.2003, 24.04.2000	8	Nanowater	Rainwater	high
490		Creek No. 8	[illegible]	2.6	1.6	2268	1480	303	18.06.2012,14.05.2009, 26.04.2008, 2.06.2006, 30.03.2005, 7.06.2005, 16.08.2005 , 18.03.2004, 18.04.2004 , 28.05.2004 , 28.10.2003, 2.12.2003, 24.04.2000	9	Nanowater	Rainwater	high
491		Creek No. 9	[illegible]	7.1	10	2100	1282	115	18.06.2012,14.05.2009, 26.04.2008, 2.06.2006, 30.03.2005, 7.06.2005, 16.08.2005 , 18.03.2004, 18.04.2004 , 28.05.2004 , 28.10.2003, 2.12.2003, 24.04.2000	10	Nanowater	Rainwater	high
492		Creek No. 10	[illegible]	4.5	3	1850	1295	123	18.06.2012,14.05.2009, 26.04.2008, 2.06.2006, 30.03.2005, 7.06.2005, 16.08.2005 , 18.03.2004, 18.04.2004 , 28.05.2004 , 28.10.2003, 2.12.2003, 24.04.2000	11	Nanowater	Rainwater	high
493		Creek No. 11	[illegible]	3.9	3.3	1800	1315	124	IV-VII	12	Nanowater	Rainwater	average
494		Creek No. 12	[illegible]	1.5	1.7	1600	1330	180	IV-VII	13	Nanowater	Rainwater	average
495		Creek No. 13	r. Kyrk-Kichik	2	1	1800	1400	200	IV-VII	14	Nanowater	Rainwater	average
496		Creek No. 14	[illegible]	3	2,2	1840	1427	138	IV-VII	15	Nanowater	Rainwater	average
497		Creek No. 15	[illegible]	6.8	18	2140	1442	103	IV-VII	16	Nanowater	Rainwater	average
498		Creek No. 16	[illegible]	5.7	7	2120	1480	112	IV-VII	17	Nanowater	Rainwater	average
499		Creek No. 17	[illegible]	3.8	4.1	2110	1495	162	IV-VII	18	Nanowater	Rainwater	average
500		Creek No. 18	[illegible]	2.7	1.4	1920	1530	144	IV-VII	19	Nanowater	Rainwater	average
501		Creek No. 19	[illegible]	2,3	1.9	1730	1540	83	IV-VII	20	Nanowater	Rainwater	average
502		Creek No. 20	r. Shut (left)	1,2	2.4	2850	2520	275	IV-VII	21	Nanowater	Rainwater	average
503		Creek No. 21	[illegible]	1.3	3.1	2720	2315	312	28.04.2018, 7.05.2010, 9.03.2007, 15.004.2006	22	Nanowater	Rainwater	average
504		Creek No. 22	[illegible]	2.4	3.4	2660	2000	275	17.07.2017, 18.05.2017, 20.04.2016, 8.05.2014, 19.03.2014, 9.01.2013, 1.04.2010, 24.07.2008, 28.05.2008	23	Nanowater	Rainwater	high
505		Kuyuktepa	r. Akbura	6	15.1	2760	1480	213	IV-VII	24	Nanowater	Rainwater	average
506		Creek No. 23	The Drainless Stream	4.7	2.6	2080	1685	200	IV-VII	25	Nanowater	Rainwater	average
507		Katta-Algali	R.Akbura (left)	5	5.1	2200	1390	162	IV-VII	26	Nanowater	Rainwater	average
508		Togoloi	[illegible]	8.3	14	2080	1380	84	IV-VII	27	Nanowater	Rainwater	average
509		Creek No. 24	[illegible]	3.3	3.8	1480	1360	36	27.02.2019	28	Nanowater	Rainwater	average
510		Creek No. 25	[illegible]	9.3	16.8	1920	1345	62	27.02.2019	29	Nanowater	Rainwater	average
511		Creek No. 26	[illegible]	3.6	2.4	1760	1282	133	IV-VII	30	Nanowater	Rainwater	average
512		Creek No. 27	[illegible]	2,2	4.7	1560	1270	132	IV-VII	31	Nanowater	Rainwater	average
513		Creek No. 28	[illegible]	4.4	3.4	1780	1258	118	IV-VII	32	Nanowater	Rainwater	average
514		Creek No. 29	[illegible]	3.1	3.2	1560	1248	101	IV-VII	33	Nanowater	Rainwater	average

