CENTRAL ASIAN INSTITUTE FOR APPLIED GEOSCIENCES

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Content

INTRODUCTION AND OVERVIEW

Central Asia (including countries of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) is one of the hot spots for studying intra-continental geo-processes and global change phenomena. The region has significant influence on weather, climate and water cycle not only over the territory of Asia but in global scale. Active geodynamic processes due to the continuous orogenesis induce a high seismicity and landslide susceptibility in the region. The high dynamics of the regional geologic regime, the on-going Global Change but also human activities are responsible for the frequent occurrence of natural disasters in Central Asia as earthquakes, floods, landslides, glacial lake outburst, mudflows, avalanches and droughts. These natural and anthropogenic hazards often result in human and economic losses, environmental problems, and have a strong negative impact on sustainable development and society welfare in Central Asia.

The assessment of risk related to any natural and anthropogenic changes that are possible to occur in Central Asia, and the development of adaptive measures of risk mitigation are of strategic importance due to the impact of such processes on the population and on the political stability of the region.

CAIAG is aware that some of the topics show no significant changes or new scientific questions compared to previous Research and Development Plans. To a large extend this is due to the fact that high quality and long-term monitoring programs of Global Change effects (i.e. reduction of glaciers) and Natural hazards (i.e. seismicity) are absolutely needed in the region and that this principal duty is expected from the government of Kyrgyzstan.

Research and Development Program

The Research and Development Program of CAIAG for the period 2020-2022 (R&D PROG 20/22) is focused on four priority directions, which are important for the Central Asian region and which are also reflected in the organizational structure of CAIAG:

1. Geodynamics and georisks;
2. Climate, water and glaciers;
3. Monitoring and data management systems;
4. Capacity development.

The scientific challenges and tasks will be tackled in a long-term perspective using an advanced scientific monitoring infrastructure created in international cooperation:

- Study of regional change processes and development trends and their effect on the environment;
- Monitoring and assessment of natural hazards, disaster risk reduction including the development of early warning technologies;
- Applied multi-disciplinary research in the field of geodynamics and water resources, including research of glaciers, rivers, reservoirs, underground water;
- Capacity building, training courses, education and public outreach.

A large part of CAIAG's work is dedicated to provide scientific services to scientific and public communities.

- Operation and long-term maintenance of monitoring networks for Earth processes consisting of seismic, geodetic and hydro-meteorological stations all over Central Asia, and the integration of these networks into global systems.

- Application of remote sensing techniques for research activities – analysis of high- resolution space images, radar and interferometric data that extend the area covered by the monitoring networks for environmental and geological processes.
- Operation and update of a geo-data platform and open access information system for Central Asia.
- Consulting services for decision-makers and public communities.

One of the focuses of the monitoring activities is the extension and operation of the data collection system in a real-time mode with the purpose to establish rapid response and early warning systems for different disasters (earthquakes, landslides, hydro-meteorological). An important step in these activities will be the preparation of proposals on disaster risk reduction measures and population safety measures together with the governmental authorities and organizations in Central Asia. The Capacity Building Department of CAIAG will do this work for local communities and population.

All topics are of critical importance for:

- the estimation of the probability of occurrence of natural and anthropogenic disasters,
- the purpose of sustainable water supply in Kyrgyzstan and in adjacent regions (Uzbekistan, Kazakhstan and the Xinjiang province of China),
- the development of large scale technical projects in the region, like hydroelectric power station cascades, high voltage power lines, water storage reservoirs and railway and road systems.

The R&D Program for the years 20/22 is supplemented by a number of projects implemented under GFZ's Global Change Observatory in Central Asia or by larger projects under the aegis of the Development Banks (World Bank, Asian Development Bank and other Foundations).

CAIAG will implement the R&D scientific program following the Strategy of CAIAG adopted in 2012. The proposed program also takes into account the priorities and objectives of the newly adopted "Development Program of the Kyrgyz Republic for 2018-2022" and the "National Platform of the Kyrgyz Republic for Disaster Risk Reduction".

DEPARTMENT 1: GEODYNAMICS AND GEORISKS

TOPIC 1.1. STUDY OF LANDSLIDES OF KYRGYZSTAN

Responsible executor: Usupaev Sh.

Co-executors: Moldobekov B., Orunbaev S., Abdybachaev U., Konokov T., Rakhmatilla U. Zarylbek, Anarkulov B.

1.1.1. Topic short name

Landslides of Northern Kyrgyzstan

1.1.2. Relevance of the topic

Over the past period 2013-2018, the inventory of landslide-hazardous areas in the southern regions of Kyrgyzstan was completed. As a result, a catalog and a map on the distribution of landslide hazardous areas that jeopardize infrastructure, residential and industrial facilities as well as human activity, were compiled (Fig. 1). All these products were submitted to the Department of Monitoring of the MES of the Kyrgyz Republic.

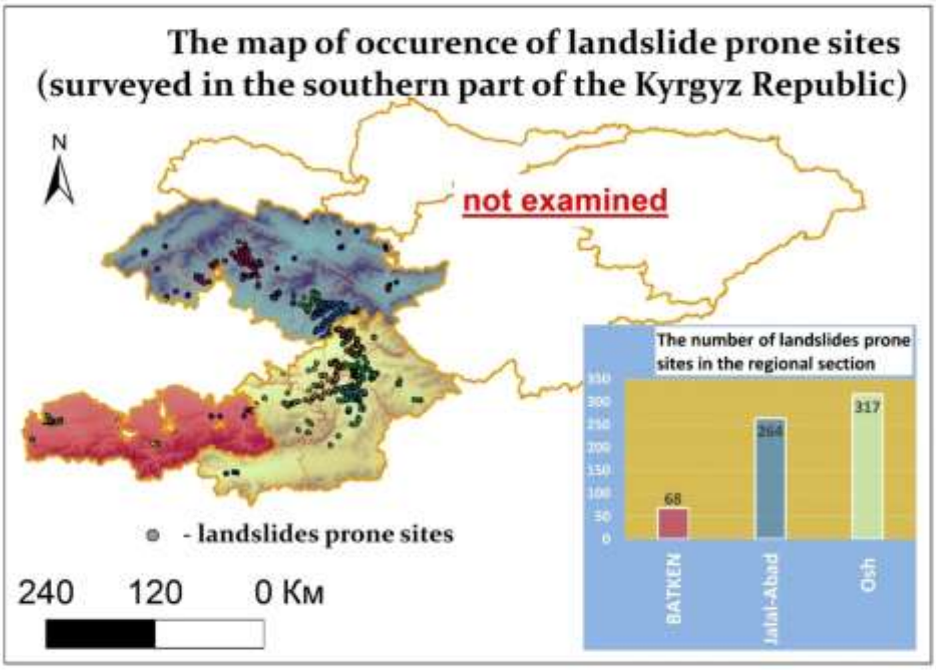

Fig. 1.1.1 Landslides distribution map

It is planned to continue the work for the northern regions of the country: Issyk-Kul, Naryn, Talas, and Chui oblasts during the forthcoming period 2020-2022.

Currently, in the northern part of the Republic, landslides are activated in the village of Min-Kush (December 1, 2018) and on the Bishkek-Naryn-Torugart road (Kyzyl-Bel landslide). A Summary on this landslide is reflected in the CAIAG’s R&D Program report for 2018.

Separately, it is planned to create a long-term monitoring system for the seasonal surface displacement dynamics on the Kyzyl-Bel landslide, with integration of an automated data collection and registration module to solve quantitative analysis problems applying statistical and mathematical methods.

Comprehensive step-by-step on-ground research with the use of remote sensing methods and data post-processing seems to be a demanded topic for surveying the territories, which will allow to fill the lack of free data and expert information.

1.1.3. Topic goals and objectives

The first goal of the topic based on the newly created catalog of landslide sites and on the results of decryption of satellite images for the northern part of the Kyrgyz Republic, is to compile a landslide map of potential susceptibility of the territory and to compile a map of the landslides spatial distribution.

