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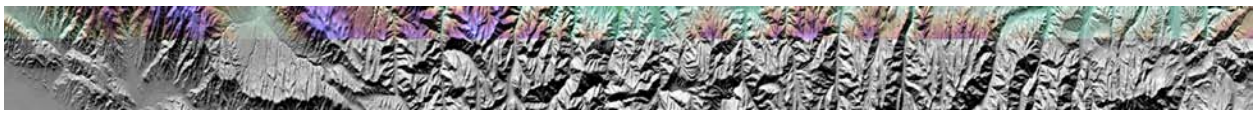
Function	Name	Date	Signature
Co-Director	Dr. Bolot Moldobekov	22/07/12	
Co-Director	Prof. Jörn Lauterjung	22/07/12	



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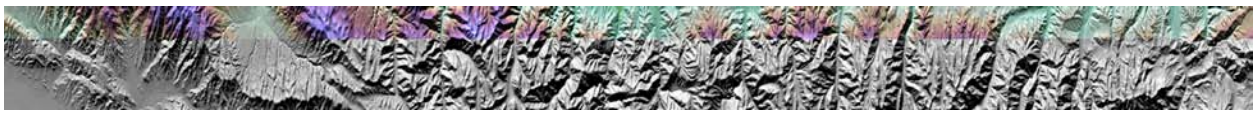
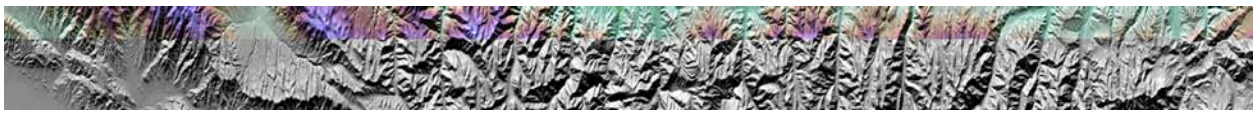




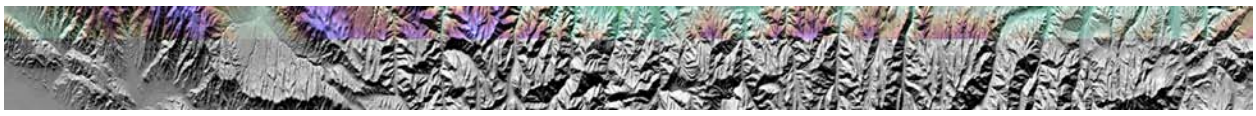
Introduction and Overview

Central Asia is the region which embraces the territories of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. With its complex and contrasting relief it represents the world's outstanding natural laboratory for studying the intra-continental processes. With the highly active water cycling over its most elevated parts this region has a profound influence on the atmospheric heating process, the weather, the climate and the water cycle in entire Asia and on a global scale. Active geodynamic processes related to the continuing orogenesis in the major territory of Asia induce high seismicity in the region.

As a consequence of these extreme dynamics in the regional geologic and atmospheric regime natural hazards, such as earthquakes, floods, landslides, glacial lake outbursts, avalanches and droughts, are frequent in Central Asia, partly also coupled with phenomena of Global Change and partly connected with and enlarged by human-induced events and engineering activities. Such natural and natural-technogenic processes often lead to disasters which cause the loss of life and property, environmental problems and have a strong negative impact on the sustainable development and well-being of the societies in Central Asia.

The assessment of risks related to each of the natural and human-made changes that can occur in Central Asia and the development of adaptation measures is of strategic importance due to the impact such processes will have on the societies, the interrelationships between the different countries and, consequently, the political stability of the region. However, very often natural processes and catastrophes have a triggering effect leading to cascade phenomena, and a simple single risk analysis procedure might be insufficient to provide end-users and stakeholders with realistic scenarios. Therefore the concept of multirisk analysis is inspiring also the R&D programme of CAIAG and the respective services offered by the institute.

A growing number of scientists and organisations from all over the world have started to set up new multi-disciplinary observing programs with most advanced technology in international co-operation and are intensifying scientific research projects in order to improve the data base for relevant observations and data products and to enhance understanding and modelling of the underlying natural and human-induced processes in the region. One of the key aspects will be the role to be played by CAIAG. CAIAG is intended to become a regional centre that aims to develop tools for the management of natural disasters and risk mitigation. CAIAG has been, and should be in the future, a competent and reliable regional partner for supporting and implementing projects and activities not only in Kyrgyzstan, but over the whole CA region. In particular, CAIAG is able to provide



invaluable logistical support, especially for the maintenance and operation of infrastructure of scientific institutions. CAIAG shall also assist in outreach activities by helping with the networking between all Central Asian countries, institutes and ministries. Last, but not least, CAIAG could become a strategic centre for the training of CA-scientists and decision makers, strengthening its relationships with universities and academic institutes.

The Research and Development Programme

The CAIAG Research and Development Programme for the period 2012-2013 (R&D PROG 12/13) is focused on four priority themes, which are fundamental for the Central Asian region:

I. Geodynamics and georisks;
II. Climate, water and glaciers;
III. Information and monitoring systems;
IV. Capacity Development.

CAIAG has defined priority areas of research which have to be tackled in a long-term perspective, which need an advanced scientific monitoring infrastructure and which are based on international cooperation. The research and working areas are:

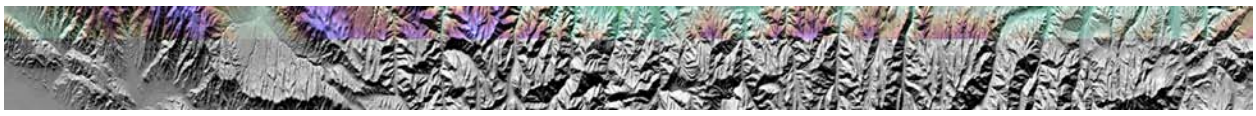
a) Global and regional change processes and their effect on the environment;

b) Monitoring and assessment of natural hazards (multi hazard approach), reduction of risks related to natural hazards including multi risk assessment and early warning technologies development and justification;

c) Applied multi-disciplinary research in the field of geodynamics and geohazards; water and land resources including research of glaciers, rivers, reservoirs, underground water; and,

d) Capacity development, training courses, education and public outreach.

The focus of research activities at CAIAG aims to contribute to a better understanding of the interrelations and interface processes between the above mentioned research topics and processes. Therefore it will be important to follow a multi-process (multi hazard) approach for the Central Asian region resulting in a multi-risk approach for Central Asia and based on this, to develop a sustainable adaption strategy to a changing world in terms of changing environment, changing society and new challenges due to an increasing growth of population and globalization. Besides these general goals, it is of utmost importance to have an independent unit with geoscientific expertise especially for the consulting of the public and political sector for planned geotechnical projects in the Central Asian region like the establishment of big hydro-electrical power plants, dams, traffic infrastructure or the



earthquake resistant building of strategic important infrastructures like hospitals, schools, official buildings, etc.

An important and central part of the research in the above mentioned fields is the long-term operation and delivery of scientific services not only to the scientific community but also to the public, i.e.

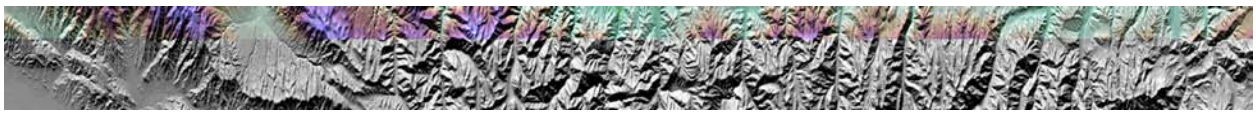
- Operation and long-term maintenance of sensor networks for the monitoring of processes on the Earth's surface. This includes seismic, geodetic, geoelectric and hydro-meteorological sensor networks all over Central Asia and the integration of these networks in global systems. In addition, the integration of relevant satellite data and information like high resolution satellite images, radar data or interferometric data become more important and enable to cover larger areas for monitoring of the environment and geological processes.
- Operation of an overarching Geodata- and Informationsystem for an open access supply of relevant data, maps and decision-relevant information.
- Consulting services for decision-makers and the public

The monitoring activities aim to extend and operate a real-time data acquisition system with the ultimate goal to establish a Rapid Response and Early Warning System for any type of disasters like earthquakes, landslides, hydro-meteorological hazards or man-made impacts on the environment. An important step in these activities will be the preparation of proposals on disaster risk reduction and the development of preparedness measures together with government bodies and the respective organizations in Central Asia. This will be performed under strong involvement of the Capacity Development unit at CAIAG.

For the first time the component of assessment of environmental changes impacts and climate change impact on the social and economic development is introduced in the R&D programme. According to predictions, the consequences of the climate variability affect adversely the water resources, farming and forestry, power production and industry. As a result, probably, it will have an affect on food security and water supply, power security and human health and will result in deterioration of poverty situation in the region.

The proposed projects will be carried out during the next 2 years and aim at primarily the acquisition of basic observational data and the performance of scientific research activities in three key areas of Kyrgyzstan. These are:

- The region of the Sary-Dshaz river basin covering the Enylchek glacier, which is one of the largest fresh water and potential hydropower source in the area;
- The area of the Issyk-Kul and Chui depressions, where the city of Bishkek and a resort and tourist zone of international importance are located; these territories require a



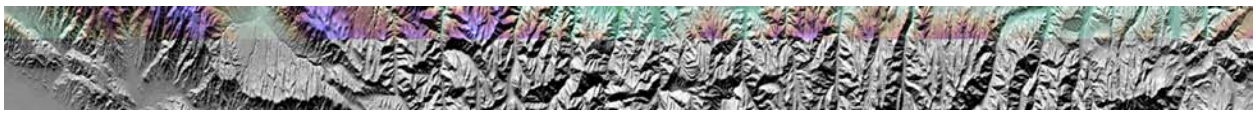
particular approach in the development of seismic risk and human-made impact reduction measures with regard to climate change.

- The territory of mountain margin within the Ferghana basin and Inner Tien-Shan, which is the most populated zone in Central Asia and is prone to various risks of natural disasters (earthquakes, landslides, floods etc.)

