"ASSESSMENT AND MITIGATION OF RISKS FROM MUDSLIDESS AND FLOODS IN THE TERRITORIES OF THE BISHKEK CITY"

I. Background

The territory of the Kyrgyz Republic is largely exposed to the impact of mudslides and floods. Settlements (95% of all settlements of the republic are located on the banks or alluvial cones of rivers or temporary watercourses), transportation, communications, farmland, hydroelectricity, irrigation facilities and other objects are affected by mudslides and floods.

Development of exogenous geological processes is facilitated by extreme glaciation, high-mountain outburst lakes, deep intended (shame) of landscape, its significant steepness, the high height of the watershed ridges, and a huge amount of loose-clastic material such as gravel, crushed stone, sand, clay that feeds mudslides.

The reason for the cause of mudslides and floods are heavy rains, outbursts of mountain lakes and interglacial reservoirs. An increase in the volume of water in the lake can lead to the destruction of the dam and the formation of powerful mudslides. Such a phenomenon was observed in 2012 in Chui region when powerful mudslides came out of the side valley of Adygene into the main valley and blocked the Ala-Archa River.

II. Objectives

The main objective of assessment is to assist by UNDP CO to **support the process of enhancing and scaling up effective water, mudslides and flood management practices to reduce vulnerability to climate-induced water stress and flood hazards in Bishkek**.