The second goal is to investigate the seasonal dynamics of the slowly moving Kyzyl-Bel landslide with identification of causal relationship, where one of the tasks is to set-up a local multiparameter station with data logger (precipitation, temperature, ground moisture at different depths, hydrostatic water level sensors).

Methods to achieve goal 1:

(i) Field survey of sites using drone;
(ii) GPS measurement of control points (GCP);
(iii) Interviewing stakeholders;
(iv) Decrypting satellite scene images by direct features;
(v) Statistical and mathematical methods of data analysis;

Methods to achieve goal 2:

(vi) DInSAR (including open source software);
(vii) Geodetic measurements of control points with a tacheometer (GCP);;
(viii) Analyzis of a time series data of photogrammetric survey;
(ix) Geophysical exploration by vertical electrical sounding;
(x) Data correlation analysis;

1.1.4. Current status

Goal 1 – Decrypting of landslides based on optical images and collecting archive materials and publications is ongoing.

Goal 2 - In 2018, Turkish company STFA group drilled 7 holes of various depth and inclinometric measurements were taken (CAIAG R&DP report as of 2018)

1.1.5. Work plan and necessary resources

The duration of the project: 2020-2022

2020 (First half of the year)

- Field surveys of landslide-prone areas in Chui and Issyk-Kul regions with a drone.
- Purchasing sensors and date loggers for local multiparameter station.

2020 (Second half of the year)

- Installation of local monitoring system on the Kyzyl-Bel landslide. On-ground geodetic measurements of GCP and photogrammetric survey in September and/or October and their analysis. Geophysical measurements.
- Report on the results of 2020

2021

- Field surveys of landslide-prone areas in Naryn and Talas regions using drone. Ground geodetic measurements of GCP and photogrammetric surveys in April, July, October and their analysis. Repeated geophysical measurements.
- Report on the results of 2021, compiling catalog and map on landslide distribution for Northern Kyrgyzstan.

2022

- Ground geodetic measurements of GCP on the Kyzyl-Bel landslide body and photogrammetric survey in April and their analysis.
- Publication of scientific results.
- Report on the results of 2020-2022.

Required resources:

For goal 1:

- Transport – 2 pc.
- Drone - 1 pc (available since 2018);
- GPS receivers - 1-2 pc (available since 2013)

For goal 2:

- Tacheometer Leica TS09 - 1 pc. (available since 2013);
- Software Agisoft Photoscan & ArcGIS - 1 package (available since 2013);
- Ground Resistivity Meter *4point light 10W*-1pc. (available since 2018);

Manpower:

Dept. 1 – 252 man-month

Dept. 2 – 4 man-month

Dept. 3 – 1 man-month

Special resources required:

4000-4500 Euro - purchasing sensors for local Multiparameter station : precipitation gauge, atmospheric temperature sensors and ground moisture meter at different depths, hydrostatic water level sensor (OTT or equivalent), solar panel and battery, etc.;

1000-1500 Euros - purchasing geological maps of a scale of 1: 200,000 in the Russian Geological Research Institute named after A.P. Karpinsky.

1.1.6. Internal and external collaboration

During implementation of the theme (goal 2), internal collaboration with colleagues from the Department 2 “Climate, Water and Natural Resources” is planned for the purpose of evaluating the criteria for choosing data loggers/sensors, as well as solving problems of analyzing meteorological data. In cooperation with Department 3 “Monitoring and Data Management System”, it is expected to install the local monitoring system on the Kyzyl-Bel landslide.

External cooperation with GFZ, Potsdam (Section 1.4 Remote Sensing & Section 2.2 Geophysical Deep Sounding) on data exchange, advanced training of CAIAG young employees on data processing of DInSAR and Geoelectrical Tomography is also expected.

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TOPIC 1.2. STUDYING MODERN TECTONIC MOVEMENTS IN THE FAULT ZONES OF PAMIR-TIANSHAN JOINT

Responsible executor: Moldobekov B.

Executors: Zubovich A., Usupaev Sh., Orunbaev S., Abdybachaev U., Sharshebaev A., Mosienko O., Konokov T., Anarkulov B.

1.2.1. Topic short name

Study of modern movements and deformations in Pamir-Alai

1.2.2. Relevance of the topic

The geodynamic processes occurring at the junction of the Pamir and Tien Shan ranges (in the Pamir-Tien-Shan joint zone), especially the modern tectonic movements and associated seismic events, have always aroused great interest among scientists. At the same time, the overwhelming majority of studies were aimed at studying its depth structure, kinematics, and the dynamics of the tectonic processes taking place and associated earthquakes (Nikonov A.A., etc.). Separate works (A. Zubovich, etc.) were carried out by definition of geodynamic (geodetic) values in the region, such as mass movement and reduction of the earth's surface. But directly in the Pamir-Tien-Shan joint zone, modern tectonic movements, massive stress condition, fault activity and their connection with seismic events were insufficiently studied. Study of modern tectonic movements by geological, geophysical and geodetic methods makes it possible to determine the types of movements and their amplitudes, the zone of main displacement (slip plane) and rocks deformation, as well as its activity at the present time. Use of instrumental measurements (GPS, drone, geophysical equipment), remote sensing data and GIS technology are particularly relevant in the detailed studies of fault zones. The GPS monitoring conducted by CAIAG in this area showed good results [Zubovich etc., 2016]. Data from 4 stations of the Western Alai GPS profile found significant displacements of 6 mm/year on the southernmost 5 km sector of the profile (Fig. 1.2.1). Earthquakes in the region in 2015, 2016, and 2017 interrupted the smooth tectonic movement, changed the tectonic regime, and thus provided new information on the impact of seismic events on the Earth's crust.

According to our preliminary studies, at least two fault systems are well distinguished in the Trans-Alai foothills and the Alai depression — this is the right handed shear crossing the Altyn-Dara valley and the main thrust in the Trans-Alai Ridge. Also, these systems of faults are well expressed in the relief, in the form of benches and terraces, in some places there are collapse sink-holes and subsidence surfaces. All these processes occurring in these fault zones once again confirm its tectonic activity.

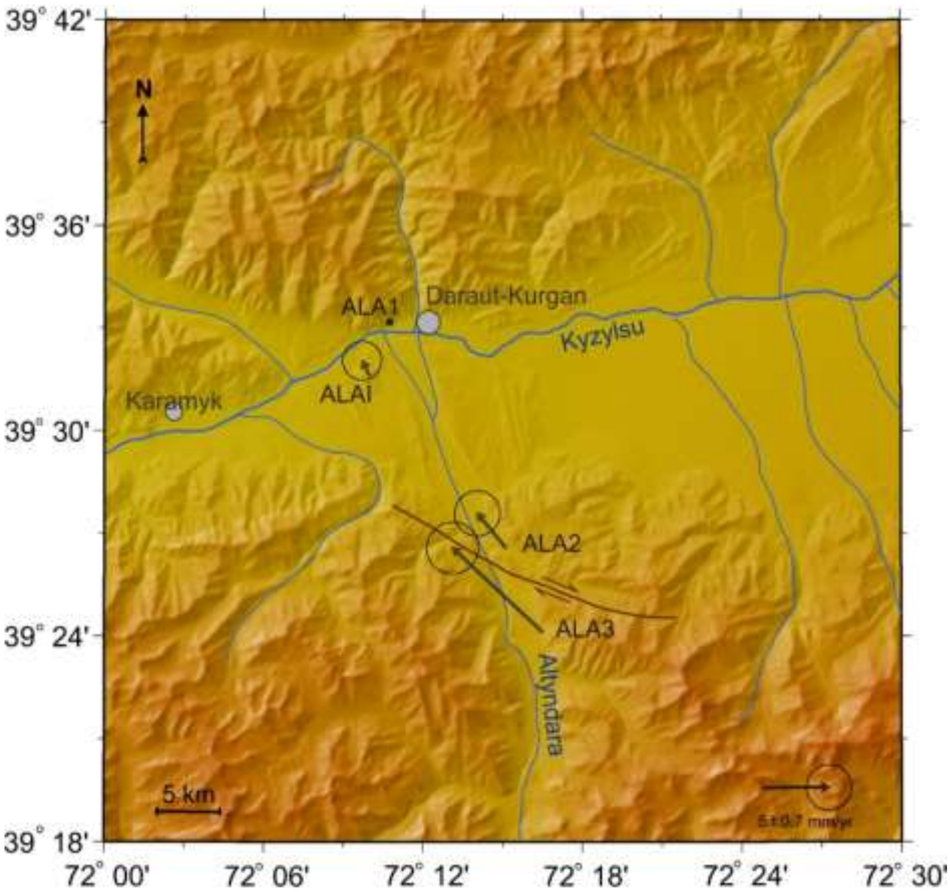

Fig. 1.2.1. Map of velocity vectors from three stations of the West Alai GPS relative to the fourth ALA1