All three areas are of critical importance for investigations on the probability of the occurrence of both natural and natural-technogenic disasters. They are also of crucial importance for the adequate water supply in Kyrgyzstan and in adjacent regions like Uzbekistan, Kazakhstan and the Xinjiang province, for the planning of large scale geotechnical projects in the region, such as hydroelectric power station cascades, high voltage power lines, water storage reservoirs and railway and road systems, and other prospective plans with great impact on the socio-economic development of the Central Asian countries and on the welfare of their population.

The CAIAG R&D Programme 12/13, as presented in this document, is considered to be complemented by a number of projects being carried out under the ‘Global Change Observatory - Central Asia’ initiative, launched by GFZ Potsdam and a number of German and international partner groups. A close coordination and joint execution of projects in both programs is subject of joint discussions.

With a sound infrastructure base and personnel capacity accumulated previously, CAIAG intends to strengthen them and implement its plans on compliance with CAIAG’s Development Strategy.



Theme 1: Geodynamics and georisks

Theme Supervisor: Sh.Usupaev

1.1 Project: Integrated geological-geophysical (neotectonic, seismological and engineering-geological) research of the Sary-Djaz river basin as an area for future construction of hydroelectric power plants

Project executors: Usupaev Sh., Moldobekov B.D., Kalmetieva Z.A., Zubovich A.V., Shakirov A.E.

1.1.1 Project short title

Integrated geological-geophysical research of the Sary-Djaz river basin

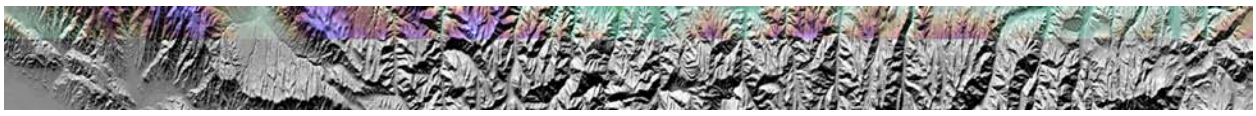
1.1.2 Project outline

The Sary-Djaz river basin is located at the north-eastern part of Kyrgyzstan, at the highest place of Tien Shan. Principal feeders are the rivers Enelchek and Ak-Suu. The main water resources of the Sary-Djaz River are concentrated at the largest Tien Shan glaciers called Southern and Northern Enelchek (with a distance of over 60km and an average thickness of 200-300m), Ak-Shiyrak glacier and one of the largest glacial lakes “Merzbacher”.

The high altitude location, the partitioned complicated relief, isolation and remoteness and a severe climate entail that the area is not developed and populated, there are no people living permanently in this area. The transboundary Sary-Djaz River is not much used by Kyrgyzstan but is a water source mainly for Western China (Xinjiang Uigur autonomous district) which uses 75% of its flow. The construction of 4-5 hydro power stations with a capacity of about 1,5 million kW/h and water reservoirs of about 500 mil. cubes at the Sary-Djaz river would be an incitement for the development of Kyrgyzstan and Western China.

In addition, the Sary-Djaz river basin provides a wide base for the development of nonferrous and polymetallic metallurgy. Big deposits of tin, tungsten, copper, lead, molybdenum, polymetals and tantalum represent the significant industrial value.

For a sustainable industrial development of the region it is necessary to continue the research, initiated by CAIAG in 2008-2009, on studying new tectonics and seismicity, recent motions, engineering-geological conditions as well as on assessing dangerous natural processes both at the Sary-Djaz basin and at the potential locations of future dam sites of hydropower stations. Due to exploration of mineral deposits it will be necessary to make an assessment of risks related with environmental impacts as well as climate change.



1.1.3 Project objectives and methods

Long-term aims:

On the basis of integrated research of the area, scientifically justified recommendations will be made for the construction of hydro power stations and mining facilities.

The outputs of the research and monitoring network will provide the basis of the database for implementing detailed geological, engineering-geological and hydrological studies aimed at the construction of hydro power and mining facilities.

Short-term aims:

The short-term aims include the investigation of geodynamics, seismology, neotectonics, cryopedology and engineering-geological processes in the region which represent geo-hazards to the future hydro-technical facilities and their infrastructure. Also, the identification of the main factors of natural disaster development and environmental impact is planned.

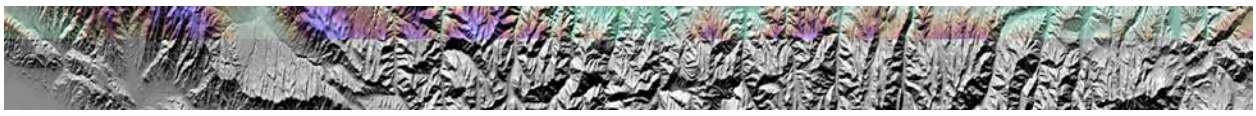
Methods:

- Geological methods (study of geological structures, neotectonical analysis, paleoseismology, fission track analysis);
- Engineering-geological and cryopedological methods (disaster location mapping);
- Seismological methods (spatial and time distribution and identification of earthquake focuses, seismotectonic deformations);
- Geophysical methods of research (engineering seismology, magnetic-electrical exploration);
- Remote sensing methods (radar, multispectral and GNSS station positioning).

1.1.4 Current status and special requirements

In 2008-2009, the first stage of research was started when an outline description of the region's geodynamics and seismicity was prepared on the basis of the analysis of literature data and some field works. At the first stage of project implementation the following results were achieved (2008-2009):

1. Reconnaissance field works have been completed;
2. Active fractures have been mapped and neotectonic maps have been created;
3. Earth deformation data recorded by GNSS stations were analysed and interpreted;
4. Geophysical studies of geodynamic charasteristics of large fractures were carried out and the glacier capacity was determined in the area of Merzbacherlake;
5. Spatial and time distribution of earthquake epicentrum and sources were analysed.



1.1.5 Internal and external cooperation

The project will be implemented by CAIAG staff of Departments 1, 2, 4 together with GFZ and Vienna University. Also, close cooperation will be kept with the Seismology Institute of the Kyrgyz National Academy of Sciences, the Kazakh National Nuclear Center and Xingjian – Uigur Seismological Unit (China).

Coordination with Central Asia Global Change Observatory.

The proposed project is linked with Subtask 2.2 “Geodynamics: conjunction in subsurface and surface movements” and particularly with its Subsection “Surface processes as integral response to geodynamics”.

1.1.6 Work plan and necessary resources

Project duration: 2012-2013

2012:

- Continuation of field engineering-geological and cryopedological research;
- Continuation of study of time series of GNSS stations’ positioning for identification of changes in horizontal and vertical movements b y main structures;
- Geophysical research (engineering seismology, geomagnetics).

2013:

- Preparation of geological, seismological and engineering-geological and cryopedological maps with explanatory notes and recommendations;
- Scientifically justified assessment of engineering-geological conditions for the construction of hydro-technical facilities.

Labor input:

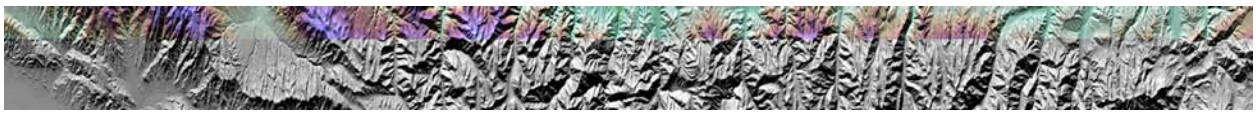
Dept 1 – 60 man/month

Dept 2 – 52 man/month

Dept 4 – 30 man/month

Required observations and equipment:

- Seismic observations: data of broadband digital seismic stations with high resolution, software for processing seismometric data, historical data on seismicity of the area in Kyrgyzstan;
- Measurements of surface motions;
- Creation of a network for measuring the magnetic field in the studied area;
- Time series of 3D location of sensors GPS/GLONASS;



- Optical and radar satellite images of the area and software for processing these materials;
- Measurement of seismic noises and earthquakes for making seismic micro-zoning maps at future dam sites of hydro power stations.

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1.2 Project: Seismic micro-zonation of the Bishkek city territory (continuation of research)

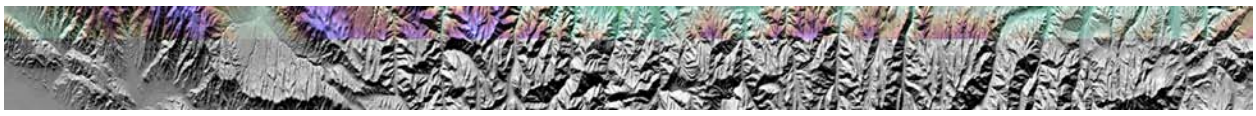
Project executor: Usupaev Sh.

1.2.1 Project short title

Seismic micro-zonation of Bishkek city

1.2.2 Project outline

Central Asia is one of the most earthquake-prone regions. Evidence of that are the earthquakes with 9-10 intensity having occurred in the last 100-200 years, as Belovodskoe (1885), Vernenskoe (1887), Chilikskoe (1889), Keminskoe (1911), Ashgabadskoe (1948), Khaitskoe (1949), Suusamyrskoe (1992), which caused the loss of many thousand lives and destruction.



The high level of seismicity in the territory of big cities and settlements means a constant threat to the safety of human life and affect the social and economical development of nations. Therefore, the precise and objective maps of seismic microzonation of big cities and industrial facitilies territories are of high economic and social importance as it provides the efficient distribution of industrial and urban buildings, so that enables the reduction of construction costs.

Scientifically justified quantitative data about the nature of ground shaking during the strongest earthquakes in a given area allow the application of anti-seismic measures which guarantee stability of buildings and, constructions and, of course, it gives the possibility to raise the security for population.

At present in practice of seismic microzonation of city territories, important industrial objects and hydrotechnical constructions two approaches were established.

The first approach is of an engineering-geological type which is based on qualitative, empirically established dependence of seismic intensity increment and engineering-geological attributes of different soil types. The given approach used to be applied within the former USSR territory, and at present it is used in certain CIS countries.