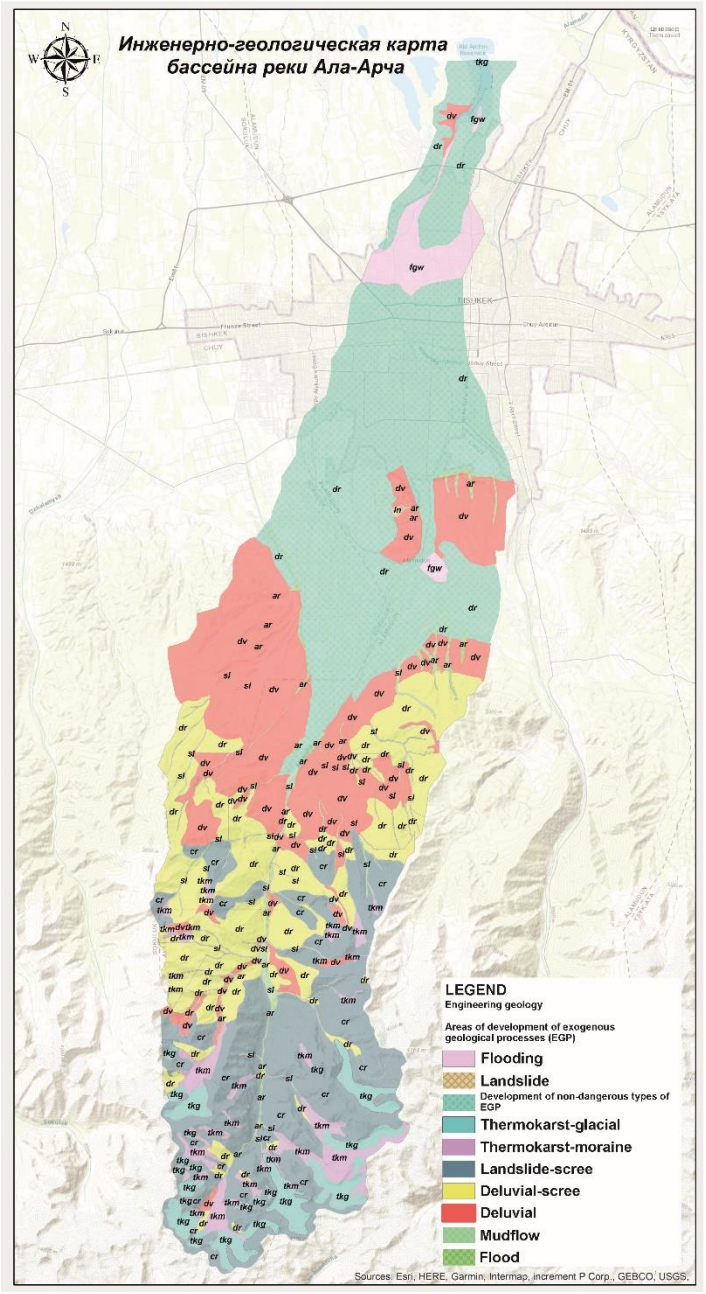
III. Carried out activities

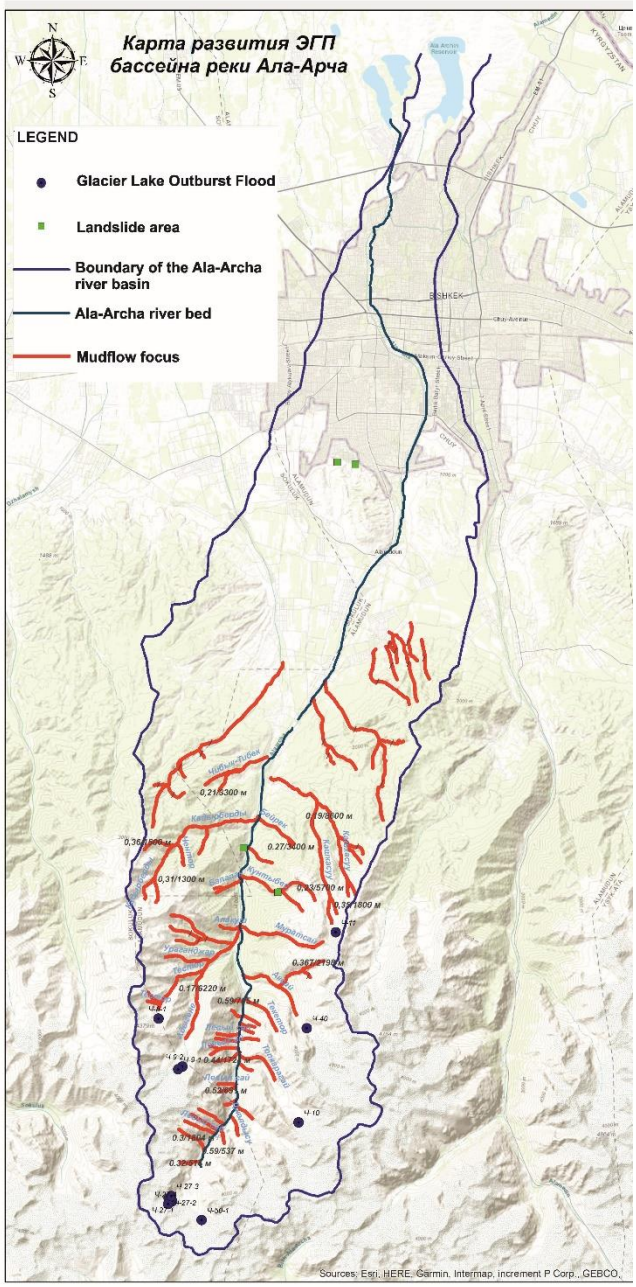
#	Planned activities	Achieved results
1	**Analysis and systematization of data on the history of the study of the development of mudflow processes in the Ala-Archa River valley**	**A retrospective analysis was carried out with primary conclusions and a plan for conducting an engineering-geological hazard assessment on the Ala-Archa River and near the city of Bishkek.** *Powerful flows of dirty water with abnormally high flow rates repeatedly passed along the Ala-Archa channel, which reached the city of Bishkek, destroying road and pedestrian bridges, flooding coastal areas. In some years, the consequences of manifestations of such flows were simply catastrophic.* *The reason for the formation of mudflows and floods in the valley of the Ala-Archa River is heavy rains, outbursts of high-altitude lakes and intraglacial reservoirs. For large mudflows, often caused by lake outbursts.* *Since in each side valley of the Ala-Archa River there are conditions for the action of three factors:* *- the presence of mudflow centers in the mountain valley;* *- the possibility of accumulation in the mountain valley of a large volume of water and its subsequent discharge;* *- the presence of loose clastic material on the bottom and sides of the valley, which may be involved in the mudflow process.* *, then the formation of powerful mudflows is possible in each of them.* *Modern modeling methods make it possible to carry out various simulations of the runoff of mud and mudflows in complex terrain, and allows for a detailed analysis of the danger of mudflow formations. The conducted retrospective analysis served as a kind of data calibration to refine the modeling parameters and served as a tool for further analysis using new numerical modeling and visualization techniques.*