No.	Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse, km	Mudflow catchment area , square km	Absolute height, m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods	Map-scheme	Mudflow type	Possible causes of mudflows	Mudflow activity
				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
515	Akbura River Basin	Creek No. 30	[illegible]	6.7	11	2000	1238	114	16.04.2007, 08.09.2009, 13.05.2010, 9.04.2012, 9.07.2012, 18.11.2014, 20.04.2016	34	Nanowater	Rainwater	high
516		Creek No. 31	[illegible]	3	3.1	1520	1230	97	16.04.2007, 08.09.2009, 13.05.2010, 9.04.2012, 9.07.2012, 18.11.2014, 20.04.2016	35	Nanowater	Rainwater	high
517		Creek No. 32	[illegible]	2.6	1.4	1480	1210	104	16.04.2007, 08.09.2009, 13.05.2010, 9.04.2012, 9.07.2012, 18.11.2014, 20.04.2016	36	Nanowater	Rainwater	high
518		Creek No. 33	r. Akbura (left)	2.4	0.9	1470	1200	112	16.04.2007, 08.09.2009, 13.05.2010, 9.04.2012, 9.07.2012, 18.11.2014, 20.04.2016	37	Nanowater	Rainwater	high
519		Creek No. 34	[illegible]	2	0.9	1440	1195	122	16.04.2007, 08.09.2009, 13.05.2010, 9.04.2012, 9.07.2012, 18.11.2014, 20.04.2016	38	Nanowater	Rainwater	high
520		Creek No. 35	[illegible]	1.8	0.7	1400	1187	118	16.04.2007, 08.09.2009, 13.05.2010, 9.04.2012, 9.07.2012, 18.11.2014, 20.04.2016	39	Nanowater	Rainwater	high
521		Creek No. 36	[illegible]	1,2	0.5	1320	1185	112	IV-VII	40	Nanowater	Rainwater	average
522		Creek No. 37	[illegible]	6	14	1670	1170	83	IV-VII	41	Nanowater	Rainwater	average
523		Creek No. 38	[illegible]	3	2.8	1390	1140	83	IV-VII	42	Nanowater	Rainwater	average
524		Creek No. 39	[illegible]	5	4.6	1360	1155	43	IV-VII	43	Nanowater	Rainwater	average
525		Creek No. 40	[illegible]	6.7	10.6	1420	1110	46	9.07.2012	44	Nanowater	Rainwater	average
526		Creek No. 41	[illegible]	3.2	3.9	1310	1080	72	IV-VII		Nanowater	Rainwater	average
527		Akbura	It's getting lost	136	2540	4080	690	30	27.05.1924, 29.06.1928,12.07.1928, 5.06.1929,02.06.1930,17. 06.1930, 07.06.1930, 22.05.1931,4.07.1953, 2.08.1999, 24.07.2008, 28.05.2008, 1.04.2010, 19.06.2012, 9.01.2013, 8.05.2014, 19.03.2014, 20.04.2016, 17.07.2017, 18.05.2017, 02.12.2020	46	Nanowater	Rainwater	high
528	Aravan river basin	Creek No. 1	r. Aravan	1.4	3.3	1090	1030	43	IV-VII	1	Nanowater	Rainwater	average
529		Creek No. 2	r. Koschansai (right)	2.4	1.8	1570	1310	108	9.06.2014	2	Nanowater	Rainwater	average
530		Creek No. 3	[illegible]	5.2	7.5	1500	1300	38	IV-VII	3	Nanowater	Rainwater	average
531		Creek No. 4	[illegible]	3.2	3.2	1520	1243	87	IV-VII	4	Nanowater	Rainwater	average
532		Creek No. 5	[illegible]	3.5	2.9	1560	1205	101	IV-VII	5	Nanowater	Rainwater	average
533		Creek No. 6	r. Karakol (right)	2	1.4	1560	1190	185	IV-VII	6	Nanowater	Rainwater	average
534		Creek No. 7	[illegible]	3.4	3.2	1480	1200	82	IV-VII	7	Nanowater	Rainwater	average
535		Creek No. 8	[illegible]	2.5	1,2	1400	1220	72	13.01.2018, 9.06.2014, 28.03.2013, 18.05.2012, 2.06.2009	8	Nanowater	Rainwater	average
536		Creek No. 9	r. Yangisai (right)	2	0.7	1470	1337	67	IV-VII	9	Nanowater	Rainwater	average
537		Creek No. 10	[illegible]	3.2	1.5	1500	1350	47	9.06.2014, 4.04.2013, 18.05.2012, 03.12.2010 , 11.06.2005, 6.05.2005	10	Nanowater	Rainwater	average
538		Creek No. 11	[illegible]	3.8	2.9	1510	1360	39	13.01.2018, 7.04.2015	11	Nanowater	Rainwater	average
539		Creek No. 12	r. Yangisai (right)	1.5	0.6	1520	1377	95	13.01.2018, 7.04.2015	12	Nanowater	Rainwater	average
540		Creek No. 13	[illegible]	3.3	4.2	1560	1400	48	13.01.2018, 7.04.2015	13	Nanowater	Rainwater	average
541		Creek No. 14	[illegible]	2.5	1.3	1560	1420	56	13.01.2018, 7.04.2015	14	Nanowater	Rainwater	average
542		Creek No. 15	[illegible]	0.7	0.5	1480	1436	63	13.01.2018, 7.04.2015	15	Nanowater	Rainwater	average
543		Creek No. 16	[illegible]	2	1.7	1540	1445	48	13.01.2018, 7.04.2015	16	Nanowater	Rainwater	average
544		Creek No. 17	[illegible]	1,1	0.4	1560	1450	100	13.01.2018, 7.04.2015	17	Nanowater	Rainwater	average
545		Creek No. 18	[illegible]	0.7	0.5	1500	1455	64	13.01.2018, 7.04.2015	18	Nanowater	Rainwater	average
546		Creek No. 19	[illegible]	1.5	0.5	1630	1470	107	13.01.2018, 7.04.2015	19	Nanowater	Rainwater	average
547		Creek No. 20	[illegible]	3.4	3.4	1760	1510	74	9.06.2014, 4.04.2013, 18.05.2012, 03.12.2010 , 11.06.2005, 6.05.2005	20	Nanowater	Rainwater	average
548		Creek No. 21	r. Karakol (right)	2.6	1.4	1540	1330	81	IV-VII	21	Nanowater	Rainwater	average
549		Creek No. 22	[illegible]	4.5	0.3	1720	1320	89	IV-VII	22	Nanowater	Rainwater	average
550		Creek No. 23	[illegible]	1	0.8	1420	1310	110	IV-VII	23	Nanowater	Rainwater	average