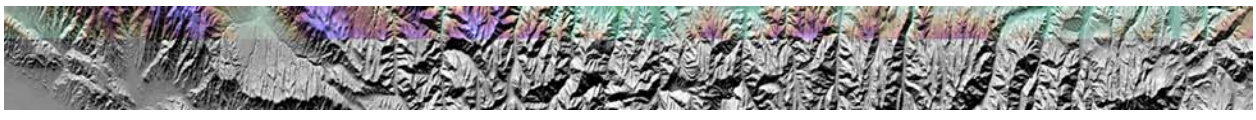
The second approach is of instrumental type which includes a method of seismic rigidity and a method of amplitude-frequency characteristics. This method is more advanced and it is used in developed western countries.

The method of seismic rigidity is based on the empirically established dependence between the intensity of the seismic impact on a building or construction, and the seismic rigidity of soil, ground water level and thickness of loose sediments.

The method of amplitude-frequency type is based on the experimental study of motion of different soil types during an earthquake event. The significant advantage of this approach in comparison with other methods is that it provides real ground motion but not estimated one.

In our case, we have used the approach of experimentally studying of amplitude-frequency characteristics of soil oscillations, caused by strong earthquakes. For this purpose continuous recordings of seismic motions (earthquake recordings) have been carried out simultaneously at several (up to 200) points with different soil conditions within the territory of Bishkek. The data obtained has been used for the estimation of the influence of various soil types on the basic characteristics of seismic waves caused by strong earthquakes. The characteristics of soil conditions will be derived on the basis of archival material (prospecting seismology, borehole drilling, hydrogeology, etc.). A detailed study on soil types has been carried out by field work using digital acquisition systems and seismometers (Nakamura method, microseisms). As a final result of the conducted research a seismic microzonation map of Bishkek city is created with quantitative parameters of seismic influence, which needs to be completed in 2013.

The new map will be given to the State agency on construction and architecture of the Kyrgyz Republic as a normative document for modeling of destructive seismic events and design of seismic buildings and constructions. As well the map will be used by the municipal authority of Bishkek to plan the general development of the city and by the Ministry of Emergencies of the Kyrgyz Republic for the development of prevention measures.



1.2.3 Project objectives and methods

Main project aim – composition of up-dated micro zonation map for Bishek city

Long-term objectives:

Drawing up the series of maps on “Seismic hazard assessment and microzoning”, “Seismic vulnerability”, and “Seismic risk” for Bishkek city within the framework of the EMCA project

Short-term objectives:

- Acquisition, processing and analysis of seismic data,
- Study of soils frequency characteristics using the measurements of noise and earthquakes registration,
- A map of zoning on the soil conditions will be worked out.
- Finalization of seismic microzoning maps and continuation of “Seismic vulnerability” and “Seismic risk” maps.

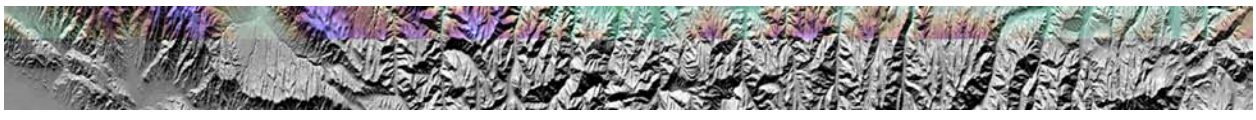
Methods:

- engineering - geological method based on qualitative empirical correlation (dependance) of seismic magnitude increment and engineering-geological ground properties;
- Instrumental method including the assessment of seismic hardness and amplitude and frequency characteristics
- Geological method (new tectonics, paleo-seismology, fission track analysis)
- Engineering – geological and hydrogeological (mapping of sites of hazardous processes and phenomena, soil conditions assessment, determination of depth of underground water occurrence)

1.2.4 Current status and special requirements

In 2008-2010, a number of research works on seismic microzonation of Bishkek was carried out jointly with specialists from the German Research Centre for Geosciences (GFZ) and the National Institute of Geophysics and Volcanology, Italy (INGV). Additional methodological and financial support became available owing to the joint project «Cross-boundary disaster prevention in Central Asia», realized by InWEnt, GFZ and CAIAG under the financing of the German Federal Foreign Office and integration in the CAREMON and CASCADE projects. The new project EMCA (Earthquake Model in Central Asia) which was launched in 2011 extends the objectives and goals of the previous CASCADE project and contributes to the methodological framework of seismic microzoning activity.

One of the principal tasks of seismic microzonation was the spotting of sites in the research area with various intensities of shaking differing in engineering-geological, tectonic, hydrogeological, geomorphologic and seismological conditions. The results of seismic data processing from Bishkek territory were acquired considering the expansion of its area until 2025.



Based on the results of seismic noise measurements the spectral ration of horizontal and vertical components was identified and the scheme-map of frequency (resonance) characteristics was developed. (Fig.1.2.1)

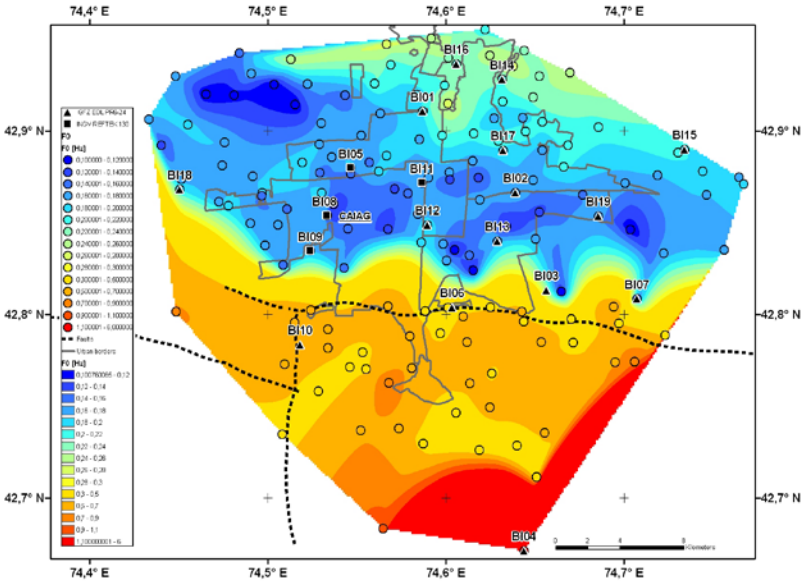


Fig.1.2.1. The scheme-map of house footings frequency (resonance) characteristics, defined on the base of seismic noise measurements in the territory of Bishkek.

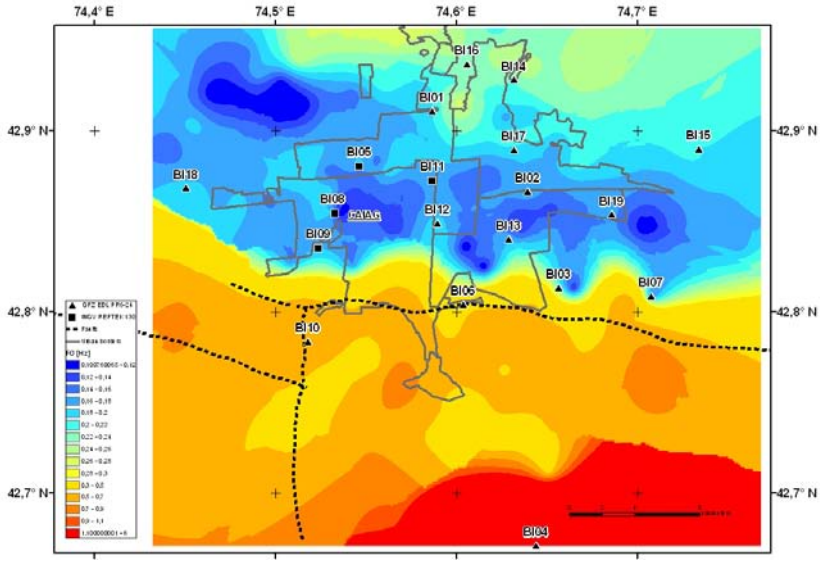


Fig.1.2.2. The scheme-map of house footings frequency (resonance) characteristics, defined on the base of earthquakes registration in the territory of Bishkek

Moreover, CAIAG completed geophysical measurements to identify the width of the active Issyk-Ata fault, in the southern part of Bishkek (186 points, according to 6 profiles perpendicularly along the fault extension). The investigated area is a 9-point zone. Results from the acquired instrumental data analysis show that the width of the fault varies from

some tens of meters to 400m (Fig.1.2.3). According to this fact, the zone of their impact in the normative-building documents should be revised for further minimization of risks and threats to the population in this hazardous zone.

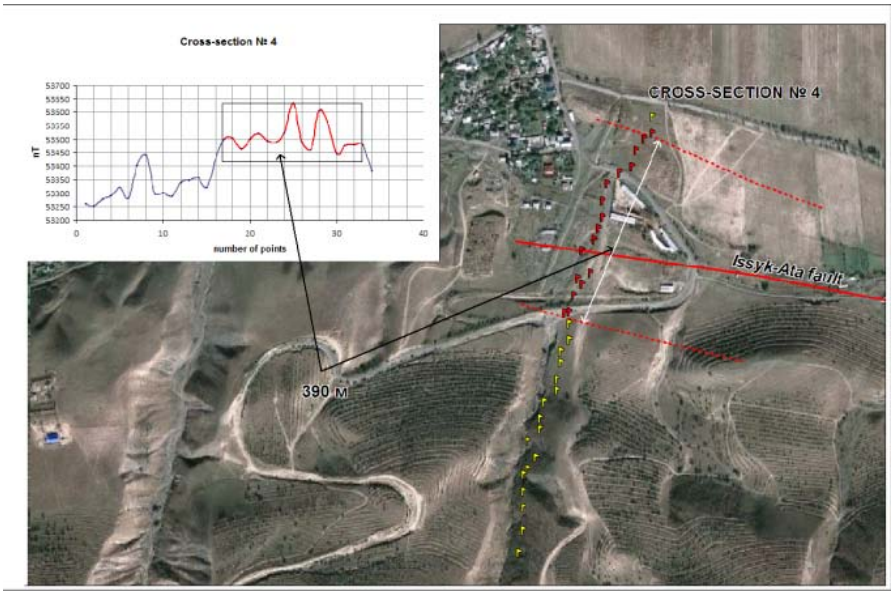


Fig.1.2.3. Active Issyk-Ata fault measurement

1.2.5 Internal and external cooperation

The project will be implemented by specialists from 1st and 4th departments of CAIAG.