2	**UAV field surveys and hydrodynamic modeling**	**Field studies were carried out with the aim of building a digital elevation model and modeling, as well as for the operational survey of hazardous areas. These activities were carried out using drones.** *Further, 3 methods were used to model mudflow and flood flows based on the data of the digital elevation model and the literature review.:* *- RAMMS - supports 3D modeling and belongs to the type of discrete models using the block method.* *- утвержденная национальная методика «Порядок определения зон паводкового и селевого поражения при прорывах горных озер на территории КР» (СП КР 22-102:2001)* *- HEC-RAS - software package implements one-dimensional and two-dimensional approaches to hydraulic modeling of river flows, runs in a Windows environment and includes a graphical interface, hydraulic analysis components, data storage and management, graphical and reporting tools.* *Based on the results of the simulation, the data obtained were loaded as vector layers into ArcGIS and then compared using special tools to identify discrepancies.* *Thus, the model built in the RAMMS program expands the affected area in the upper part (up to the city of Bishkek), which may be due to the features of the relief and the calculation algorithm used, as well as the limitations associated with the DEM), so the wave height calculated in RAMMS is greater than that calculated by the SP KR 22-102:2001 by 0.5 meters, in some places by almost 1 meter. This is possible because, according to SP KR 22-102:2001, the flow rate that runs along the channel is not lost and is a constant value until the very last profile, which is incorrect and does not consider losses and costs. The RAMMS model, on the contrary, considers the factor of reducing the flow rate and reducing the height of the breakthrough wave. In the HEC-RAS program, a given flow rate is passed through profiles built using a digital elevation model.*
	Development of recommendations for strengthening the existing system of monitoring and predicting the threats of mudflows based on the results of the study, as well as to minimize the impact of mudflows on the environment and infrastructure	**Basic recommendations and schemes have been developed for a system for promptly informing the relevant authorities about a possible mudflow hazard in the Ala-Archa River valley to reduce the impact of the risk and threats of mudflows on the population and infrastructure.** *The study, considering modern methods and approaches in disaster risk reduction and modeling, made it possible to develop recommendations that can be conditionally divided into the following stages:* ➢ *Changing the main institutional approaches and mechanisms in DRM;* ➢ *Development of engineering solutions to reduce the risks of mudflow and flood hazard along the Ala-Archa riverbed;* ➢ *Development of practical recommendations for stakeholders and administration of Bishkek city and population.* *Thus, the main recommendations obtained from the results of this study can be divided into institutional and practical, based on the results of the simulation (more than 10 recommendations).* *Taking preventive mitigation measures must be implemented by set of measures, including an institutional approach and several practical engineering measures. Only a comprehensive solution to the problem of rehabilitation of the Ala-Archa riverbed can help in solving several problems associated with the expansion of the city of Bishkek, the development of riverbed territories, and will also allow carrying out protective measures for the city's infrastructure facilities located near the riverbed.* *For implementation of institutional and practical measures, required more than 900,000.00 USD investments (410 thousand USD for institutional measures and 500 thousand USD for the implementation of protective measures along and in the channel of the Ala-Archa River).*