CATALOGUE OF MUDFLOW-PRONE RIVERS IN KYRGYZSTAN

No.	Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse, km	Mudflow catchment area, square km	Absolute height, m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods	Map-scheme	Mudflow type	Possible causes of mudflows	Mudflow activity
				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
551	Aravan river basin	Creek No. 24	R	4	3.1	1800	1300	125	IV-VII	24	Nanowater	Rainwater	average
552		Creek No. 25	R	2	1.5	1580	1295	142	IV-VII	25	Nanowater	Rainwater	average
553		Creek No. 26	R	0.9	0.5	1400	1290	122	IV-VII	26	Nanowater	Rainwater	average
554		Creek No. 27	R	4	3.9	1880	1290	122	IV-VII	27	Nanowater	Rainwater	average
555		Creek No. 28	R	2	0.8	1650	1450	108	13.01.2018, 7.04.2015	28	Nanowater	Rainwater	average
556		Creek No. 29	R	4.5	5.5	2000	1480	116	13.01.2018, 7.04.2015	29	Nanowater	Rainwater	average
557		Creek No. 30	R	4.2	4.6	1920	1530	93	13.01.2018, 7.04.2015	30	Nanowater	Rainwater	average
558		Creek No. 31	R	5	8.9	2000	1580	84	13.01.2018, 7.04.2015	31	Nanowater	Rainwater	average
559		Creek No. 32	R	5.5	13.9	1915	1590	59	13.01.2018, 7.04.2015	32	Nanowater	Rainwater	average
560		Creek No. 33	Lev. Tributary of the Channel Chile	1.5	0.5	1540	1420	80	IV-VII	33	Nanowater	Rainwater	average
561		Creek No. 34	Same	1,1	1,2	1460	1380	73	IV-VII	34	Nanowater	Rainwater	average
562		Creek No. 35	R	2	1,2	1560	1370	95	IV-VII	35	Nanowater	Rainwater	average
563		Creek No. 36	R	1.8	1	1560	1380	100	IV-VII	36	Nanowater	Rainwater	average
564		Creek No. 37	R	1.5	1.6	1480	1370	73	IV-VII	37	Nanowater	Rainwater	average
565		Creek No. 38	R	1.7	1	1600	1370	135	IV-VII	38	Nanowater	Rainwater	average
566		Creek No. 39	r. Aravan (left)	1	0.6	1500	1150	350	IV-VII	39	Nanowater	Rainwater	average
567		Creek No. 40	R	0.6	0.5	1200	1120	133	IV-VII	40	Nanowater	Rainwater	average
568		Creek No. 41	R	3	7	1380	1110	90	IV-VII	41	Nanowater	Rainwater	average
569		Creek No. 42	R	6.1	10	1460	1070	64	7.10.2016 , 24.03.2001	42	Nanowater	Rainwater	average
570		Creek No. 43	R.Aravan (left)	5.5	4.1	1320	1060	47	IV-VII	43	Nanowater	Rainwater	average
571		Creek No. 44	R	10.2	10.7	1580	990	58	IV-VII	44	Nanowater	Rainwater	average
572		Creek No. 45	R	5.5	7.2	1200	980	40	IV-VII	45	Nanowater	Rainwater	average
573		Creek No. 46	R	1.5	1.7	1070	970	67	IV-VII	46	Nanowater	Rainwater	average
574		Aravan	is lost	102	1960	3520	530	36	1923, 5.05.1927,20.05.1928, 23.07.1928,22.05.1931, 23.06.1931,1.07.1931,23.07. 1931,13.02.1934, 1953, 3-5.07.1977, 11.06.2005, 10.04.2007, 17.07.2014, 19.03.2011,6.05.2014, 12.04.2011,21.05.2018	47	Nanowater	Rainwater	high
575	The Abshirsai River Basin	Creek No. 1	R.Abshirsai (right)	2.7	3.1	1120	1060	22	13.08.2001,11.06.2005,28 .06.2024	1	Nanowater	Rainwater	average
576		Creek No. 2	R	5.5	11.3	1250	1110	25	13.08.2001,11.06.2005,28 .06.2024	2	Nanowater	Rainwater	average
577		Creek No. 3	R	6	18.9	1280	1120	27	13.08.2001,11.06.2005,28 .06.2024	3	Nanowater	Rainwater	average
578		Creek No. 4	R	4	4.7	1290	1160	32	13.08.2001,11.06.2005,28 .06.2024	4	Nanowater	Rainwater	average
579		Creek No. 6	R	6	8.4	1340	1170	28	13.08.2001,11.06.2005,28 .06.2024	5	Nanowater	Rainwater	average
580		Spillway channel Sysyk-Bulak No. 6	The Drainless Stream	-	-	-	-	-	13.08.2001,11.06.2005,28 .06.2024	6	Nanowater	Rainwater	average
581		Creek No. 7	R. Aksay (left)	2.6	1.4	1670	1670	115	13.08.2001,11.06.2005,28 .06.2024	7	Nanowater	Rainwater	average
582		Creek No. 8	R	4	4.9	1630	1630	172	13.08.2001,11.06.2005,28 .06.2024	8	Nanowater	Rainwater	average
583		Creek No. 9	R	1.8	3.3	1420	1420	117	13.08.2001,11.06.2005,28 .06.2024	9	Nanowater	Rainwater	average
584		Creek No. 10	R	4.2	3.2	1380	1380	124	13.08.2001,11.06.2005,28 .06.2024	10	Nanowater	Rainwater	average
585		Creek No. 11	R	4.6	7.4	1240	1240	74	13.08.2001,11.06.2005,28 .06.2024	11	Nanowater	Rainwater	average
586		Creek No. 12	Left Tributary of the river (right)	4.6	4.4	1210	1210	82	13.08.2001,11.06.2005,28 .06.2024	12	Nanowater	Rainwater	average
587		Creek No. 13	Left Tributary of the river Aksay (left)	7.4	4.8	1680	1190	63	13.08.2001,11.06.2005,28 .06.2024	13	Nanowater	Rainwater	average
588		Creek No. 14	R	6	1.8	1680	1180	82	13.08.2001,11.06.2005,28 .06.2024	14	Nanowater	Rainwater	average

No.	Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse, km	Mudflow catchment area, square km	Absolute height, m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods	Map-scheme	Mudflow type	Possible causes of mudflows	Mudflow activity
				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
589	The Abshirsay River Basin	Creek #15	L	2	0.3	1310	1010	65	13.08.2001,11.06.2005,28 .06.2024	15	Nanowater	Rainwater	average
590		Creek #16	R.Abshirsay (left)	0.6	0.3	1100	600	150	13.08.2001,11.06.2005,28 .06.2024	16	Nanowater	Rainwater	average
591		Creek #17	The Drainless Stream	15	3.6	970	600	25	13.08.2001,11.06.2005,28 .06.2024	17	Nanowater	Rainwater	average
592		Creek #18	L	10	5	860		26	13.08.2001,11.06.2005,28 .06.2024	18	Nanowater	Rainwater	average
593	Basin of the Isfayramsay river	Creek #1	r. Isfayramsay (right)	1.5	1.7	1190	1020	113	IV-VII	1	Nanowater	Rainwater	average
594		Creek #2	L	2,2	2.7	1200	1010	86	IV-VII	2	Nanowater	Rainwater	average
595		Creek #3	R	1,1	0.6	1200	1050	137	3.04.2015, 25.07.2008 23.07.2004, 29.05.2003, 9.06.2003	3	Nanowater	Rainwater	average
596		Creek #4	L	1.8	1	1240	1060	100	IV-VII	4	Nanowater	Rainwater	average
597		Creek #5	L	3.4	3	1320	1070	73	IV-VII	5	Nanowater	Rainwater	average
598		Creek #6	L	3.6	10.5	2400	2000	111	IV-VII	6	Nanowater	Rainwater	average
599		Chuvai	L	19	94.6	2750	1080	88	18.12.2015, 2.05.2011, 21.10.2011, 3.08.2009, 2.07.2009, 16.04.2008, 21.04.2004, 21.04.2005, 2.08.2003, 4.09.2003	7	Nanowater	Rainwater	high
600		Creek #7	r. Chuvai (right)	5	6.1	2900	1680	244	18.12.2015, 2.05.2011, 21.10.2011, 3.08.2009, 2.07.2009, 16.04.2008, 21.04.2004, 21.04.2005, 2.08.2003, 4.09.2003	8	Nanowater	Rainwater	high
601		Pum	r. Isfayramsay	23	94.6	3680	1200	108	IV-VII	9	Nanowater	Rainwater	average
602		Kalta -Karagandy	L	3.7	11.3	2740	1470	343	IV-VII	10	Nanowater	Rainwater	average
603		Tegermach	L	30	287.4	3980	1490	82	18.06.1966, 1977	11	Nanowater	Rainfall, Glacial	average
604		Cholok-Kain	L	4.6	14.1	2800	1543	274	IV-VII	12	Nanowater	Rainwater	average
605		Wallet	r. Isfayramsay	3.7	17	2620	1480	308	IV-VII	13	Nanowater	Rainwater	average
606		Tamchi	L	3.1	7	2200	1440	245	IV-VII	14	Nanowater	Rainwater	average
607		Kul	L	2,2	43.8	3500	1470	94	IV-VII	15	Nanowater	Rainwater	average
608		Creek #8	L	3.5	4	1780	1300	137	IV-VII	16	Nanowater	Rainwater	average
609		Tamashasay	L	7	16.5	1960	1300	96	IV-VII	17	Nanowater	Rainwater	average
610		Creek #9	r. Tamashasay (right)	2	1.8	1680	1440	120	IV-VII	18	Nanowater	Rainwater	average
611		Creek #10	r. Isfayramsay (left)	1.5	7.08	1440	1240	133	IV-VII	19	Nanowater	Rainwater	average
612		Creek #11	L	3	2.9	1220	1060	53	IV-VII	20	Nanowater	Rainwater	average
613		Creek #12	L	4.5	6.8	1300	1050	56	29.05.2003, 21.03.2001	21	Nanowater	Rainwater	average
614		Creek #13	L	1.3	1.3	1180	1040	108	IV-VII	22	Nanowater	Rainwater	average
615		Creek #14	L	7	9.4	2230	1000	176	23.06.2012	23	Nanowater	Rainwater	average
616		Isfayramsay	r . Syrdarya (left)	95	2220	3750	950	29.5	24.05.1931,23.07.1931,24 .07.1931,15.05.1932,1934 ,13.02.1934,2.04.1934,2.0 6.1934,30.06.1948,10.06. 1949,16.06.1949,24.08.19 49,VI-VII 1953, 1966, 1977, 16.11.1999, 21.03.2001, 29.05.2003,19.11.2004, 9.06.2003, 23.06.2012	24	Mudstone	Rainfall, Glacial	high
617	The Shahimardan River basin	Shakhimardan	r.Syrdariya (left)	63	1300	4400	1080	52.7	20.05.1923,10.05.1928,8. 06.1928,3.05.1929,2.07.1 929, 31.07.1929,26.06.1930,27 .06.1930,30.06.1930, 1.07.1930,10.07.1931,22. 07.1931,19.06.1934,02.07 .1962, 07.1998 , 24.06.2000, 21.03.2001, 21.07.2002, 15.05.2003, 21.04.2005,17.04.2008, 25.02.2010, 3.08.2009, 30.05.2012, 27.09.13, 18.10.12,28.04.11, 23.06.2012, 3.04.2015, 23.03.2015, 9.03.2017,	1	Mudstone	Rainfall, Glacial	high
618		Tegerek	r.Shakhimardan (right)	6.5	6.6	1600	1400	31	02.07.1962, 21.08.2009	2	Mudstone	Rainwater	high