External interaction: Close cooperation, first of all over the installation of new observation points, with GFZ and the National Institute of Geophysics and Vulcanology, Italy (INGV).

1.2.6 Work plan and necessary resources

Duration of the project – 2012-2013

2012

- Additional engineering-geological, hydro geological and geomorphological large-scale surveying of recently built up territories of Bishkek city.

2013:

- Preparation of the final report, creation of the digital maps on seismic microzonation including the georisks assessment;
- Publication of the results of integrated research.

Labor input

Department 1 – 120 man/month

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1.3 Project: Landslide study by ground observations and remote sensing methods (in the pilot area of the Fergana basin mountainous margins, Northern and Inner Tien-Shan)

Project executors: A.Mandychev, A.Detushev

1.3.1 Project short title

Landslide study of the Fergana basin region, Northern and Inner Tien-Shan

1.3.2 Project outline

Landslide processes are widespread in the territory of Kyrgyzstan and adjoining Central-Asian countries because of predominance of mountain landform. Sliding phenomena correspond to a considerable part of registered natural disasters in the territory of the Kyrgyz Republic.

Landslides are formed under the impact of various factors such as geomorphologic, geologic (including tectonic and lithologic), seismic, climatic, hydrological, hydrogeological and engineering-geological characteristics. There are both natural and anthropogenic components in the system of factors.

Landslides cause a significant and severe economic damage and result in life losses. Therefore, the study of landslides and the elaboration of measures to reduce the hazard risks are of great importance.

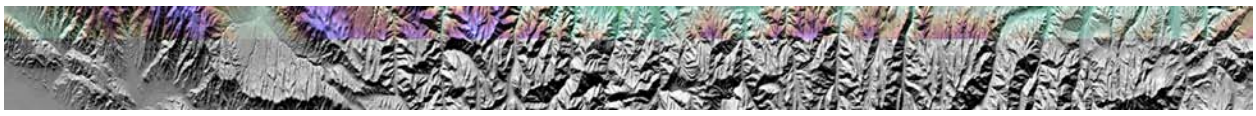


Fig.1.3.1.Scheme of studied landslides location

The given project, which is planned to be executed in the period from 2012 to 2013, is a logical continuation of the project 2, implemented within 2008-2009 in the territory of the cities Minkush (inner Tien-Shan), Gulcha and Maylisu (Fergana hollow). During these years actual data have been collected and analysis concerning climatic, hydrological, hydro-geological, geologic and seismic conditions of research areas, as well as analysis of the previous research results of «Tuuksu» landslides around Minkush, «Koytash» around Maylisu and «Gulcha» around the identically-named city is carried out. In 2008-2009 these landslides were studied in detail during a field survey by measuring the morphometric characteristics, mapping using GPS Topcon GB-1000, as well as high-precision testing of landslide micro-motions. In addition, the soil and ground water were sampled for the granulometric and chemical analysis.

Fig. 1.3.2. Field works near Gulcha, Mailisuu, Minkush cities

Selection and preliminary analysis of detailed space images of Quick Bird etc., covering the studied landslides, have been made. Digital maps of sliding areas in GIS MapInfo environment have been prepared, and characteristics of the main factors, determining the initiation and dynamics of sliding processes, have been defined according to the research results.

Due to the short period of the study and insufficient provision with special measuring equipment, it was only possible to make the preliminary conclusions about landslide structure, the mechanism and factors of their dynamics. It requires continuation of study and more detailed explanation.

Thereby, within this project, it is proposed to continue the detailed research of three landslides investigated before and start a new observation on the big Tatyr landslide, located 30 km south of Bishkek in the Chon-Kurchak hole. That landslide is well accessible for transport; it has interesting geological structure and forming conditions. That can allow providing the detailed low-budget investigations and obtain the scientific results which can be applicable for the dynamics forecasting for other similar landslides.

Both the archive and remote sensing data, Landsat, Aster, Spot, Quickbird and other satellite images will be used for the retrospective and actual analysis of landslide activity on a regional scale. In addition, a differentiated radar interferometer (TerraSAR-X) is planned to be used for observing the cracks and junctions early formation and assessing the landslide body deformations.

It is planned to compare and verify the remote sensing observation data with the actual situation on the site during the fieldworks. Various methods of ground survey (geologic, geophysical, geodesic, using GPS Topcon GB-1000, electronic tachometer) are supposed to be used on a local scale.

The fieldwork will comprise the following procedures: soil sampling for humidity definition, analysis of particle size and mineral composition and other physical and mechanical characteristics, sensing by electromagnetic penetrating radar or by broadband seismic station and geophone acoustic noise measuring.

The main task of landslide modeling will be executed on the basis of defining and refinement of the poly-factor mechanisms of landslide process formation and the construction of qualitative, and then quantitative operating models. The specification of key factors characteristics, as well as the seismicity (Z.Kal'met'eva, 1st Dept), which define the nature of sliding process development, the patterns of their correlation and the spatial-temporal development will be in the research focus.

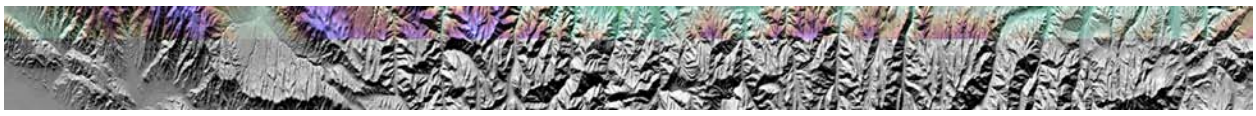
The elaboration of the forecast algorithm of the landslide process development will be conducted at the final stage of research on the basis of synthesis of all acquired results. As a project outcome the guidelines on risk assessment of landslide processes and on measures of hazard reduction will be prepared, in particular, on the basis of an early warning system creation and scientifically substantiation of measures on engineering-geologic ground stabilization of the sliding slopes.

1.3.3 Project objectives and methods

Long-term objectives:

The purpose of the project meets the Development Strategy of CAIAG on "Geodynamics and georisks" work area, which stipulates the analysis of hazardous exogenic processes and phenomena trends related to climate changes in the territory of Kyrgyzstan and adjoining countries.

The main objective of this project is to continue with detailed research on characteristic landslides, on the basis of which the modeling and forecast of landslides is developed, as well as to accomplish a complex risk assessment of landslide processes.



It is supposed to improve the understanding of landslide process on a regional scale in its correlation with tectonic structure, geomorphologic and lithologic formations, seismic activity, change of climatic, hydrological, hydrogeological and engineering-geological conditions in the high activity landslide areas along the east margins of the Fergana basin and Inner Tien-Shan.

This conception will be based on the developing of a detailed factorial landslide hazard and risk assessment system in a spatial-time scale and the monitoring of landslide phenomena and trigger factors, causing a slope destruction initiation (atmospheric precipitations, seismicity, structure and lithology).

The elaboration of landslide development forecast in concrete areas and of guidelines to reduce landslide hazards will be continued. For the future it is planned to develop recommendations to create an early warning system for landslide phenomena in the Central-Asian region.

Short-term objectives:

Within the frame of the present project the investigation of three typical landslides - selected in the course of the analysis of existing geologic, engineering-geologic, hydro geological, hydrological, climatic, remote data and field explorations - will be continued in the territory of Minkush, Maylisu, Gulcha. Additionally, the Tatyr landslide located near to Bishkek city will be considered (Fig.1.3.3.).

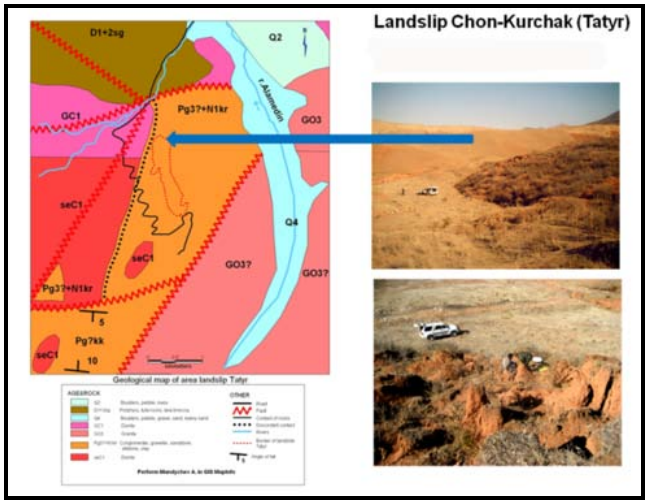


Fig.1.3.3.Scheme of the Tatyr landslide's geological and tectonic structure

The formation of a database will be continued, comprising the landslide characteristics and data analysis results that were received from the automatic station network and landslide field measurements. On the basis of these data the preliminary predictable models of landslide dynamics are expected to be developed in connection with climatic changes, seismic activity, geological conditions and anthropogenic activity. The conception of an early warning of dangerous motions of landslides and the forecast of areas threatened by landslide processes will be elaborated *in situ* with recommendations on how to reduce landslide hazards.