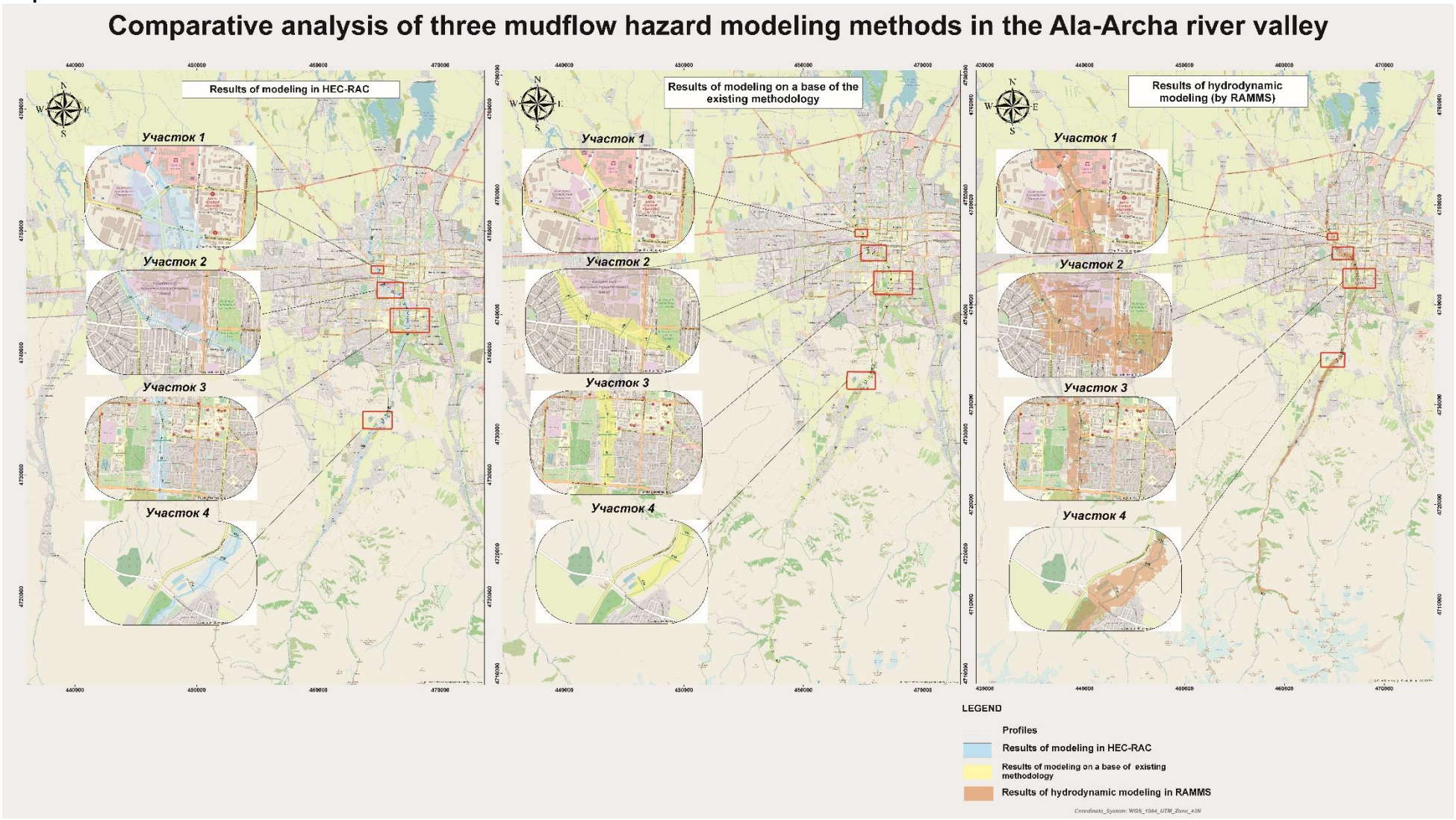
Map 1.

Engineering-geological map and map of the development of hazardous exogenous geological processes





Map 2.


Comparative analysis of three mudflow hazard modeling methods in the Ala-Archa river valley
Results of modeling in HEC-RAC
Участок 1
Участок 2
Участок 3
Участок 4
Results of modeling on a base of the existing methodology
Участок 1
Участок 2
Участок 3
Участок 4
Results of hydrodynamic modeling (by RAMMS)
Участок 1
Участок 2
Участок 3
Участок 4
LEGEND
Profiles
Results of modeling in HEC-RAC
Results of modeling on a base of existing methodology
Results of hydrodynamic modeling in RAMMS