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No.	Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse, km	Mudflow catchment area - square km	Absolute height, m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods	Map-scheme	Mudflow type	Possible causes of mudflows	Mudflow activity
				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
619	The Shahimardan River basin	Kyzyl -Bulak		19	61	1800	1200	32	07.1962, 9.03.2017, 21.12.2015, 19.03.2009, 19.03.2008, 2007, 9.06.2003, 29.05.2003, 21.03.2001	3	Mudstone	Rainwater	high
620		Dugova	R.Shakhimardan (left)	19	125	4300	1520	146	1927	4	Mudstone	Rainwater	high
621		Tashbulak	[illegible]	12	27.4	2300	1200	92	15.07.2017, 18.12.2015, 25.01.2014, 18.06.2011,6.09.2010, 15.02.2010, 14.05.2009, 29.03.2009, 26.06.2008, 15.07.2008, 4.04.2008, 2.08.2004, 29.07.2003, 4.09.2002,1.07.2002, 4.09.2000	5	Mudstone	Rainwater	high
622		Peshkaut	[illegible]	19	56.4	2900	1240	87	15.07.2017, 18.12.2015, 25.01.2014, 18.06.2011,6.09.2010, 15.02.2010, 14.05.2009, 29.03.2009, 26.06.2008, 15.07.2008, 4.04.2008, 2.08.2004, 29.07.2003, 4.09.2002,1.07.2002, 4.09.2000	6	Mudstone	Rainwater	high
623		Ankhor	[illegible]	12	36.3	1860	1080	65	1935,1942,18.04.1963,19. 04.1963, 21.04.1963, 1977	7	Mudstone	Rainwater	high
624	The area between the Shakhimardan and Sokh rivers	Creek #1	r. Budarlyk (right)	1.7	7.3	650	595	32	IV-VII	1	Mudstone	Rainwater	average
625		Creek #2		2.4	22	660	595	27	IV-VII	2	Mudstone	Rainwater	average
626		Creek #3		2.1	38	600	560	19	IV-VII	3	Mudstone	Rainwater	average
627		Creek #4	r. Budarlyk (right)	6	3.4	720	530	32	IV-VII	4	Mudstone	Rainwater	average
628		Creek #5	[illegible]	4.5	80	650	510	31	IV-VII	5	Mudstone	Rainwater	average
629		Creek #6	[illegible]	10	11	920	510	41	IV-VII	6	Mudstone	Rainwater	average
630		Creek #7	ar. Dizak -Kurgan (right)	10	21.3	860	504	35.6	IV-VII	7	Mudstone	Rainwater	average
631		Shchunksay	Yangiyaryk (left)	41	196	2800	500	56	8.07.2009, 17.04.2008	8	Mudstone	Rainwater	average
632		Creek #8	Shchunksay (left)	14.5	21	1340	740	42	8.07.2009, 17.04.2008	9	Mudstone	Rainwater	average
633		Sary-Kamysh	r. Yangiyaryk (right)	23.8	88.2	2400	880	64	IV-VII	10	Mudstone	Rainwater	average
634		Creek #9	R. Sarykamysh (left)	2.5	4	1010	910	40	IV-VII	11	Mudstone	Rainwater	average
635		Creek #10	[illegible]	1.9	1.7	1060	980	42	IV-VII	12	Mudstone	Rainwater	average
636		Creek #11	[illegible]	8.1	10	1300	980	39.5	IV-VII	13	Mudstone	Rainwater	average
637		Creek #12	r. Sarykamysh (left)	5.6	10.5	1200	980	39	IV-VII	14	Mudstone	Rainwater	average
638		Creek #13	r. Yangiyaryk (left)	3	2.7	880	670	70	IV-VII	15	Mudstone	Rainwater	average
639		Creek #14	[illegible]	2,2	3.2	830	675	70	IV-VII	16	Mudstone	Rainwater	average
640		Creek #15	[illegible]	3.9	4.6	920	675	63	IV-VII	17	Mudstone	Rainwater	average
641		Creek #16	[illegible]	3.6	10.5	890	695	54	IV-VII	18	Mudstone	Rainwater	average
642		Creek #17	[illegible]	3.7	2,2	910	740	46	IV-VII	19	Mudstone	Rainwater	average
643		Creek #18	[illegible]	3	5.5	870	730	47	IV-VII	20	Mudstone	Rainwater	average
644		Creek #19	[illegible]	13.7	22.7	1245	740	37	IV-VII	21	Mudstone	Rainwater	average
645		Creek #20	[illegible]	3.7	5.3	900	760	38	IV-VII	22	Mudstone	Rainwater	average
646		Creek #21	[illegible]	4	11.9	895	765	32.5	IV-VII	23	Mudstone	Rainwater	average
647	The Sokh River Basin	Ily-Kol	r. Sokh (right)	5	11.8	1600	1030	114	1998, 11.12.2018, 14.07.2020	1	Nanowater	Rainwater	average
648		Creek #1	[illegible]	2	1	1700	1035	332	IV-VII	2	Nanowater	Rainwater	average
649		Creek #2	[illegible]	1.5	1,1	1420	1045	250	06.07.2018	3	Nanowater	Rainwater	average
650		Creek #3	[illegible]	1.9	2	2000	1400	316	26.01.2014	4	Nanowater	Rainwater	average
651		Creek #4	R.Kshtut (right)	2.6	2.9	2420	1400	392	11.05.2005, 11.07.2005, 14.07.2020, 13.11.2020	5	Nanowater	Rainwater	average
652		Creek #5	[illegible]	6.7	17.6	2580	1570	151	11.05.2005, 11.07.2005, 14.07.2020, 13.11.2020	6	Nanowater	Rainwater	average
653		Creek #6	[illegible]	5.6	12.4	2640	1660	175	11.05.2005, 11.07.2005, 14.07.2020, 13.11.2020	7	Nanowater	Rainwater	average
654		Creek #7	[illegible]	4.5	6	3300	1700	355	11.05.2005, 11.07.2005, 14.07.2020, 13.11.2020	8	Nanowater	Rainwater	average