1.2.3. Topic goal and objectives

The main issues remain and require clarification:

1. Determination of character and zone of deformation in the main thrust area;
2. Identification of active faults and determination of their zones;
3. Conduction of complex geological and geophysical studies in active fault zones;
4. Analysis and assessment of the geodynamic situation in the region.

The aim of the project is to study modern tectonic movements in the Pamirs-Tien Shan joint zone, their comparison with the movements over the past geological periods (Pleistocene and Holocene) and the identification of patterns of deformation processes in the fault zones.

The main research methods are field geological and geomorphological mapping, aerial photography of active fault zones with drone, GPS monitoring using permanent operating stations and calculating the rate of crustal shortening.

1.2.4. Current status

To date, separate areas of the active tectonic faults, located in the central (frontal thrust fault) and western (shear fault) parts of the Alay depression, are mapped. Based on the DEM model, the longitudinal profiles of tectonic faults were preliminarily outlined. During the field works in 2018, separate horizontal displacements along the surfaces were mapped in the shear fault zone. In 2019, aerial survey is planned using drone to identify the surface features of tectonic ledges and the manifestation of the latest structures in the relief.

To implement the project, no additional equipment is required. Only maintaining GPS stations in working condition is needed.

For profiling tectonic ledges, portable differential GPS receivers are required, and for performing geophysical works (VES and seismic profiling) in fault zones, additional geophysical equipment is needed.

1.2.5. Work plan and necessary resources

Duration of the project 2020 - 2022

2020

- Detailed engineering-geological mapping of active faults.
- Determination of places (profiles) for geological and geophysical works
- Morphological assessment of tectonic faults (benches) using GPS profiling

2021

- Conducting complex geophysical works (electrical, seismic, and magnetic exploration) on active faults to determine the geometry and zone of influence (rocks deformation).
- Processing and analysis of geophysical data, construction of engineering - geological layers.
- Collection and accumulation of data from GPS stations. Ongoing data processing and quality control. Calculation of the speeds of GPS network points displacements. Compiling time series.

2022

- Collection and accumulation of data from GPS stations. Ongoing data processing and quality control. Calculation of deformation rate in the GPS points of the network. Compilation of time series and their analysis.
- Comparison of the obtained data with geological and seismological data.
- Building a dynamic model of the Pamir-Tien Shan joint.
- Mapping of new structures and modern movements of the studied area (with explanatory note).
- Report, publication of the results.

Necessary resources:

- Transport - 2 pc;
- Drone - 1 pc (available since 2018);
- GPS receivers - 1-2 pc (available since 2013);

- Set of geophysical equipment (VES, seismic exploration and dip-needle work);
- Tacheometer TS09- 1 pc (available since 2013);
- Software Agisoft Photoscan & ArcGIS – 1 package (available since 2013);
- Soil resistivity meter *4point light 10W*-1 - 1 pc (available since 2018);

Requested resources:

Manpower:

Dept. 1 - 108 man-month
Dept. 2 – 4 man-month.

Field works:

Dept. 1 – 18 man-month.
Dept. 2 - 3 man-month

1.2.6. Internal and external collaboration

During the project implementation, external cooperation with colleagues from GFZ (Section 4.1 Lithosphere Dynamics, Dr.B. Schurr, deep tectonics studies and Section 2.2 Geophysical Deep Sounding, Dr. Ch. Haberland, active tectonics studies) is planned, as well as with the Institute of Geology and Seismology of the Academy of Sciences of the Republic of Tajikistan.

Internal cooperation: the project will be implemented together with the staff of the department 3.

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TOPIC 1.3: ASSESSMENT OF SEISMIC HAZARD AND RISK FOR THE TERRITORIES OF CITIES OF KYRGYZSTAN.

This topic consists of two interrelated sub-topics:

A. Study of soil using of V_s30 method on the example of cities of Kyrgyzstan.

B. Engineering – seismometric method of soil-structure interaction system vulnerability on Bishkek city.

A. Study of soil using V_s30 method on the example of cities of Kyrgyzstan.

Responsible executor: Usupaev Sh.

Executors: Orunbaev S., Moldobekov B. Jusupova K., Altynbek uulu T., Sharshebaev A., Rakhmatilla Uulu Z., Anarkulov B.

1.3.1. Topic short name

Soil study with V_s30 method

1.3.2. Relevance of the topic

The whole territory of Kyrgyzstan is located in an active zone and vulnerable to seismic hazard and risk. In this regard, seismic impact to buildings and engineering structures particularly relevant. The relevance is also due to the use of new technologies and methods, namely: a) measuring Vs30, which makes it possible to make "Typification maps" of the distribution of speed Vs30 to a depth of 30 meters for any sites; b) compilation of digital elevation models (DEM) with high resolution (1 arc-second ~ 30 meters), to adapt Vs30 to a specific location.

These methods are also applicable to the study of landslides, landslide-prone slopes and tectonic fault zones.

1.3.3. Topic goals and objectives

The main goal of this research is the seismic impact assessment to densely populated and urban areas, using Vs30 technique. For this purpose, it is necessary to determine area parameters, which may explain the changes in its amplification. As well, as take measurements of the seismic group Vs30. The following tasks will be tackled:

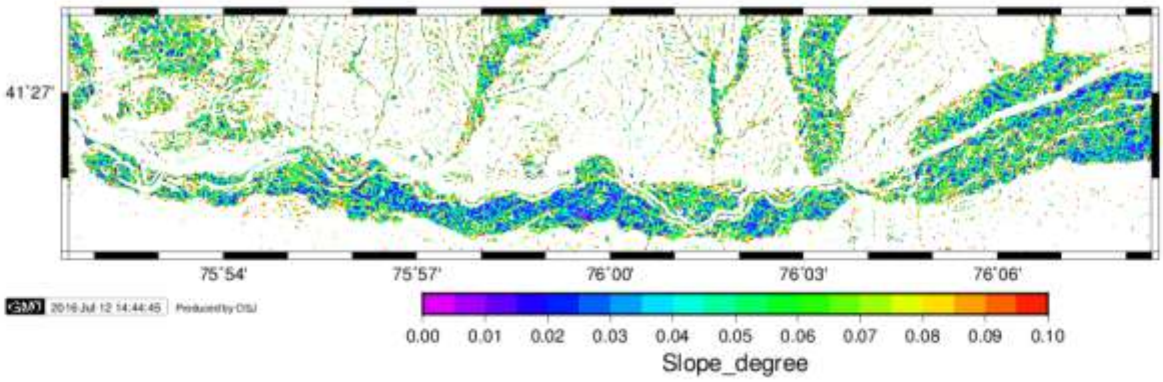
1. Collection, analysis and systematization of available data on the seismic and geological properties of the soil column.

2. Compilation of a Vs30 classification Map (the main parameter of Vs30 is the average speed of the upper 30-meter soil column) for the territory of densely populated cities of Kyrgyzstan.