Methods:

- Decoding of detailed alternative data of remote sensing (multi-spectral, hyper-spectral, radar);
- Ground geophysical measurements (acoustic geophone sounding, penetrating radar sensing or seismic station), geodesic measurements (GPS measurements, topographical surveying by electronic tachymeter), measurements by the automatic hydrometeorological stations;
- Geomorphologic, geologic, hydrological, hydro-geological and engineering-geologic field surveys; study of relief peculiarities, tectonic structure, lithologic formation, conditions of inundation and water satiation, landslide slope and landslide body, mineralogical composition, filtration features, granulometrical composition and other physical-mechanical properties of landslide soils;
- Spatio - temporal modeling of landslide processes and risk assessment

1.3.4 Current status and special requirements

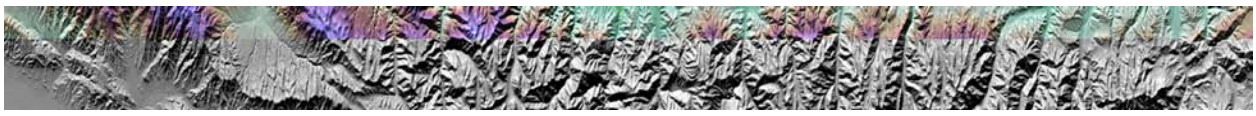
During the period from 2008-2011, actual facts for the development (geologic and tectonic structure, hydrological and hydro-geological conditions, climatic parameters) of three studied landslides and their close vicinities were collected. Due to detailed data analysis the planning and realization of further field surveys became feasible.

In 2008-2009, a detailed field exploration with measurements of the morphometrical parameters and topographical surveying, applying GPS Topcon GB 1000, and high-precision testing of landslide units micro motions were executed on the following landslides: «Tuuksu» around Minkush city, «Koytash» around Maylisu and «Gulcha» around Gulcha city. In addition, soil and groundwater were sampled for granulometrical and chemical analysis. The detailed space images of QuickBird etc., covering the observed landslides, have been selected and preliminary analyzed. Landslide areas have been digitized in MapInfo based on research results and the correlation of parameters of the main factors which condition the origin and evolution of landslide processes. These data have been included into the database and will be further used for the landslide process mechanism analysis.

For the project implementation alternative optical and radar space images of high resolution are required.

For detailed research there is a necessity to have the following instrumental equipment: electromagnetic penetrating radar and a portable seismic station in order to study the landslide structure and lithologic discontinuity, to assess the landslide body capacity and for a correlation of its dry and moist parts, as well as the geophone to determine the acoustic noise of a landslide.

For the high-precision operative landslide topographical survey it is necessary to use the electronic tachometer. For the observation of microclimatic conditions around landslides a mobile automatic weather station of the type “VAISALA” is required. It is essential to



allocate financial means for the lab analysis to define the physical-mechanical parameters of the soil and their mineralogical composition, as well as to study the chemical composition of surface water and ground water related to a landslide.

1.3.5 Internal and external cooperation

The project will be executed in joint work by the Department 1, 2 and 4 of CAIAG. Close cooperation with GFZ, the Institute of Geology, the Institute of Physics and Rock Mechanics, EMSE NAS KR, MES KR, the State Geology Agency and the Osh State Institute of Engineering Research is in the progress. Furthermore, collaboration is planned with the University of Liege, Belgium and with scientists of the adjoining Central-Asian countries Kazakhstan, Uzbekistan and Tajikistan.

1.3.6 Work plan and necessary resources

Duration of the project: 2010 - 2013

2012:

- Acquisition and analysis of the archive and actual data, remote sensing data, formation of a geo-database on landslides section;
- Detailed field surveys in the Tatyr landslide site, realization of field measurements and analysis of the representative landslides' main parameters;
- Purchase of the "WorldView-2" space images of 2012 year and its decoding on four representative landslide sites.

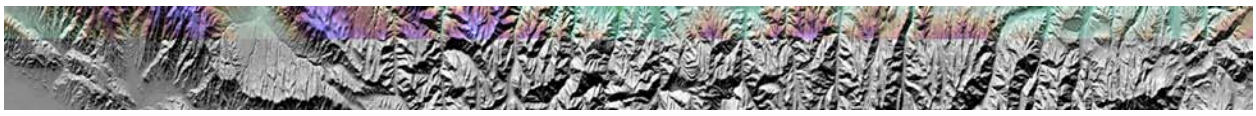
2013:

- Remote sensing, seismological, climatic, geologic, hydrogeological data and physical-mechanical landslides parameters analysis;
- Detailed field surveys in four sites, topographical GPS and digital tacheometer survey.
- Creating a base for the landslides monitoring network by way of benchmarks, precipitation gages, installation of automatic stations for the seismic, meteorological and geodesic (GPS) characteristics measurements;
- Generalization of the main multifactor regularities of mechanisms in the studied landslide formation; Substantiation study of the forecast algorithm for the landslide development and measures on risk reduction and early warning system schemes

Required human resources:

Department 2 - 107 persons - month

Required observation and equipment:



- Decoding of optical and radar images of high resolution and images with resolution of 0,6 m/l with different shootingtime (Quick Bird, Terra SAR-X);
- GPS binding of measurement points, leveling, high-precision topographical survey by electronic tachometer;
- Field survey on morphometry, structure, landslide lithologic formation, hydrological and hydro-geological conditions in landslide areas, landslide soil sampling;
- Study of physical-mechanical parameters of landslide soil samples in specialized labs;
- Analysis of the hydro-chemical and geochemical characteristics of surface and ground water related to landslides, soil samples in specialized labs;
- Sensing by penetrating geo-radar, seismic sensing, measurement of acoustic noises by geophone;
- Ground meteorology: observation of temperature, humidity and precipitation by automatic weather stations

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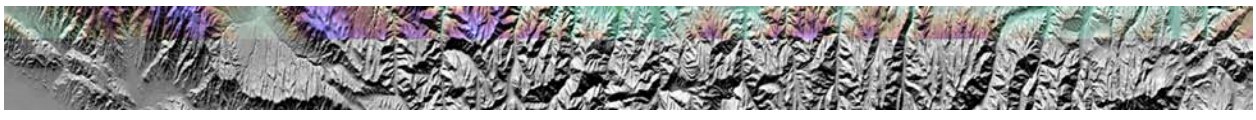

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1.4 CAIAG seismological research

Project executors: Z.A.Kalmetyeva, K.Jusupova

1.4.1 Project short title

Seismological research

1.4.2 Project outline

The Tien-Shan range is a system of young and growing mountains, characterized by sharp topography, high peaks (more than 7000 m), high seismic activity (historical earthquakes of M=8.4) and a high level of natural hazards (landslides, mudflows, floods etc.). It is clear that all these inseparably related phenomena and the analysis of their relation are of great importance to understand the nature of hazardous phenomena, since on this basis preventive risk reduction measures can be taken.

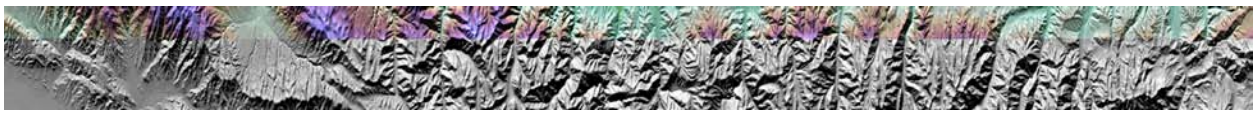
Currently, following the planned development of instrumental observation network and field research, data on surface deformations, meteodata and data on landslide activity were collected by space geodesy and remote sensing in CAIAG's database. Further, CAIAG has data on seismic observations, carried out both by fixed stations of CAIAG, and local networks (withinTIPAGE and Fergana projects, Kambar-Ata explosion). CAIAG already has experience in using these data, for example, for analyzing a focal zone of the Nurin earthquake, having occurred in 2008 [1], where GPS data, data from TIPAGE network and geological data were used. Encouraging tentative results were acquired when comparing GNSS data and seismology in the Sary-Djaz river basin area (see the project). Comparative analysis of landslide and seismic activity was started [2]. The planned installation of accelerometers' network inKyrgyzstan in 2012 to create a rapid response system expands the potential of such analysis.

In 2012-2013 it is planned to use data from the Fergana network in order to conduct a comparative analysis of seismic and landslide activity for the surroundings of the mountains in the Fergana depression.

1.4.3 Project objectives and methods

- Installation and adaptation of programs to process data of local autonomous seismic networks, including the creation of a seismic events' catalogue, determination of the earthquake focal mechanisms, assessment of site-effects and dynamic parameters

- Description of the general seismicity of the region according to data of seismic observations in Kyrgyzstan, including data on underlying structure, spatio-temporal behaviour of seismicity (historical events and results of instrumental observations), and spatial distribution of types of motions in earthquake focuses.



- Recent structures and their impact on hazardous natural process development.

- Comparative analysis of the general seismicity, landslide activity and meteodata over the last 50 years.

- Comparative analysis of instrumental observation data on landslides in Mailysai and seismic data from Fergana network.

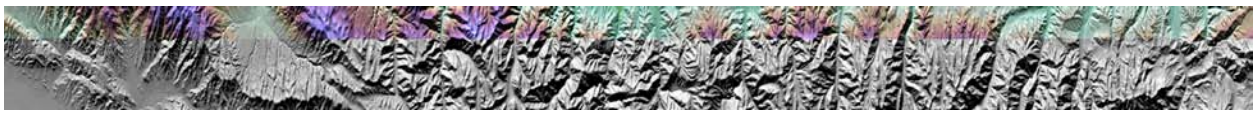
1.4.4 Current status and special requirements

By 2010 CAIAG has already had its own stationary network of seismic stations (three stations), whose data was - together with data from CAREMON network, as well as from other stations of world networks – put into the SeisComp software package, which collects, shares and processes seismic observation data automatically in real time. However, after the Nura earthquake, we faced the necessity to process data from autonomous networks. A typical situation was the processing of observation data from the Kambar-Ata explosion.

But in particular the necessity became clearer after acquiring the first results of our comparative analysis of seismic and landslide activity in the Northern Tien-Shan, conducted according to the data from the Institute of Seismology of NAS KR and the Research Station of RAS, and now it was necessary to begin with the processing of data from the Fergana network. Therefore in 2012 we have set the SEISAN [3] program, which was recommended in the courses on seismology, regularly conducted by GFZ under the direction of P.Borman, where the potential of this program was demonstrated and its text was shared to the course participants.