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				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
655	The Sokh River Basin	Asangavar	[illegible]	8.7	23.7	4210	2040	250	11.05.2005, 11.07.2005, 14.07.2020, 13.11.2020	9	Nanowater	Rainwater	average
656		Palme	R.Kshtut	7.8	16	3960	2000	251	11.05.2005, 11.07.2005, 14.07.2020, 13.11.2020	10	Nanowater	Rainwater	average
657		Creek #8	[illegible]	4.9	7	3400	1850	316	11.05.2005, 11.07.2005, 14.07.2020, 13.11.2020	11	Nanowater	Rainwater	average
658		Creek #9	[illegible]	3.1	6.7	2120	1630	158	11.05.2005, 11.07.2005, 14.07.2020, 13.11.2020	12	Nanowater	Rainwater	average
659		Creek #10	R. Sokh (right)	4	6.2	2440	1300	285	IV-VII	13	Nanowater	Rainwater	average
660		Creek #11	[illegible]	8.1	18.9	3720	1360	291	28.05.2010, 21.07.2009	14	Nanowater	Rainwater	average
661		Creek #12	[illegible]	4.8	2	2880	1370	315	28.05.2010, 21.07.2009	15	Nanowater	Rainwater	average
662		Creek #13	[illegible]	4	3.9	3100	1400	425	IV-VII	16	Nanowater	Rainwater	average
663		Augul	[illegible]	8.2	43.1	2700	1480	149	28.05.2010, 21.07.2009	17	Nanowater	Rainwater	average
664		Koshkarchi	[illegible]	10	43.5	2800	1550	125	27.04.2009	18	Nanowater	Rainwater	average
665		Barefoot	[illegible]	4	15.7	2200	1660	135	IV-VII	19	Nanowater	Rainwater	average
666		Rout	R. Sokh (l)	12.5	77.6	2980	1487	119	3.06.2013, 21.07.2013,21.07.2009	20	Nanowater	Rainwater	average
667		Sargytashma	R.Raut (right)	5	15	2800	2143	131	3.06.2013, 21.07.2013,21.07.2009	21	Nanowater	Rainwater	average
668		Symap	r.Raut (left)	4.2	12	2840	2040	190	3.06.2013, 21.07.2013, 21.07.2009	22	Nanowater	Rainwater	average
669		Ular	[illegible]	3.2	4	2900	1870	322	3.06.2013, 21.07.2013,21.07.2009	23	Nanowater	Rainwater	average
670		Palal	r.Sokh (left)	10.3	26.6	3700	1500	155	28.05.2010, 26.07.2010	24	Nanowater	Rainwater	average
671		Creek #14	[illegible]	2,2	4.8	1820	1460	164	IV-VII	25	Nanowater	Rainwater	average
672		Creek #15	[illegible]	2,3	7.2	1900	1450	196	3.12.2019	26	Nanowater	Rainwater	average
673		Creek #16	[illegible]	3	3.3	2300	1270	343	IV-VII	27	Nanowater	Rainwater	average
674		Creek #17	[illegible]	4.8	12.2	2300	1250	219	IV-VII	28	Nanowater	Rainwater	average
675		Creek #18	[illegible]	2,2	6	1760	1230	241	IV-VII	29	Nanowater	Rainwater	average
676		Creek #19	r. Aksu (right)	2.7	4.2	1700	1340	133	26.06.2003, 15.05.2003, 24.06.2005, 7.04.2008, 6.06.2008, 18.01.2010, 27.09.2013, 14.01.2014, 15.12.2015, 3.07.2015	30	Nanowater	Rainwater	high
677		Creek #20	[illegible]	2,3	3.8	1900	1460	191	26.06.2003, 15.05.2003, 24.06.2005, 7.04.2008, 6.06.2008, 18.01.2010, 27.09.2013, 14.01.2014.15.12.2015, 3.07.2015	31	Nanowater	Rainwater	high
678		Creek #21	[illegible]	3.6	2.5	2600	1540	294	26.06.2003, 15.05.2003, 24.06.2005, 7.04.2008, 6.06.2008, 18.01.2010, 27.09.2013, 14.01.2014.15.12.2015, 3.07.2015	32	Nanowater	Rainwater	high
679		Danga	[illegible]	2.6	3.4	2700	1720	377	IV-VII	33	Nanowater	Rainwater	high
680		Dzhankurgan	r.Aksu (left)	2.5	10.1	1800	1580	88	26.06.2003, 15.05.2003, 24.06.2005, 7.04.2008, 6.06.2008, 18.01.2010, 27.09.2013, 14.01.2014.15.12.2015, 3.07.2015	34	Nanowater	Rainwater	high
681		Creek #22	[illegible]	3.5	5	1760	1410	100	26.06.2003, 15.05.2003, 24.06.2005, 7.04.2008, 6.06.2008, 18.01.2010, 27.09.2013, 14.01.2014.15.12.2015, 3.07.2015	35	Nanowater	Rainwater	high
682		Creek #23	[illegible]	2.6	1.8	1660	1410	96	26.06.2003, 15.05.2003, 24.06.2005, 7.04.2008, 6.06.2008, 18.01.2010, 27.09.2013, 14.01.2014.15.12.2015, 3.07.2015	36	Nanowater	Rainwater	high
683		Creek #24	[illegible]	5.6	8.1	1800	1330	84	3.07.2015, 15.12.2015. 14.01.2014. 27.09.2013, 18.01.2010, 7.04.2008, 6.06.2008, 24.06.2005, 15.05.2003, 26.06.2003,	37	Nanowater	Rainwater	high
684		Creek #25	[illegible]	3.3	2	1620	1280	103	3.07.2015, 15.12.2015. 14.01.2014. 27.09.2013, 18.01.2010, 7.04.2008, 6.06.2008, 24.06.2005, 15.05.2003, 26.06.2003,	38	Nanowater	Rainwater	high