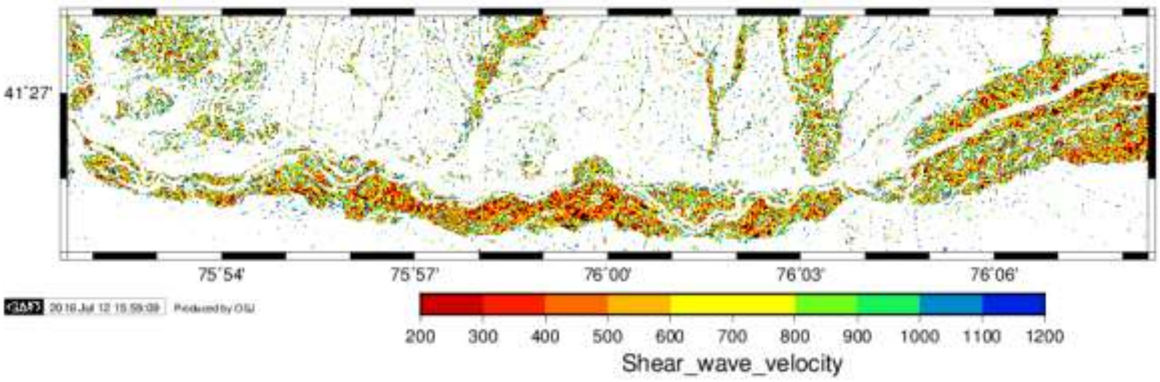
3. Soil classification by seismic properties in relation to the seismic codes of the most seismically active countries in the world.

1.3.4. Current status

Currently, a seismic micro zonation map was compiled for the cities of Bishkek, Karakol and Naryn, in the frame of the EMCA project. The spatial variability of site effects was estimated based on measurements of seismic events and noise, for a certain period of time (month, half year, year), using a seismic network. A pilot map of the distribution of Vs30 and topographic gradient was also developed, for the first time for the city of Naryn and its agglomeration (Kyrgyzstan) (Fig. 1.3.2 a and b).



a)



b)

Fig 1.3.1 a) Map of calculated topography slope by using Vs30 method b) Map of the distribution of shear wave velocity using slope as a proxy for Naryn city and its suburbs.

1.3.5. Work plan and necessary resources

2020-2021

- Conducting integrated remote and ground-based instrumental studies using seismic stations for compiling Vs30 classification maps for selected sections of major cities of Kyrgyzstan (Bishkek, Naryn, Osh);
- Processing and analysis of the data

2022

- Compilation of the Vs30 classification map with an explanatory note;
- Preparation of a final report.

- Publication of results

Required resources:

- Transport – 1 pc;
- Seismic stations – 8 stations;
- Batteries for the stations – 60 pc.
  - Involvement of specialists in the field of geophysics and seismology - 2 people.

Manpower for Task A:

№	Definition of activities	2020	2021	2022
1	Development and data processing	16 man-month	16 man-month	16 man-month
2	Field work	8 man-month	8 man-month	8 man-month

1.3.6. Internal and external collaboration

During the project implementation period, external cooperation with partners from GFZ (sections 2.4 and 2.6) is planned to improve the established monitoring system and further analysis and risk assessment.

Internal collaboration: the project will implemented jointly with employees of Department 3.

B. Engineering seismometric method of monitoring the vulnerability of the soil-structure system on the example of the city of Bishkek

Responsible executor: Usupaev Sh.

Executors : Orunbaev S., Zhusupova K., Altynbek uulu T., Sharshebaev A., Zhaparkulova A., Rakhmatilla Uulu Z., Anarkulov B , + involved specialist .

1.4.1. Short topic name

Monitoring the vulnerability of the soil-structure system

1.4.2. Relevance of the topic

Engineering-seismometric method of monitoring the vulnerability of soil-structure system, using accelerometers in the wells to a depth of 50 to 150 m and in buildings of up to 11 floors, will provide full-scale data of fluctuations (shakings) in the soil and buildings, during natural earthquakes. Processed data will allow to receive curves of dependencies of soil-structure for assessment of vulnerability and building resistance to earthquakes. With the intensive development and urbanization of large cities, the obtained dependence' curves are very necessary and relevant when designing and constructing high-rise buildings and engineering structures in the highly seismic zones of the Central Asian Mountainous Countries.

Obtained quantitative data on the nature of the ground motion during strong earthquakes, allow the use of anti-seismic measures that guarantee the stability of buildings and structures, as well as reduce the seismic risk and increase the safety of the population living in houses with different seismic resistance and vulnerability to earthquakes.

1.4.3. Goals and objectives.

The goal of the project is: to study the dependencies of soil-structure system during natural seismic events.

The interaction of soils - structures (building structure) can be defined as a process in which the reaction of the soil during earthquakes affects the movement (shaking) of the building structure, and the movement of the building affects the reaction of soils. This determines the dynamic effect of the soil-structure system during an earthquake.

To study the interaction of the soil-structure system, it is necessary to solve the following tasks:

1. Integrate networks of monitoring SOSEWIN with engineering-seismometric method of evaluation of vulnerabilities of soil-structure system placed in wells in the buildings of MES ;

2. Collection, processing and analysis of data obtained;

3. Identification of patterns of distribution of seismic fluctuations in complex engineering and geological conditions, including a graph of the equation for predicting the movement of soil (GMPE).

4. Based on the data obtained, the construction of the curves of the dependencies of the soil-structure to assess the stability of building structures;

5. Assessment of the vulnerability of buildings at the experimental site during significant earthquakes in order to take measures to mitigate seismic risk;

As a result, it is expected to get a retrospective and modern picture of the interaction of the soil-structure system during tangible earthquakes at the experimental test site, the obtained curves of dependencies of soil-structure can be used in the design and calculation of the structural stability of the building.

1.4.4. Current state

Since 2013, CAIAG together with GFZ began to create a seismic monitoring network (SOSEWIN) of buildings in Bishkek (Fig. 1.4.1). 9 different types, designs and number of storeys of buildings were chosen, where accelerometers were installed at different levels and floors. Also the well with a depth of 150 m was drilled in the backyard of CAIAG , where 11 seismic sensors (accelerometers) were installed at different depths (0-15-30-45-60-75-90-105-120-135-150m.) Data from the SOSEWIN monitoring network are being sent in real time mode to the CAIAG server, for subsequent processing and analysis.

Figure 1.3.7.1. Seismic network SOSEWIN

Later, partners from GFZ proposed a project to built a monitoring system for **dynamic effects** of soil-structure interaction for identifying the fluctuations (shakings) of ground and buildings during earthquakes. The test site was chosen on the territory of the Ministry of Emergency Situations consisting of 3 buildings, in Bishkek, Cholpon-Atinskaya str.1A, where 4 wells were drilled with a depth of 50 m. in these 4 wells, 16 accelerometers were installed at different depths (0-15-30-50) and in three buildings 15 accelerometers were installed on different floors to record the vibrations of buildings (Fig. 1.3.3. and 1.3.4).

Fig. 1.4.2. Monitoring test site consisting of wells (red circles) and buildings (orange rectangles)

Fig 1.4.3. Installation diagram of a network of accelerometers in wells (red cylinders) and buildings (green).

By the beginning of 2019, all installation works to ensure electricity supply and Internet communication were completed. Currently, the created system is working in test mode and sensors are being verified and the data incoming to the CAIAG server is processed in real time mode.

In order to analyze and evaluate the soil-structure interaction during strong earthquakes and mitigate their consequences, it is planned to invite one specialist civil engineer to the CAIAG in the field of assessing the vulnerability of buildings and structures (earthquake-resistant construction and design). In addition, negotiations are taking place with Kyrgyz Scientific Research Institute of Seismic Construction and Design (KSRISCD) on cooperation in the use of data from the established network of soil-structure observations for the design of sustainable buildings and structures.