Research activities in the Northern Tien-Shan showed that landslide activation starts when a diversion of pressure from the horizon occurs after certain stabilization of horizontal pressure [2]. The location of landslides coincides with the edges of the overlying structures, moving towards sedimentary rocks of the Chui depression. This result makes us draw a particular attention to analyze a stressfield of the Earth core with analyzing landslide processes. The south-western part of Kyrgyzstan is more exposed to the landslide impact. But this part of the Tien-Shan differs from the northern part, both in the history of its development, and in structure. And, the spatial localization of the landslides here has a more complicated distribution. Therefore, a comparison of the analysis results is of major interest for these two different sites of the Tien-Shan. The observation data from the Fergana network provide a unique opportunity to conduct analogous research in the Fergana territory, especially as instrumental observations of landslides in the Mailysai have been conducted within the network location for years. During this network maintenance in May 3, 2012 there was a landslide in the Oitala area, which was recorded in the nearest station № 22.

2011 was devoted to processing of the earth quake energy and the dynamic characteristics determination method [4]. Considering the relevance of this issue not only for particular research, but also for determining these parameters in any seismic observation data processing center, a joint discussion of these issues with specialists from the Institute of Seismology of NAS KR, the Research Station of RAS and the National Nuclear Center of Kazakhstan was organized.



1.4.5 Internal and external cooperation

The given project will be implemented by specialists from Department 1 of CAIAG. All-round cooperation with profiling organizations in Kyrgyzstan (Institute of Seismology of NASKR), Kazakhstan (NNC, Institute of Seismology), and Russia (Research station in Bishkek) will be in the progress.

GFZ will be a major cooperating organization in the external cooperation. When processing the method of earthquake records spectralanalysis, Stefano Parolai gave us valuable consultations. The results of comparative analysis of seismic and landslide activity were discussed several times with Uli Wetzel, Sigrid Roßer, Christian Haberland and Bernd Schurr.

The present project by its content is closely connected with the tasks of Theme 3 of CA GCO project (Earth's Surface Dynamics).

1.4.6 Work plan and necessary resources

2012:

- Adaptation of the Seisan program for determining earthquake dynamic parameters and mechanisms of their focuses
- Spatiotemporal analysis of the Fergana seismicity
- Comparative analysis of the data on seismicity, landslide activity and meteorological conditions over the last 50 years
- Comparative analysis of micro shocks, recorded by seismic stations of IS NAS KR, with instrumental data on landslide motions in the Mailysai.

2013:

- Determination of site-effects for observation points of the Fergana network, determination of earthquake dynamic parameters.
- Comparative analysis with the data of instrumental landslide observations in the Mailysai.
- Preparation and writing a report on acquired results over 2012-2013.

Required human resources:

- Department 1 – 60 person-months

Required additional resources:

- Engineer-programmer (for part time work)

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Theme 2: Climate, water and glaciers

Theme supervisor: J.Karamoldoev

2.1 Project: Studying of the Inylchek glacier for the assessment of the glacier balance, morphological and dynamic characteristics and its climatologic and hydrological conditions

Project executors: R. Usubaliev, A.Dudashvili, E.Azisov, A.Mandychev

2.1.1 Project short title

Study of the Inylchek glacier

2.1.2 Project outline

The climate change is the main cause of the Tien-Shan glaciation regression which has been observed during the last decades. It conduces to a reduction of common water resources, activation of mud flows, spring flood and outbursts of glacial lakes. The largest glacial Lake Mertzbacher, dammed by the glacier, is notable for one of the strongest and regular annually repetitive outburst glacial flood. A study of hydrological, climatic, and glaciological changes, related to atmospheric circulation changes in regional and global scale, is possible around this lake, in the central part of the Inylchek glacier, and in the place of the fusion of its two branches: the Northern and Southern Inylchek.

The present project is the continuation of the project 4 implemented in 2008-2009. Such factors as climatic, hydrological and glaciological parameters of the Inylchek glacier will be studied in this project.

The study of the Inylchek glacier will be carried out in the Mertzbacher station base, which was jointly established by CAIAG and GFZ in August, 2009. It is planned to enlarge the set of measurement facilities for the Inylchek investigation.

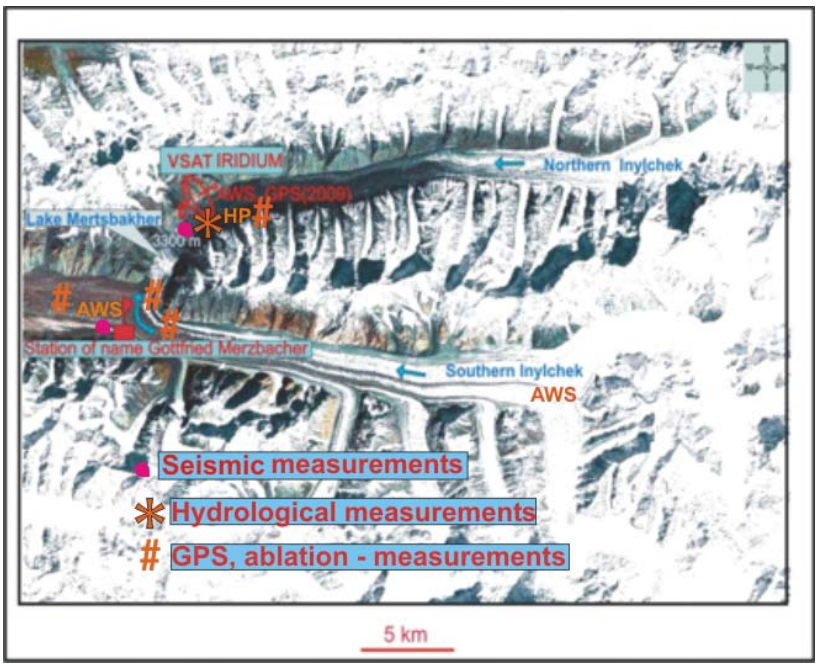


Fig.2.1.1. Inylchek glacier and Merzbacher lake study area

Fig.2.1.2. High elevation scientific station named after Gottfried Mertzbacher

During the glaciological survey it is planned to study the glacier mass balance changes by the morphometric parameter observations in representative areas and the motion rate of the glacier's upper part using remote radar sensing methods, GPS measurements and field measurements *in situ* of the surface runoff, solar radiation level and ablation size.

Optical multi-spectral and radar space glacier images decoding is an important component of research that could allow defining morphological features and parameters, the character of interglacial holes, cracks and canals heterogenity distribution of both surface and interglacial run off.

Automatic weather stations will provide information on temperature, precipitation, humidity, atmosphere pressure, wind and total solar radiation. It will enable to explore the influence of climate changes on the glacier balance dynamics, the Inylchek river runoff and the outburst runoff regime of the Mertzbacher Lake.

A more exact estimation of the summer glacier runoff separately for the North and South Inylchek glaciers is provided using automatic hydroposts, tracer agents like paint or salt and a water flow velocity gauge - Acoustic Digital Current Meter (Ott ADC). Glacier melt water, seasonal snow cover, aeolian pit-run fines (melkozem) and dust-organic substances from the glacier's surface will be sampled for chemical, mineralogical, and granulometric analysis.

Water level fluctuations of the Mertzbacher Lake and its glacial surface shall be recorded with a water pressure sensor developed by GFZ; an Open-GPS - sensor using laser scanning technology and visual observation with high-resolution web-camera will be applied for the monitoring of permanent water surface changes. In the long-term perspective an automatic system based on Open GPS technology will be established for the monitoring of dangerous outbursts at high mountain lakes.

Likewise the exploration of the Mertzbacher Lake and its bottom sediments is planned using the Raymarine A50D echo sounding device. Also a mechanism of glacial dam outburst will be studied. The glacier's structure, its thickness, and the physical and mechanical characteristics of the ice will be defined by a shallow-focus broadband seismic sensing or

electromagnetic penetration geo-radar. A measurement of the glacier's acoustic noises is also planned.

In addition, a project on the deep ice-coring study of the Inylchek glacier is expected to be implemented in collaboration with Japanese, US and German scientists. That will make it possible to improve the understanding of the present and past (about 1000 years) global and regional climatic regimes and relevant natural processes influencing the variability of water-glacial resources and the environment in the region.

All acquired data will be comprised into the GIS "Inylchek", and will be part of the Central Asian geo-database, that will be available to create models for the Mertzbacher Lake regime, the Inylchek River, and the Inylchek glacier dynamics.

All data will be an important contribution to the planning and realization of a safe economic development of the Sarydjaz river basin, particularly, for designing, constructing and maintenance of hydroelectric power systems in this region. Moreover, these data will set a scientific basis for the assessment of climate and environmental change and forecast in the Central-Asian region.

2.1.3 Project objectives and methods

Long-term objectives:

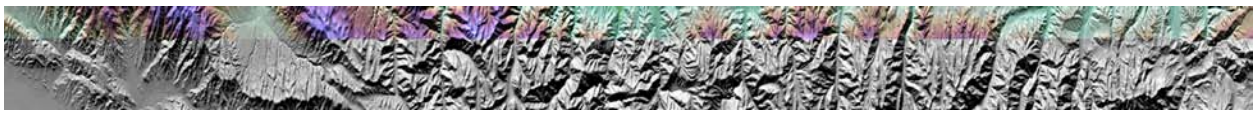
The framework of the project corresponds to the direction "Climate, water and geoecology" of CAIAG's Development Strategy which provides the projection of trends of climate and water resource changes in Kyrgyzstan and Central Asia.

The main objective of this project is an acquisition of climatic, hydrological and glaciological key parameters on the Southern and Northern Inylchek glacier, the Inylchek river and the Mertzbacher lake. To achieve the project goals a monitoring of the long-term and short-term dynamics of the Inylchek glacier will be provided using the combined sensor system for remote sensing installed in the Mertzbacher complex station base. Time series parameters on these systems and results obtained on the basis of their analysis will become an integral part of the Central Asian geo-database.