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				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
685	Karaganda river basin	Karaunkur	r.Karadarya (right)	126	1510	2960	645	22.4	11.05.1949,8.05.1951,9.04.1964,29.05.2008, 27.02.2003,6.06.2012,29.09.2011, 15.05.2009, 7.04.2009, 29.05.2008,9.02.2017,17.03.2020	1	Nanowater	Rainwater	high
686		Shaidansai	r.Karaunkur (right)	30	131	2900	720	132	30.06.1948,28.01.2003, 24.05.12, 25.07.2012,6.06.2012, 11.12.2018 ,21.05.2018, 21.12.2015,	2	Nanowater	Rainwater	high
687		Kugart	R.Karadarya (right)	105	1370	3220	720	24	14.04.1931,19.04.1931,01.05.1932,23.06.1934,11.05.1949, 12.05.98, 25.08.2008, 2.03.2011, 1.09.2004,19.05.2014,30.03.2018, 20.11.2018	3	Nanowater	Rainfall, snowmelt	high
688		Kurgantam	R. Cougart (left)	25.2	95	2120	1110	40	16.05.1960,27.05.1963, 13-17.05.1964, 31.05.2018	4	Nanowater	Rainfall, snowmelt	high
689		Kondova	R.Yasi (left)	20	98	2198	1120	62	24.01.2014, 12.03.2013, 2.11.2007	5	Nanowater	Rainwater	high
690	Naryn region	Shamsi (Kochkor)							07.1987, 25.07.2007, 9.09.2015	74	Mudstone	Glacial, Buzulgansu Lake Outburst	average
691	Vakhsh	Karamyk	Vakhsh	6.46	29.7	2896	2312	90	1.10.2018, 7.05.2017, 20.10.2010	1	Nanowater	Rainwater	average
692		Creek	Is lost	3.11	5.64	2920	2575	111	03.07.2017	2	Mudstone	Rainwater	average
693	Shakhimardan	Tashbulak	Kara - Kechuu right	8.98	37.7	1828	1276	61	11.07.2017, 03.06.2019, 11.05.2022,15.07.2017, 18.12.2015, 25.01.2014, 18.06.2011, 6.09.2010, 15.02.2010, 14.05.2009, 29.03.2009, 26.06.2008, 15.07.2008, 4.04.2008, 2.08.2004, 29.07.2003, 4.09.2002,1.07.2002, 4.09.2000	3	Mudstone	Rainwater	high
694		Kara -Kechuu	Ak- Suu (left)	-	-	-	-	-	16-17.04.2008, 2007, 15.04.1997,03.06.2019, 19.04.2018, 18.12.2015, 29.03.2009,25.07.2008, 1.07.2002, 7.08.2002	4	Nanowater	Rainwater	high
695	Shahimardan Sokh	Gavlan	-	-	-	-	-	-	3.07.2017 , 3.05.2005, 12.09.2002,15.05.2018	5	Nanowater	Rainwater	average
696		Ak- Suu	Sokh (left)	-	-	-	-	-	21.12.2015, 6.09.2010, 25.07.2006, 21.03.2001,06.07.2021,9.03.2017, 3.04.2015, 23.03.2015, 27.09.2013, 18.10.2012, 28.04.2011, 21.04.2005	6	Nanowater	Rainwater	high
697	Isfara	Aksai	Isfara (left)	4.18	43	1584	1290	70	11.05.2022,14.04.2009, 27.07.2008,3.12.2019	7	Nanowater	Rainfall, snowmelt	high
698	Syr Darya	Leilek	-	-	-	-	-	-	07.07.2023, 21.05.2018, 19.05.2022, 05.06.2019, 09.06.2018, 03.08.2021,17.02.2011, 14.09.2011, 25.03.2008, 13.07.2005,14.06.2018,03.06.2009,21.12.2020	8	Nanowater , Mudstone	Rainwater	high
699		Rawat	is lost	3.8	4.98	2077	1734	90	20.06.2018,24.04.2014, 7.05.2010, 28.07.2005	9	Nanowater	Rainwater	high
700		Isfana	is lost	-	-	-	-	-	12.07.2020, 02.05.2020, 07.07.2023, 13.05.2018, 24.06.2014, 8.02.2013, 2.07.2012, 16.06.2011, 27.06.2011, 3.08.2011, 12.04.2010, 18.05.2009, 23.04.09, 27.07.2008, 22.04.2004, 14.05.2003, 14.03.2002, 30.03.2002, 24.05.2002	10	Nanowater	Rainwater	high
701		Nameless creek	is lost	2.41	2.75	1385	1197	78	13.05.2018, 04.06.2019,28.05.2016, 27.02.2015	11	Nanowater	Rainwater	high
702		Isfara	is lost	-	-	-	-	-	23.06.2018, 25.05.2017,13.11.2020	12	Nanowater , Mudstone	Rainfall, snowmelt	average

No.	Zone	Watercourse name	Where and from which bank is the water flow directed?	Length of watercourse, km	Mudflow catchment area, square km	Absolute height, m		Average slope of the watercourse bed	Mudflow dates or mudflow hazard periods	Map-scheme	Mudflow type	Possible causes of mudflows	Mudflow activity
				Total length	Total area	Height of the source of the watercourse	Height of the mouth of the alluvial fan	Slope from source to top of alluvial fan, ‰					
703	the Chatkal river	Chirchik	Sary-Jaz	-	-	-	-	-	04. 1953	1	Nanowater	Rainfall, snowmelt	average
704	Sary - Jazz river basin	Sary-Jaz	Sary-Jaz	-	-	-	-	-	VII-IX	2	Nanowater , Mudstone	snowmelt, glacial	average
705	the Ak-Shyyrak river	Creek Ak- Shyrak	Creek Ak- Shyirak (left)	7.06	29.3	3734	2610	159	VII-IX	3	Nanowater , Mudstone	snowmelt, glacial	average
706	Sary Jazz river basin	Utash	Creek Ak- Shyirak (right)	6.83	11	3724	2877	124	VII-IX	4	Nanowater , Mudstone	snowmelt	average
707		Irtash	Uch-Kel (left)	31.69	860	3457	2937	16	VII-IX	5	Nanowater , Mudstone	snowmelt, glacial	average
708		Sarychat	Kuilu (right)	9.19	49.7	3540	3305	26	VII-IX	6	Nanowater , Mudstone	snowmelt, glacial	average
709		Koiche	Cholokkapchigay (right)	26	250	3716	2908	31	VII-IX	7	Nanowater , Mudstone	snowmelt, glacial	average
710		Kichi-Uzongu-Kuush	Uzongu-Kuush	18	94	3691	3000	38	VII-IX	8	Nanowater , Mudstone	snowmelt, glacial	average
711		Ken-ter	Sarytor (right)	5.34	16.5	3755	3663	17	VII-IX	9	Nanowater , Mudstone	snowmelt, glacial	average
712	Naryn River basin	Chakyr-Korumdu	r.Naryn	29	293	3752	3173	20	VII-IX	10	Nanowater , Mudstone	snowmelt, glacial	average
713		Jagalmai	r.Naryn	10.2	245	3559	3291	26	VII-IX	11	Nanowater , Mudstone	snowmelt, glacial	average
714	Basin of the Chon Kemin river	Goddessdog	r.Chon-Kemin (left)	5.41	21.5	2247	1397	157,116451	VII-IX		Mud-stone, alluvial	snowmelt, rainfall	average
715		Zhangyz -Tal	r.Chon-Kemin (left)	9.61	28.5	2713	1395	137,1488033	VII-IX		Nanowater	Rainstorm	average
716		Tar- Suu	r.Chon-Kemin (left)	10.15	25.2	3127	1512	159,1133005	VII-IX		Nanowater	Rainstorm	average
717		Kalmak-Ashuu	r.Chon-Kemin (left)	9.36	32.1	3335	1640	181,0897436	VII-IX		Nanowater	Rainstorm	average
718		Uzun-Bulak	r.Chon-Kemin (right)	3.9	3.2	1951	1540	105,3846154	VII-IX		Nanowater	Rainstorm	average
719		Balyk -Sai	is lost	5.15	6.8	1947	1563	74,5631068	VII-IX		Nanowater	Rainstorm	average
720		Ushbulak	is lost	7.86	11	2702	1632	136,1323155	VII-IX		Nanowater	Rainstorm	average
721		Tegirmen-Suu	is lost	9.12	41.5	3237	2077	127,1929825	VII-IX		Nanowater	snowmelt, rainfall	average
722		Dzhynalik	is lost	5.05	11.7	2784	2064	142,5742574	VII-IX		Nanowater	snowmelt, rainfall	average
723		Kek-Bulak	is lost	5.25	10.7	2667	1815	162.2857143	VII-IX		Nanowater	snowmelt, rainfall	average
724		Kok-Tash	is lost	13.9	50.2	3258	1657	115,1798561	VII-IX		Nanowater	snowmelt, rainfall	average
725		Ortho -Kaindy	is lost	10.23	24.2	3257	1724	149.8533724	VII-IX		Nanowater	snowmelt, rainfall	average