1.4.5. Work plan and necessary resources

Project Duration **2020-2022**

2020

- Carrying out geophysical measurements of the ground-soil structure in Bishkek (downhole accelerometric monitoring, registration of earthquakes in wells and buildings), determining the relationship of soils and buildings ;
-
- Preparation of the annual report.
- Publication of the results.

2021

- Analysis and interpretation of data with the compilation of digitized dynamic classification of soils and buildings;
- • Preparation of a final report with GIS maps.
- • Publication of the results.

2022

- Conducting distance and instrumental studies on a phased basis with the compilation of classification cards Vs 30 for cities of Kyrgyzstan, assessing seismic risk and compiling a classification map for the interaction of soils and buildings .
- Publication of the results.

<u>Required Resources:</u>

- Transport - 1 unit;
- Cube and 4.5 Hz sensor seismometer - 8 stations;
- Batteries for the station -60 units
- Specialist in the field of geophysics and seismology;
- A civil engineer - designer and / or specialist in the field of earthquake-resistant civil engineering construction will be involved.

<u>Labor costs for task B:</u>

No.	Definition of activities	2020	2021	2022
1	Data Development and Processing	16 people / month	16 people / month	12 people / month

2	Field works Department 1 – 5 man a month Department 3 - 5 man/month	10 man/ month	10 man/ month	10 man/ month

1.4.6. Internal and external cooperation

During the project implementation period, external cooperation is planned with colleagues from GFZ (sections 2.4 and 2.6) to improve the existing monitoring system and continue to analyze and assess risks. It is also planned to involve specialists from Kyrgyz Scientific Research Institute of Seismic Construction and Design (KSRISCD) and International University of Innovative Technologies (IUIT).

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DEPARTMENT 2: CLIMATE, WATER AND GLACIERS

Head of topic: Usubaliev R.

TOPIC 2.1. STUDY OF REFERENCE GLACIERS OF KYRGYZSTAN TO DETERMINE THEIR MASS BALANCE, MORPHOLOGICAL AND DYNAMIC CHARACTERISTICS, ICE RUNOFF AND THEIR CLIMATIC CONDITIONS

Responsible executor: Usubaliev R.

Executors: Mandychev A., Osmonov A., Azisov E., Kenjebaev R., Esenaman uulu M. and Daiyrov M.

2.1.1. Topic short name

Study of reference glaciers of Kyrgyzstan (Fig. 2.1.1.).

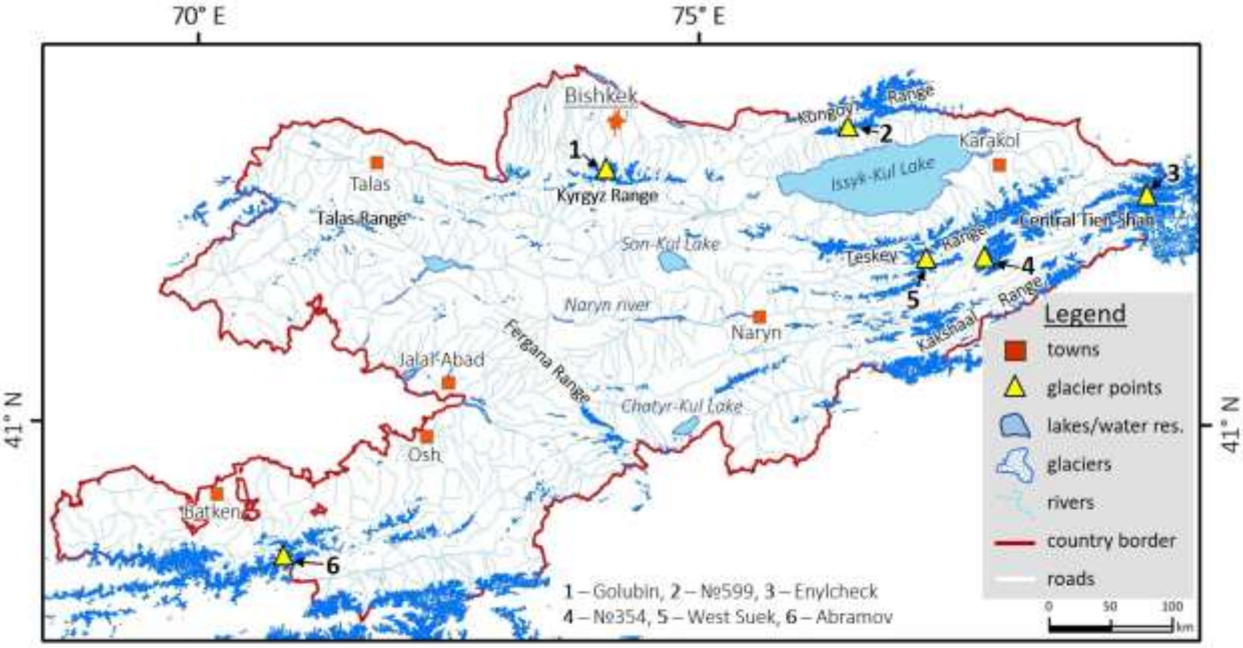

Fig. 2.1.1. Representative glaciers of Kyrgyzstan

2.1.2. Relevance of the topic

Glaciers represent a significant part of the water resources of Kyrgyzstan; at present, the water reserves are estimated at about 495 km^3. In recent decades, due to the climate warming, the negative mass balance prevails in the glaciers, they reduce in area and volume, and the water reserves concentrated in the glaciers, reduce correspondingly. In order to forecast glaciers' influence on water resources in Central Asia, it is necessary to study their trends of nature and speed of change rate. This task is resolved in the framework of this project by studying in detail the reference glaciers of Kyrgyzstan, as well as in the process of their inventory and clarification by space images.

2.1.3. Topic goal and objectives

The goal of the project: to determine the extent, trend and dynamics of changes in the glacier component of water resources of Kyrgyzstan under the influence of climate change to forecast changes in river runoff, water content in reservoirs, as well as to assess development of hazardous processes in the form of glacial lakes outbursts and related with them mudflows.

Methods:

- Decryption of remote sensing data (optical multispectral, hyperspectral and radar).
- Geodetic measurements and GPS based monitoring: high-precision point measurements, high-precision topographic measurements with an electronic tacheometer.
- Field measurements of glaciological parameters: ablation and accumulation, ice temperature and ice movement speed rate by monitoring displacement of ablation rods and reference points with GPS and electronic tacheometer.
- Determination of glacier structure, its thickness, ice physical-mechanical parameters with a georadar or with a portable digital fine-focus broadband seismic station.
- Measurement of glacier’s albedometry.
- GIS-based spatial-time modeling.

In outcome, it is expected to get a retrospective and modern picture of changes in the area, ice thickness and structure of the above mentioned glaciers and glacial systems; calculate mass balance and glacier runoff.

2.1.4. Current status

Modern monitoring of the mass balance of the representative glaciers of Kyrgyzstan is being conducted since 2011/12. In 1990s, the observations were completely stopped due to financial difficulties. From a scientific point of view and practical importance, to obtain sufficient objective and reliable data, at least 10 years of monitoring and determining the mass balance of the glacier is required. In the past, the character of glaciation, glacier regime and glacier runoff were studied quite well, and in 2018 the inventory of glaciers of Kyrgyzstan was carried out. However, in connection with the ongoing climate changes, it is also necessary to make adjustments, obtain new data and results using modern techniques and approaches.

2.1.5. Work plan and required resources

The project duration: 2020–2022.

2020

- Analysis of remote sensing data, actual material on glaciological, climatic, hydrological conditions and parameters in the areas of the Abramov, Golubin, Western Suyek, № 354, № 599, Enilchek glaciers and others applying climatic indicators.
- Field work on glaciers. Ablation, accumulation and topographic and geodetic (GPS) measurements, geophysical sounding of the glacier.
- Processing and analysis of the obtained data and development of a multifactor model of the interrelation of climatic and glaciological elements in the glacier system. Determination of the glacial components in the water balance and glaciers mass balance, development of GIS models of glaciers.