In a longer-term perspective it is expected to study and to improve the understanding of the regression of the Inylchek glacier and its dynamic changes related to global climate changes and their influence on the water balance in Central Asia. A special emphasis will be lain on the identification of those triggers, that cause the outburst of the Mertzbacher Lake glacial dam, and as well on the establishment of an integrated remote sensing system to monitor the glacial dam outbursts.

Short-term objectives:

The most important short term objective is to measure the series parameters which are needed for the substantiation, modeling and forecast of the glacier, the water, and atmospheric subsystems, particularly in the aspect of possible geo-hazard risk occurrence and water resources change. This process comprises a systematic collection of already



existing and newly acquired data, e.g. data on ice ablation, ice traverse speed, hydrological, hydro-chemical and meteorological parameters, as acquired both from remote sensing observations and repeated field measurements and continually operating, recording and transmitting ground sensor stations in the region.

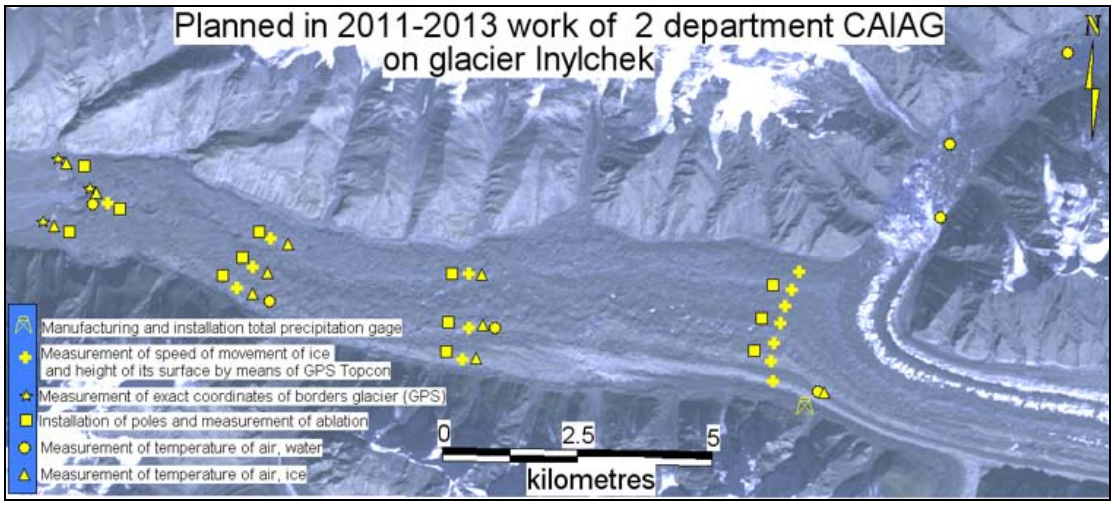


Fig.2.1.3. Scheme of planned activities of 2nd department for 2012-2013

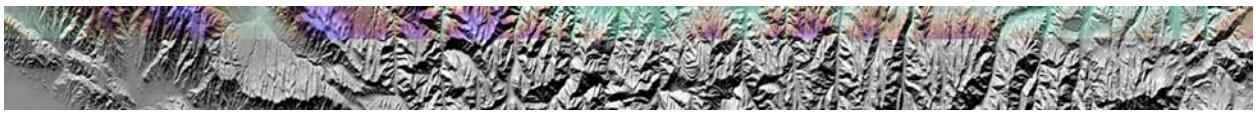
Thus, in the short term perspective the installation of automatic meteorological, hydrological and geodetic sensor stations, equipped with special sensors for satellite communication, will have a priority on the Inylchek glacier study.

The final objective of the project is the assessment of the water-ice balance of the Inylchek glacier based on the analysis of acquired data and the development of multifactor models of the main natural factor correlation, which define the functional principle and the evolution of the Inylchek glacier system.

The data processing and the transfer to the external users will be an important task of the project.

Methods:

- Remote sensing data decoding (optical, multi-spectral, hyper-spectral and radar);
- Geodesic measurements and monitoring (Global positioning system (GNSS), GPS – reflectrometry, GPS – high-precision spot measurements, high-precision topographic measurements by electronic tachometer);
- Field measurements of meteorological, hydrological, glaciological parameters (hydro-meteorological stations and hydro-posts, measurement of water discharges, ablation and thermistor installation);
- Observations on the lake level changes using pressure sensors and continual radar measuring tools, bottom sensing of the Mertzbacher Lake by sonic depth finder;
- Monitoring the displacement of ablation rails using an electronic tachometer;
- Assessment of the glacier's structure, its thickness, physical and mechanical properties of ice using a portable digital shallow-focus broadband seismic station or



electromagnetic penetrating geo-radar. Measurement of acoustic noises of the glacier;

- Chemical, mineralogical, granulometric analysis of glacier melt water samples, seasonal snow cover, aeolian pit-run fines and dust-organic substances from glacier surface;
- GIS based spatio-temporal modeling.

2.1.4 Current status and special requirements

The glaciological, climatic and hydrological data on the Inylchek glacier region and the Inylchek and Sarydjaz River basin are insufficient. An expedition carried out in 2005 in close cooperation with GFZ (W.Michajljow, H.-U. Wetzeland and others) contributed to a better understanding of the Inylchek glacier balance, the glacial flow, the ice traverse speed and the character of the level fluctuation of Lake Mertzbacher.

The installation of a complex station including a permanent GPS, an automatic weather station, and a satellite communication system in August, 2009, was the continuation of the activities mentioned above.

Fig.2.1.4 Hydrological and geomorphological studies in the Inylchek river valley

At present the Northern Inylchek automatic station is operating; meteorological, GPS, seismological and hydrological data are transmitted to CAIAG's server via VSAT system. In addition, the automatic multifunctional hydrometeorological station, equipped with an automatic precipitation gage and an automatic system for solar radiometry observation, was installed in 2010. Here, the special sensors for the measurements of the temperature of perennial frozen rocks and the humidity have been set on different levels of depth (up to 1 meter). The results of this study can give a description of the cryogenic conditions in the area of the station. Besides, two hydrological posts have been installed, the first one was installed for the measurement of the river discharge, which is fed by the meltwater of the Northern Inylchek, and the second one is located near the Mertzbacher Lake for the monitoring of the lake's dynamics and its outburst.

The proposed project will be carried out in this station base and will comprise a complex of activities relevant to the specified objectives. The successful implementation of the project will depend on the provision of the scientific equipment.

Supplementary data is necessary for the implementation of the project, including optical and high resolution radar space images of the Mertzbacher Lake region and the entire Inylchek glacier.

The electromagnetic penetrating radar and the portable seismic station are necessary for the study of the glacier's structure and discontinuity, as well as the ice thickness and density testing, and geophones are needed for the identification of the acoustic noise of the glacier.

For the high-precision operative topographical survey of the glacier an electronic tachometer is required, as well as a mobile automatic weather station of the type VAISALA for the observation of the microclimatic conditions of the glacier. A mobile hydro-post is essential to study the discharge of the liquid and solid surface runoff.

It is essential to allocate financial means to order the analysis of the chemical water composition related to glaciers and of the mineralogical-granulometric dust and sediment runoff composition in a special laboratory.

The transportation to the glacier takes 10 hours (minimum) of flight time by a helicopter.

2.1.5 Internal and external cooperation

The project is planned to be realized by researchers from Departments 2 and 4 of CAIAG in close cooperation with scientists of the GFZ Department "Geodesy and remote sensing". Specialists from Hydromet Service under the MES KR, the Kyrgyz-Slavic University, the Institute of Water Problems, and the Institute of Geology NAS KR and from other Central-Asian research centers will be involved in the project.

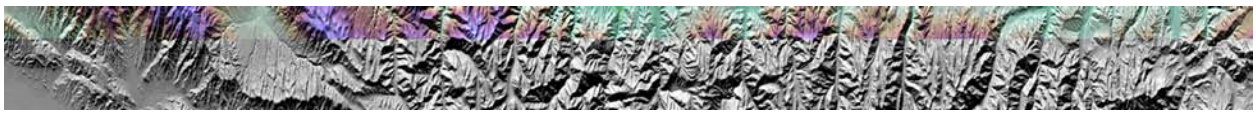
The involvement of the following partners in the project implementation is expected:

- German Aerospace Centre, DLR, Oberpfaffenhofen;
- Technical University, Computer Vision and Remote Sensing, Berlin;
- Commission on Glaciology of the Bavarian Academy of Sciences, Munich;
- Alfred Wegener Institute for Polar and Marine Research, Bremerhaven;
- Versuchsanstalt von Wasserbau, Hydrologie und Glaziologie, Swiss Federal Institute of Technology, Zürich;
- Idaho University, College of Mines and Earth Resources, Moscow, USA;
- Universities of Nagoya and Kyoto, Japan;
- Lomonosov Moscow State University, Institute of Geography of Russian Academy of Sciences;
- Cold and Arid Regions Environmental and Engineering research Institute, Chinese Academy of Sciences, Lanzhou, China.