Conclusion

The Kyrgyz Republic, as a mountainous country, is very vulnerable to climate change. The observed increase in air temperature, heat waves (thaws) and heat waves, changes in the regime and intensity of precipitation, lead to changes in the hydrological regime of all rivers, caused by a shift in the period of snowmelt and its speed, degradation of glaciers and snowfields, which affects all areas of life. Climate change also leads to an increase in the number and intensity of emergency situations, such as avalanches, landslides, mudflows, floods, etc., affecting the living environment of the population, leading to threats to their lives and well-being. The most vulnerable areas to climate risks are the valley and foothill zones of the Kyrgyz Republic, where there is a high population density and the greatest economic activity of the country is concentrated. In terms of number and frequency of passage, mudflows are in first place and make up more than 30% of all emergency situations that have occurred in the territory of the Kyrgyz Republic (Figure 40).

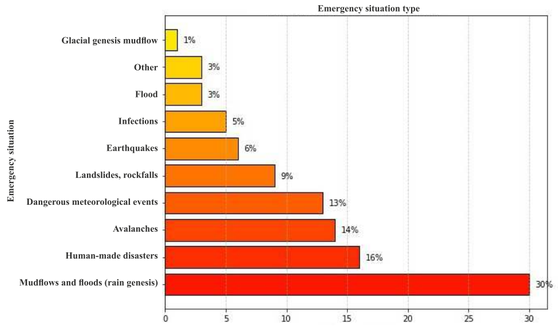

Figure 40. Distribution of emergency situations in the territory of the Kyrgyz Republic. Source: Department of Monitoring and Forecasting of Emergencies under the Ministry of Emergency Situations of the Kyrgyz Republic

Mudflow and flood are different forms of mountain flows. One form can easily turn into another and back depending on the structure of the mountain valley. Mudflows are closely related to floods and vice versa. For residents of mountain valleys, there is no big difference between a flood and a mudflow. It is necessary to protect yourself from both. Moreover, the protective measures are almost the same. Powerful mountain flows come to the densely populated foothill plains in the form of floods (only in isolated cases in the form of mudflows), but the local population calls them mudflows (Figure 41). Figure 41 shows a destructive mudflow caused by intense rainfall and causing damage to the summer cottage village of the Academy of Sciences (upstream of the village of Kashka - Suu , Chui oblast). As a result of the mudflow, bridges and roads connecting the Ala-Archa alpine camp and the city of Bishkek were damaged.

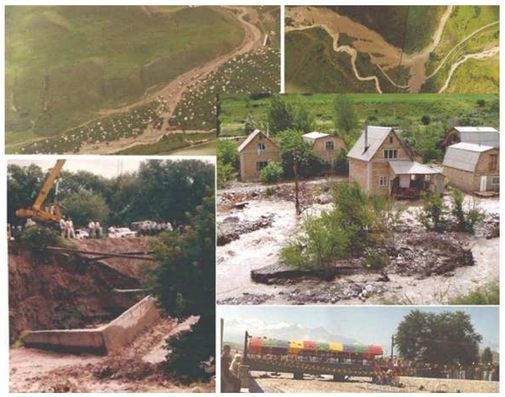

Figure 41. Ala-Archa mudflow, 2003.

In the context of climate change and related changes in the precipitation regime and intensity, there is a growing threat of increased frequency of mudflows and flash floods, as well as their occurrence in valleys that have been relatively calm for the past decades. An example of this is the mudflows that occurred in villages on the northern coast of Issyk-Kul in August 2024. In the village of Temirovka (Figure 42), the yards of more than 100 houses were flooded, about 10 houses were destroyed by a mudflow and cannot be restored, in some areas the height of the flow reached two to three meters.

Figure 42. Mudflow in the village of Temirovka , 2024. (photo by V.V. Zaginaev)

Also, due to changes in the cryosphere, liquid precipitation in the form of rain is increasingly falling at altitudes above 3000 meters in the spring and summer, overlapping with the process of snowmelt, which can also contribute to the occurrence of mudflows.

The activation of mudflow and flood processes occurs for several reasons: the number of outburst-hazardous lakes increases (new lakes appear in place of retreating glaciers); the amount of loose debris mudflow material increases (powerful accumulations of moraine-glacial complexes remain in place of retreating glaciers).

Mudflows of glacial genesis occur much less frequently, however, over the past 10 years, 5 breakthroughs of high-mountain lakes have been recorded, all lakes are of the moraine-glacial type, three lakes are located on the Kyrgyz ridge, in the valleys of the Ala-Archa, Nooruz and Sokuluk rivers , two breakthroughs occurred on the Terskey Ala - Too ridge (Aksai and Ton valleys).

In the context of climate change, a very important direction is the development of early warning systems for mudflow threats, for the adoption of preventive protective measures. Such systems should include the collection and analysis of monitoring information, as well as warning of the threat when critical values are reached. Such early warning systems should include clearly developed algorithms for action during the dangerous development of the process, in addition to the involvement of relevant services, evacuation plans to safe zones and the introduction of restrictions on movement in dangerous areas should be implemented.

The forecast of mudflow and flood hazard serves as the basis for taking preventive measures, including the construction of protective engineering structures, rational development and planning of populated areas, forest reclamation measures, cleaning of river beds, drainage and irrigation systems, and the organization of monitoring and warning services.