2021

- Field glaciological, geophysical research continue collection and analysis of remote sensing data and of GPS parameters.
- Analysis of the obtained data and development of a multi-factor model on the interrelation of climatic and glaciological elements in the glacier system.
- Determination of the components of glacial water and mass balance, development of GIS models of the glaciers.

2022

- Continue collection and analysis of remote sensing data. Fieldwork on the glaciers. Taking ablation, accumulation, topographic and geodetic (GPS) measurements, geophysical sounding of the glacier.
- Processing and analysis of the collected data and development of a multi-factor model on the interrelation of climatic and glaciological elements in the glacier system.
- Determining glacial components in water and mass balance, development of GIS models of glaciers.

Required resources:

Main works – 220 man-month
Field works – 360 man-month

2.1.6. Internal and external collaboration

The project will be implemented in collaboration with the CAIAG #3 Department, as well as in close cooperation with the researchers from GFZ, University of Fribourg and Zurich University (Switzerland). The project will involve specialists and researchers of the Directorate General of Hydrometeorology at the Ministry of Emergency Situations of the Kyrgyz Republic, the Kyrgyz National University, the Department of Geography of the Institute of Geology, the Institute of Water Problems and Hydropower of the National Academy of Sciences of the Kyrgyz Republic (NAS KR), etc.

Additional potential participants:

- Humboldt University, Berlin;
- University of Idaho, USA;
- Moscow State University named after M.V. Lomonosov;
- Institute of Geography of RAS;
- Institute of Geography of the Republic of Kazakhstan;
- Institute of Water Problems and Hydropower of the Republic of Tajikistan;
- Tajikhydromet (Tajikistan);
- UzHydromet (Uzbekistan);

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TOPIC 2.2. STUDY OF HYDROLOGICAL OBJECTS AND PROCESSES IN THE TERRITORY OF NORTHERN KYRGYZSTAN UNDER CLIMATIC INFLUENCE

Responsible executor: Mandychev A.

Executors: Kalashnikova O., Podrezova Y., Usubaliev R., Daiyrov M., Shaidyldaeva N., Omurova G. and Esenaman uulu M.

2.2.1. Topic short name

Study of hydrological objects of Northern Kyrgyzstan (Fig. 2.2.1.1.).

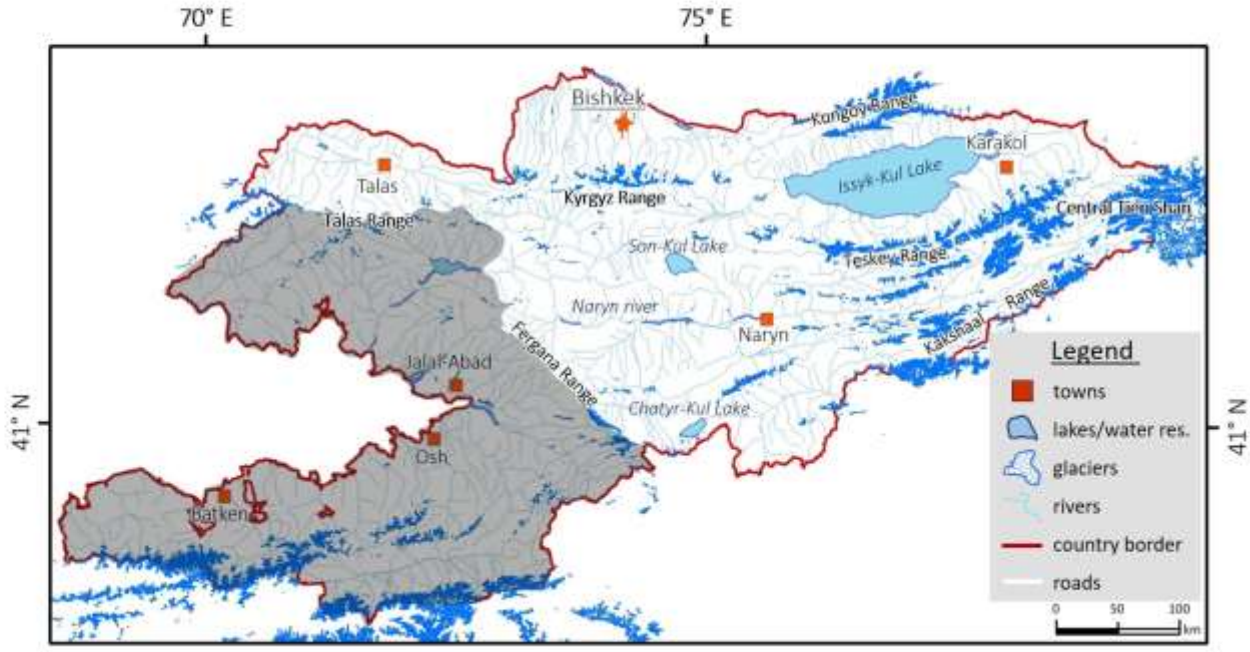

Fig. 2.2.1.1. Hydrographic objects of Northern Kyrgyzstan (white)

2.2.2. Relevance of the topic

Northern Kyrgyzstan is notable for the diversity of its natural landscapes — mountain ridges with their glaciers and high-mountain valleys, unique lakes, including high-mountain lakes and river basins with mudflow phenomena, mountain forests and semi-desert areas. A variety of physiographic and climatic conditions, numerous rivers, lakes of different sizes and groundwater with thermal-mineral waters led to development of the appropriate socio-economic sectors, various economic and communication facilities in the regions of Northern Kyrgyzstan. In this regard, there is a need for a comprehensive study of hydrological, glaciological, limnological, hydrogeological processes under climatic influence using remote sensing data and field research in order to solve various environmental problems in Northern Kyrgyzstan. The results of these studies will clarify the main causes of changes in the natural system of Northern Kyrgyzstan under the influence of anthropogenic factors and global climate change as well. They will serve as a basis for forecasting trends of these changes and developing recommendations for the rational use of natural resources of Northern Kyrgyzstan with minimal environmental damage, taking into account the sustainable socio-economic development of local communities protected from the risks of natural disasters by monitoring natural processes.

2.2.3. Topic goals and objectives

The aim of the topic is a comprehensive study of hydrological, limnological, hydrogeological processes using remote sensing data and field research to solve environmental problems in Northern Kyrgyzstan associated with dangerous anthropogenic and natural processes, changes in water resources under influence of climate changes, as well as amplifying processes of water pollution.

Tasks:

- Analysis of remote sensing data from multispectral images “Landsat 8”, “Sentinel 2” and radar satellite images “Sentinel 1A”, using data from special satellites Terra, Aqua (MODIS), Envisat, Jason 2, (altimetry, temperature, precipitation) and etc.

- Field topographic (GPS), hydrometric “Acoustic Digital Current Meter” (Ott ADC) (available), limnological and meteorological measurements. Groundwater sampling and laboratory analysis to determine the content of petroleum products.
- Analysis of the main parameters of climatic, paleoclimatic changes and the content of chemical elements in water, time series of precipitation and air temperature, level of lakes and groundwater, as well as the temperature of water and pollutants of waterbodies.
- Analysis of the spatial distribution and changes within time of the parameters based on GIS, hydrological modeling of rivers and waterbodies.

In outcome, it is expected to get a description of changes in the main hydrological, limnological, hydrogeological and climatic parameters in the territory of Northern Kyrgyzstan, taking into account modern data and paleodata, to assess their connection with changes in lake and groundwater levels, total river and glacial runoff, as well as to evaluate the ecological conditions of water and soil pollution at selected sites and to develop recommendations to reduce the risk of pollution.

2.2.4. Current status

Currently CAIAG is involved in a number of projects dealing with the topic: “Water in Central Asia” (CAWa), “Adaptation to climate change based on the ecosystem approach in the high mountain areas of Central Asia” and “Changes in annual runoff of the rivers of the Issyk-Kul basin over a long-term period”. Monitoring and assessment of mountain outburst lakes on the ridges of northern Kyrgyzstan and monitoring changes in the lakes’ level are ongoing and in the frame of the project ACROS-2 together with CAIAG colleagues from Department 3; on altimetry of water level in the Issyk-Kul Lake – with researchers from GFZ and France.

2.2.5. Work plan and necessary resources

Duration of the project: 2020-2022

2020

- Collection and analysis of remote sensing data, actual material on limnological, hydrometric, hydrogeological, climatic and paleoclimatic parameters across the territory of Northern Kyrgyzstan in the basins of the rivers of Chui and Talas valleys.
- Field studies of hydrological objects, including the coastal zone of the Issyk-Kul Lake, continued sampling of groundwater at one site of oil pollution.
- Analysis of the material obtained using various data processing methods, analysis of climatic changes and associated limnological, hydrological, hydrogeological and glaciological changes and determination of the anthropogenic burden on hydrological objects and areas of Northern Kyrgyzstan.

2021

- Continuation of fieldwork on measuring the complex of new hydrometric, environmental and GPS parameters in the basins of the rivers of Chui and Talas valleys**.**
- Obtaining new actual material by decrypting space images and comparing the results of decryption as of different time periods.

- Comparison and analysis of the obtained data in order to assess and clarify the characteristics and extent of changes in natural systems and environmental situations in the regions of Northern Kyrgyzstan in the basins of the rivers of Chui and Talas valleys and the Issyk-Kul Lake basin.

2022

- Study of the climate change influence and an increase in the anthropogenic burden on the ecological situation in the regions of Northern Kyrgyzstan.
- Development of an integrated model on the interaction of the hydrological, limnological, hydrogeological, glaciological and climatic systems in the basins of the rivers of Chui and Talas valleys and the Issyk-Kul Lake basin, compilation of digital maps in the GIS.
- Monitoring the level of Lake Issyk-Kul and others. Geodetic ground survey: geodetic measurements of the level of GPS lakes Topcon GB-1000 or electronic total station (available), as well as rivers using Ott Orpheus Mini sensors (available).
- Equipment for dendrochronological study (available).

Required human resources

- Main works - 248 man-month
- Field works - 240 man-days

2.2.6. Internal and external collaboration

The Topic is supposed to be implemented in collaboration with the CAIAG Departments 1 and 3, as well as in close cooperation with GFZ researchers (Sections 5.2 and 5.4). The Topic will involve specialists and researchers of the Directorate General of Hydrometeorology at the Ministry of Emergency Situations of the Kyrgyz Republic, The Agency for Environmental Protection and Forestry of the Kyrgyz Republic, the Kyrgyz Complex Hydrogeological Expedition of the Engineering and Geological Party of the Committee of Industry, Energy and Subsoil Use of the Kyrgyz Republic, the Kyrgyz National University (KNU), the Kyrgyz-Russian (Slavic) University (KRSU), the relevant major institutes of the National Academy of Sciences of the Kyrgyz Republic - Department of Geography of the Institute of Geology, Institute of Water Problems and Hydro Power, as well as other interested universities and research organizations of the Kyrgyz Republic and Central Asian countries.

Additional potential participants:

- Humboldt University, Berlin;
- Niigata University, Japan;
- Moscow State University named after Lomonosov;
- Siberian Federal University in Krasnoyarsk, Russian Federation;
- Institute of Geography of the Republic of Kazakhstan;
- Institute of Water Problems and Hydropower of the Republic of Tajikistan;
- Tajikhydromet, Tajikistan;
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DEPARTMENT 3: MONITORING SYSTEMS and DATA MANAGEMENT

Head of department: Zubovich A.V.

TOPIC 3.1. DEVELOPMENT AND OPERATION of the MONITORING SYSTEM OF CAIAG

Responsible executor: Sharshebaev A.K.

Executors: Shakirov A.E., Borisov M.N., Altynbek uulu T., Okoev J.

3.1.1. Topic short name

The monitoring system development of CAIAG.

3.1.2. Relevance of the topic

Every year the CAIAG monitoring network is expanding, new projects appear, and as a result of their implementation new stations are commissioned, and the importance of network support increases. Existing stations require constant maintenance and development. For example, replacing energy-saving VSAT modems can significantly save electricity at the stations and thereby increase their reliability. New stations with new technology must be integrated into the existing monitoring system so that an uninterruptible data flow to the institute's data collection and processing center is guaranteed.

3.1.3. Topic goals and objectives

- Improvement of existing stations by means of data transmission and collection (hardware or software updates).
- Integration of new stations into the monitoring system of CAIAG.
- Technical maintenance of stations (planned and unplanned).

3.1.4. Current status

The monitoring system includes:

The monitoring network consists of stations of various purpose and configuration. A common feature for all stations is to provide them with autonomous control systems, power supply and data transmission. The sensor set integrated in one station differs according to the station purpose and conditions of installation.

Nowadays the CAIAG monitoring system includes 71 stations:

Station	**Number of stations**	**Station**	**Number of stations**
ROMPS (Remote-controlled multi-parameter stations)	14	Subtidal/ Tidegauge	4

Метео	7	SPA (Snow Pack (cover) analyzer)	5
GPS	30	Photo cameras	6
Seismograph	14	Water consumption	3
Strong motion accelerometer	33		

Subsystem of data transmission depends on conditions of station location. In populated areas this is either a GSM connection or the Internet. In remote areas a VSAT satellite system (with a backup Iridium or GSM communication system) is used, or radio communication for stations located in direct visibility from other stations equipped with VSAT.

Subsystem of transmission and information processing of CAIAG is supported by modern equipment consisting of a set of servers, data storage arrays and a software complex that performs equipment control, data collection, processing and storage.

The station network is shown in figure 3.1

3.1.5. Work plan and necessary resources

№	Definition of activities	2020	2021	2022
1	Development and maintenance of monitoring system	48 man-month	48 man-month	48 man-month
2	Field work	360 man-month	360 man-month	360 man-month

3.1.6. Internal and external collaboration

The project implemented by employees of department 3 in close cooperation with the specialists from GFZ, section 1.2 and 7.1. In certain cases employees from 1st, 2nd and 4th departments of CAIAG may participate. Also the cooperation with specialists from various organizations of Kyrgyzstan, countries of Central Asia, European, Asian and American scientists will continue.

Figure 3.1.1 Layout of CAIAG monitoring stations

TOPIC 3.2. DEVELOPMENT AND SUPPORT OF CAIAG's INFORMATION SYSTEMS and DATABASES

Responsible executors: Jantaev M.M., Barkalov S**.**

Executors: Mandychev D.A., Imanalieva P., Ismailov M.

3.2.1. Topic short name:

The development and support of database and information system.

The goal of the project is the development and support of information systems and CAIAG database. In general, CAIAG adheres to the Open Access Policy to Scientific Data.

3.2.2. Relevance of the topic

Data and info products represent an important value of the institute's research activities. Therefore data and information management plays an increasing important role for research and the outcome of CAIAG. The institute operates and develops data infrastructures for a broad range of users: internal CAIAG users, users from Central Asian countries and institutions, international users and state bodies of Kyrgyzstan (i.e. the Ministry for Emergency Situations, Kyrgyz Hydromet). All data infrastructures of CAIAG are operated on the basis of an Open Access Policy

3.2.3. Topic goals and objectives

The goal is to continue the development and support of information systems and databases developed by CAIAG. Considerable time will be devoted to it's wide usage within the institute and beyond. For this purpose, various types of trainings and reference information are offered. Only Open Source products will be used as a software.

All information systems developed in CAIAG and dealing with geospatial data should be based on OGC standards and be capable of direct integration into the National Spatial Data

Infrastructure of Kyrgyzstan, as well as the “Tunduk” inter-agency data exchange system. The access policy will be open if this does not contradict the requirements of the projects and the data producers.