The main threat to the population is the destruction, flooding, silting, destruction of residential buildings and public buildings, life support facilities, infrastructure, engineering, protective, irrigation structures, changes in river beds, deterioration of the sanitary and hygienic condition of the territories. The main measures aimed at reducing the danger and risks are:

- forecasting mudflow hazard with the creation of forecast maps;
- expansion and creation of an observation network (hydroposts, weather stations);
- study of high-mountain lakes, mudflow river beds with determination of affected zones, identification of areas of narrowing of river beds, accumulation of mudflow material, etc.;
- construction of protective structures – mudflow reservoirs , canals, mudflow chutes , protective walls, guide and enclosing dams, terracing of slopes, agroforestry measures;
- implementation of development of populated areas in accordance with General Plans;
- informing the population through the media about the danger of mudflows due to changing weather conditions (high temperatures, precipitation), the threat of breakthrough of lakes, reservoirs, etc.;
- preparation of the territory for the passage of mudflows and flood flows (clearing river beds, canals, protective structures from mudflows, strengthening banks, restoration and construction of a network of irrigation ditches);
- resettlement of residents from areas of possible damage;
- creation of reserves of fuel and lubricants, materials for the construction of protective dams, preparation of equipment for emergency and protective work;
- training the population in behavior in the event of a mudflow and flood threat;
- creation and implementation of automatic warning systems about the threat of mudflows and floods.

The occurrence of mudflows and floods is closely related to extreme weather events. Analysis of the observed events shows a noticeable increase in the number of hot days per year and the number of days per year with extreme precipitation. In accordance with global assessments of changes in extreme weather events, their frequency is expected to increase further in the future. In accordance with the expected climate changes, the risks of occurrence of the main emergency situations have been determined based on an assessment of the probability of occurrence [30].

Terminological dictionary

A disaster is a serious disruption of the functioning of society that increases human vulnerability, causes large-scale human casualties and widespread environmental damage that exceeds the ability of society to cope using its own resources alone [29].

Landslide lakes. The formation of landslide lakes is associated with earthquakes, mudflows, landslides and collapses of mountain slopes. The significant (up to several tens of millions of m3) volume of water in landslide lakes makes their breakthroughs very dangerous. The stability of the dams of landslide lakes depends on the development of the drainage channels. Depending on the genesis of the dam, landslide lakes are divided into the following subtypes: 1) landslide-landslide; 2) landslide-mudflow; 3) landslide-landslide; 4) landslide-moraine.

Glacial lakes. The dams of lakes of this type, preventing the flow of melt water and thus causing their accumulation and formation of lakes, are modern glaciers. The sources of feeding of these lakes are melt water of glaciers and atmospheric precipitation. The forms of their discharge are represented by surface and intraglacial runoff, but one of them predominates depending on the subtype of the glacial lake [25].

Moraine-glacial lakes . The moraine-glacial lakes are formed on the surface of moraine-glacial complexes. Depending on the place of formation and structure of moraine-glacial complexes, lakes of this type are divided into three subtypes: 1) the subtype of intra-moraine depressions; 2) the subtype of slope moraine depressions. 3) the subtype of thermokarst funnels [25].

Moraine lakes were formed from moraine-glacial lakes of the early Holocene and Pleistocene. Lakes of intramoraine depressions were transformed into flowing moraine lakes. Their dams are represented by ancient moraine complexes of frozen loose-fragmentary low-permeability rocks. A well-developed system of water inflow and outflow determines the long life (hundreds and thousands of years) of flowing moraine lakes.

Moraine-bar lakes. In the dams of moraine-bar lakes, the base is represented by a rocky bar, which is covered by a thickness of loosely fragmented moraine material with buried ice, remaining after the degraded glacier, with a thickness from several meters to the first tens of meters. When moraine-bar lakes break through, part of their volume, lying above the level of the crest of the rocky bar, is discharged.

A sediment flow is a temporary mountain flow with a density of 1100 to 1400 kg/m3 , consisting of a mixture of water and sandy-clayey material with the inclusion of coarser debris [4].

A flood is a phase of a river's water regime, a relatively short-term and non-periodic rise in the water level in a river caused by the intense melting of snow, glaciers, or an abundance of rain.

Proluvium is a complex of loose formations that accumulate at the foot of mountains as a result of temporary flows washing away debris from the slopes.

Outburst-hazardous lakes. The stability of dams of lakes largely depends on the action of exogenous geological and hydrogeological processes that destroy the dam to the outburst-hazardous limit [25]. Only 20-30% of the total number of lakes are classified as outburst-hazardous . They have fragile dams consisting of either moraine-glacial formations or loose, weakly bound landslide-landfall deposits. Such dams can be destroyed by a number of factors.

A breakthrough of dams of high-mountain natural lakes is a formed mudflow or flood flow with destructive force, superimposed on the natural phases of the water regime of a river or temporary watercourse as a result of the complete or partial destruction of the dam body.

Disaster risk is the potential for losses resulting from disasters, expressed in human losses, material, economic and environmental damage [29].

Mudflow deposits are the products of mudflow removal, which form the relief forms of mudflow proluvial, alluvial genesis. In genetic terms , mudflow deposits are a type of proluvium. The characteristic features of mudflow deposits , in comparison with other types of proluvium, include: the weakest rounding debris. The granulometric composition of the S.o. is determined by the composition of rocks in the centers of origin and solid feeding of mudflows [28].

Mudflow focus - is a section of a mountain valley where a water flow can transform into a mudflow. Mudflow centers are divided into cuts, ruts and centers of dispersed mudflow formation.

A mudflow flood is one of the types of flows, occupying an intermediate position between a typical mudflow (mud and water-rock) flow and a flood. It differs from typical mudflows by its low saturation with debris (density less than 1100 kg/m³), and from floods by its short duration and mudflow type of hydrograph. The elements of the mudflow process - the breakdown of the channel blind area, high saturation with debris, the transfer of large debris - are realized not along the entire length, but in individual sections of the channel [27].

A mudflow is a temporary mountain flow consisting of a mixture of water and loose debris of high density, from 1400 to 2500 kg/m3 [4].

Mudflow channel - the channel of a watercourse within a mudflow basin, along which mudflows pass. The characteristic features of a mudflow channel are accumulations of mudflow deposits in the form of mudflow ridges and terraces, as well as areas of deep and lateral erosion (mudflow incisions) and corrosion of sides and bottoms composed of rocky formations [27].

Mudflow-forming deposits are loose debris material that accumulates on the bottom of a valley and at the foot of its sides after the destruction of its rocky base by weathering. These mudflow-forming deposits are called potential mudflow material [16].

An early warning system for hazardous natural processes is a set of measures aimed at providing early warning about the onset of a hazardous natural process, or informing about a specific phase of the development of this process.

Disaster risk reduction is a set of measures to reduce the vulnerability of populations and territories to disaster threats, and to increase preparedness for emergency situations based on systematic analysis and control of causal risk factors and rational use of natural resources [29].

Erosion process - is the process of erosion of the sides and bottom of a river valley by a mountain stream. The erosion leads to the collapse of the sides. If the sides are represented by terrace ledges on the surface of which there are residential buildings and outbuildings, then there is a threat of their destruction [27, 28] .

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