3.2.4. Current status

The **Data platform is** based on the Open Source and GeoNode programs, which are continuously developed and have good perspectives. It is requested that the spatial data available in CAIAG or taken by projects should be available in this Platform in accordance with the access policy of the Institute.

The **Sensor Data Storage System (SDSS)** stores data received from sensors and stations monitoring. The system was developed in CAIAG within the project CAWa. It allows to enter, edit and store sensory data in a database, to enter, edit, store and view metadata, to build time series in graphical form and to output data in tabular form in Excel format, and in unlimited multilingual. The SDSS can also store processed data, for example, satellite altimetry information automatically loaded into SDSS on water levels in Central Asian reservoirs.

CAIAG operates two **Seismic databases:**

- The database in SeisComp 3 used for standard seismological navigations and as CAIAGs earthquake catalogue.
- Data of strong movements created by the Institute of National Geophysics and Volcanology (INGV), Italy, was established within the project ACROSS. The database consist of data for the territory of Central Asia, received from CAIAG stations net.

The **GPS servers database** for storing GPS data obtained from stations of CAIAG observations and external world sources. The system allows organizing the automatic accumulation and processing of GPS data and monitoring of incoming information. During the project, a web-based software interface will be developed to control data receipt and processing, as well as display the results.

CAIAG hosts **Informational systems of state public authorities of Kyrgyzstan** and support of the Information System on the Safety of Schools and Pre-School Organizations, the National Database on Protected Areas, Biodiversity and Wild Animals.

3.2.5. Work plan and necessary resources

The work plan:

Besides the operation and development of the data infrastructure the Institute needs support in information and computing hardware and software. These are servers and storage for serving network and administrative tasks, storage and exchange of user files, hosting a database, data collection systems from monitoring stations, routine tasks for processing large volumes of information in automatic mode, FTP, Web sites and others.

№	Title of work	Resources	2020	2021	2022
1	Development and support of the Data Platform	24 man-month	+	+	+
2	SDSS development and support	20 man-month	+	+	+
3	Support and development of seismological databases	24 man-month	+	+	+

4	GPS Database Development and Support	14 man-month	+	+	+
5	Information Systems of Kyrgyz state authorities	3 man-month	+	+	+
6	Planning, design, analysis of work, implementation and administration of server components of the IT infrastructure.	14 man-month	+	+	+
7	Planning, implementation, administration of user systems and maintenance of office equipment	12 man-month	+	+	+

3.2.6. Internal and external collaboration

The work is carried out by specialist of department 3 in close cooperation with GFZ (section 1.2 and 7.1). In certain cases employees from departments 1, 2 or 4 from CAIAG may be engaged. Also the cooperation with various organizations of Kyrgyzstan and other countries of central Asia, with European, Asian and American scientists will continue.

DEPARTMENT 4: CAPACITY BUILDING AND SCIENTIFIC COOPERATION

Topic 4.1. International Cooperation, Capacity Building and Scientific bibliographic work.

Responsible executor: Zhaparkulova Ch.Sh.

Executors: Mambetaliev E.D., Momunbekov B.C., Surapova K.U., Omuralieva L.N., Orozmambetova A.O.

4.1.1. Topic short name

Capacity Building.

4.1.2. Relevance of the topic

The relevance of the topic is reflected in the development of international and national relations. The implementation of international activities of the institute in the scientific and academic fields, including the framework of the development program of CAIAG. Collection, systematization and analysis of information on the participation of departments in international activities, participation in the development of joint educational programs and projects together with international partners, conduction of training and seminars, summer schools and assistance in the search and implementation of staff development programs (studies, internships, courses).

4.1.3. Topic goals and objectives

The main goal of the topic is to strengthen and develop cooperation with international and local organizations. We want to form and strengthen a decent image of CAIAG, and actively develop the international cooperation of CAIAG. In addition we will organize and conduct scientific and representative events.

Project objectives are:

(I) Maintenance and development of cooperation between CAIAG and international and national organizations within the framework of the implementation of scientific projects and via CAIAG membership in international organizations.

(II) Interaction with state bodies of the Kyrgyz Republic on issues of international cooperation of CAIAG.

(III) Organization of work in the framework of multilateral memorandums of understanding and contracts;

(IV) Building-up and maintaining a database of international treaties and agreements important for the international cooperation of CAIAG.

(V) Organization of trainings and seminars, all kinds of support for national and international partners in organizing meetings and joint projects.

(VI) Support in preparing project applications (e.g. EU) and participation of CAIAG in tenders (e.g. World Bank, Asian Development Bank)

4.1.4. Work plan and special required resources

Currently, following main areas are realized:

(I) Fundraising (basic listing, etc.)

I. Organization of multilateral relations in the field of scientific cooperation and education;
II. Providing links to national and international funds;
III. Assistance in planning and organizing training courses and scientific conferences with foreign partners for specialists from Central Asian countries in the field of applied earth sciences.
IV. Search for sources of funding and research projects. Writing project proposals and preparing tender documents;
V. Assistance in organizing and conducting educational and PR activities among the population, employees of government bodies and local governments in the field of preventing the consequences of man-made, natural and environmental disasters.

Labor inputs:

In this direction - 72 man-month.

Special required resources:

Upgrade computers.

(II) International and scientific cooperation (basic enumeration, etc.)

I. Promoting and conducting training workshops, and providing relevant advice on the implementation of the task;
II. Interaction with the media, preparation of PR-materials- articles, press releases, presentations, news reports on the activities of the Institute on the website, constant monitoring of news on social networks on the Internet, everything that relates directly or indirectly to CAIAG;
III. Coordinating the work of local partners in holding and participating in regional conferences and seminars;
IV. Constant assistance to employees in advanced training, internships, etc.

Labor inputs:

In this direction: 72 man-month

Special required resources:

Upgrade computers.

(III) Scientific and educational program of CAIAG (basic listing, etc.)

I. Development of scientific - educational program - masters;
II. Studying international standards of masters programs;
III. Development of regulatory and legal issues on the scientific and educational program;
IV. Permanent work with universities in Central Asia and Kyrgyzstan in the field of scientific and educational programs.

Labor inputs:

The need is that work has begun and is implemented in this area. According to the shortage of specialists and a large amount of work.

In this direction, planned needs– 72 men/month

Special required resources:

Providing workplace and computer

(IV) Scientific bibliographic work (basic enumeration, etc.)

I. At present, the formation of an electronic collection based on the scanning of a book fund with the subsequent saving in PDF format is implemented.
II. Introduce RFID system components and create an electronic catalog of the book fund and archive.
III. Selection of RFID system (frequency, range, tags, readers, software, etc.) by selected criteria;
IV. Conducting work on the information support of the library website and its updating.

Required resources:

Labor inputs:

Department 4 – 108 man a month
Department 3 – 24 man a month (part-time employment)

Special required resources:

Book scanner – 5000 US dollars
Metallic bookstand – 1000 US dollars
Boxes for documents – 300 US dollars
The remaining funds will identified after selecting RFID tags and necessary system components.

4.1.5. Internal and external collaboration

Internal collaboration is the close collaboration with all departments of CAIAG on capacity building and scientific cooperation, in development of project proposals and master's program.

External collaboration is the most essential component of this project. Within the framework of this project, it is planned to deepen and expand cooperation with the main partner of both GFZ (Potsdam, Germany) and other international and national organizations and institutions.

Due to effective capacity building, we also cooperate with the following partners: Foreign Ministry of the Federal Republic of Germany, Center for International Development and Environmental Research at Justus Liebig University of Giessen (ZEU), Julius Maximilian University of Wurzburg, Scientific-Information Center of the Interstate Coordination Water Commission (SIC ICWC) Uzbekistan, Tashkent. And many other partners are available on our website.

4.1.6. References

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