2.1.6 Work plan and necessary resources

Duration of the project - 2012-2013

2012:



- Acquisition and analysis of remote sensing data, data on climatic and hydrological conditions and parameters of the North and South Inylchek glaciers, the Mertzbacher Lake and the Inylchek and Sarydjaz rivers.
- Field works on the Mertzbacher complex station base. Execution of hydrological, ablative and topographic measurements, water and dust sampling, geophysical sensing of the glacier

2013:

- Continuation of the acquisition and analysis of remote sensing, meteorological, hydrological and glaciological data and GPS parameters;
- Glaciological, hydrological and geophysical field survey.
- Analysis of the acquired data and development of a multifactor correlation model of the climatic, hydrological and glaciological elements of the Inylchek glacier system;
- Development of GIS models for the Mertzbacher Lake regime and the Inylchek glacier dynamics, testing of its water balance components;
- Development of a schematic basis for an early warning system for the outburst of Lake Mertzbacher

Required human resources:

Department 2 - 107 person - months

Required observations/data and equipment:

- Optical and radar remote sensing data (space images of various types and detailedness with different survey time);
- Geodesic and topographic measurements on the basis of networked GPS/GLONASS receivers, GPS - reflectometry, electronic tachometer and geodesic GPS Topcon GB-1000 (is available). Digital tachometer;
- Glaciological (ablation), hydrological measurements through current meter - Acoustic Digital Current Meter (Ott ADC) (is available), sediment runoff value. Sensing of the Mertzbacher Lake bottom by echo-sounder Raymarine A50D (is available);
- Geophysical sensing of the glacier to observe its thickness, structure and density using a geo-radar system or seismic station. Geophone for acoustic measurements. Geo-radar, portable mobile seismic station;
- Sample-taking to define the chemical composition of river and glacial water, the mineralogical and granulometric compositions of dust and sediment runoff. Financial means for lab analyses in special laboratories;
- Ground meteorology: automatic weather station network for temperature, precipitation and humidity observation. Automatic weather station

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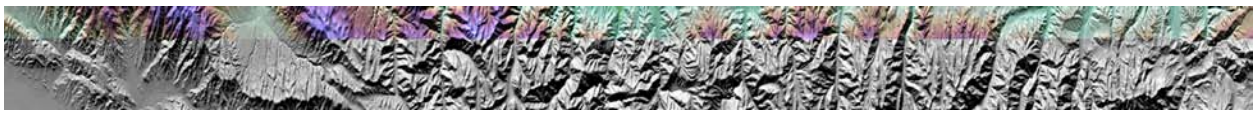

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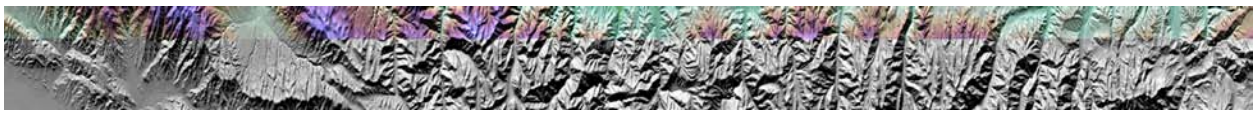


2.2 Project: Monitoring of climatic, hydrological, limnological, glaciological natural and anthropogenic processes using remote sensing data and GIS to solve the ecological problems in the Issyk-Kul lake basin

Project executors: A.Shabunin, A.Mandychev

2.2.1 Project short title

Monitoring of the Issyk-Kul lake basin

2.2.2 Project outline

The present project is planned to be implemented during 2012-2013. It replaces the Toktogul basin project which was performed in 2008-2011, and in the framework of which the intensity of erosion parameters and reservoir sedimentation level were estimated. Main activities to study the Toktogul reservoir were undertaken earlier under the previous CAIAG's RDP which was implemented within 2008-2009. A further study of erosion processes and the volume of sediments accumulated in the Toktogul reservoir became irrelevant relating to the data of the previous research and due to the construction of Kambarata-2 hydropower station.

At present, the investigation of the Issyk-Kul basin (Fig.2.3.1) is a more actual subject for research. The department has a wide database on different parameters of the Issyk-Kul Lake and possesses an extensive work experience in the area. Another strong argument for selecting this area for research was the fact that this area is rather large for researching its characteristics using remote sensing data and satellite imagery with relatively small resolution and, accordingly, with free internet access to these data.

The Issyk-Kul basin with the lake of the same name represents one of the most important areas in Kyrgyzstan in economic, recreational and environmental aspects. Climatic, hydrological, hydrogeological and lymnological studies within this area would enable to make recommendations for a rational use of the basin's natural resources and to solve ecological issues related to economic activities and climate warming. In particular, from 1960 to 2005 the air temperature increased by 1-1,5°C at the near-shore zone of the Issyk-Kul basin. The tendency of climate warming in the Issyk-Kul region outlined since the 60-s of the last century had an effect on the water temperature in the lake. Thus, according to V.V.Romanovsky and A.G.Shabunin, the temperature of depth water in the lake increased by 0,5°C.

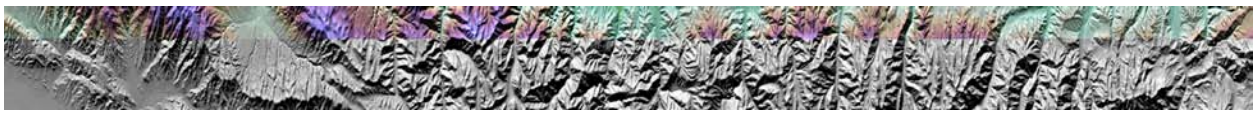


Fig.2.2.1. Issyk-Kulbasin

Warming has led to a decrease of the glaciation. A lot of research works have been devoted to the study of mountaing glaciation reduction in Central Asia due to climate warming. According to assessments of these works, the area of glaciation (including Issyk-Kul basin) reduces by 0,5 - 1% per year. In future, such reduction will negatively affect the flow of glacier fed rivers, water inflow from these rivers to the Issyk-Kul Lake, and consequently the level of the lake. All these factors lead to an alteration of the ecological situation in the region.

Along with the climate change the lake has been used for recreation and tourism year by year. Anthropogenic activity in the Issyk-Kul lake basin (increase of water consumption, growth of population, motor transport, building of lots of recreation centers in the foreshore) has led to an increase of the load on the water resources of both the closed lake and its basin.

Within this project it is planned to collect and analyze the actual observation data of the last years on climatic, hydrological, hydrogeological, limnological and other parameters of the studied area. Moreover, due to the fact that a number of existing meteorological stations and hydrological posts in the Issyk-Kul lake basin are not sufficient for a qualitative analysis of the parameters, it is expected to use broad band satellite data (optical images, radiometric and radar data). In particular, it is planned to decode the elements of natural environment, as well as to analyze the spatial distribution of the principal climatic characteristics.

Collected actual data will be used to analyze the ecological state in the Issyk-Kul lake basin and forecasting the impact of climate change and the increase of anthropogenic load on morphometrical, hydrodynamical and thermical characteristics of the lake, as well as on water, glacier and other natural resources of the whole basin. The acquired results of the project will enable to develop recommendations for a rational use of the water resources in the Issyk-Kul basin which would promote the economic development without any prejudice to the environment.

2.2.3 Project objectives and methods

Long-term objectives:

The objective of the present project complies with CAIAG's strategy in the dimension of

«Climate, Water and Geoecology» which stipulates a forecast of the climate and water resources change tendencies in Kyrgyzstan and Central Asia.

The main long-term objective of the present project is to study the impact of climate change and anthropogenic load on the ecological state of the ecosystem in the Issyk-Kul lake basin. Impact assessment will be provided on the basis of analysis of changes in principal climatic and hydrological indicators.

Short-termobjectives:

In short term perspective, the climatic, hydrological, hydrogeological, limnological, and glaciological studies in the Issyk-Kul lake basin are planned on the basis of existing actual data, remote sensing data and data of *in situ* measurements of separate characteristics.

It is also expected to fill in and develop the database with hydrological and hydrodynamic parameters of the lake, as well as climatic, hydrogeological, limnological parameters of its basin.

Methods:

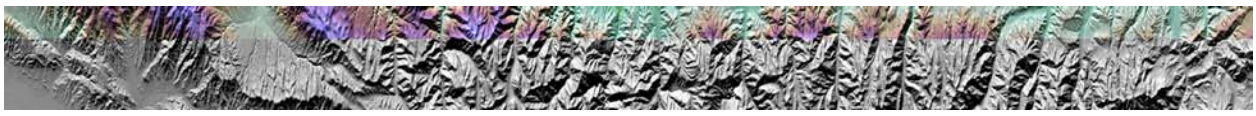
- Analysis of remote sensing data by multispectral and radar space images, use of the data acquired from specific satellites (altimetry, temperature, precipitation).
- Analysis of time series of parameters of precipitation, temperature, river and groundwater flow, lake level.
- Field topographic, echo-sounding, hydrological, meteorological measurements.
- Analysis of spatial distribution of parameters based on GIS, modeling of the lake's water balance and its basin.

2.2.4 Current status and special requirements

Study of theI ssyk-Kul Lake and its basin has a long history and lots of scientific publications were devoted to it. At different times a number of climatic, hydrological, glaciological, limnological and other studies were conducted in this region.

Specialists of the Department «Climate, Water and Geoecology» of CAIAG have experience in conducting research activities in this region. They directly took part in implementing the R&D Programme and many international projects on studying the lake and its basin. In particular, A.G.Shabunin was involved in many international expeditions, carrying out the instrumental observations of the temperature regime of the Issyk-Kul Lake, its dynamics and physical-chemical features (color, transparence, oxygen content etc.). Also he took part in the core sampling from the basin bottom. Further, based on the results of field data analysis he defended the PhD thesis on the following topic: «Hydrodynamic processes in the Issyk-Kul Lake and their role in the ecological situation formation in its basin».

A.N. Mandychev studied the Issyk-Kul basin groundwater. As a result, the depth groundwater resources were assessed, renewable resources and the ecological state of the groundwater of quaternary water-bearing complex, being the main source of drinking water, were specified for the first time.Some of these studies were performed within the following projects:



- Scientific works of the Institute of Water Problems and Hydropower, National Academy of Sciences, Kyrgyz Republic - "Creation of the informational support system for water resources management in the Issyk-Kul oblast (2000-2003) and unit of inquiry-communications system in the Issyk-Kul oblast" (2006-2010).
- International project «APELIK» – «Assessment and forecast of the environmental changes in the Issyk-Kul lake» (2000-2004).
- International project «КР330.3» under ISTC grant – «Study of the water balance and hydrodynamics of the Issyk-Kul Lake using isotope methods» (2002-2005).

Currently, there is sufficient information in the database on hydrological, climatic, limnological and other characteristics of the Issyk-Kul lake basin, including both archived information acquired from meteorological and hydrological stations and posts and actual information acquired from satellite data (lake level, surface temperature etc).

The specific requirements for this project are:

- Satellite images of various types and details with different shooting time, necessary for analyzing spatially distributed parameters and mapping the region to assess an anthropogenic load.
- Funds for performing an analysis of chemical composition, contamination and other water characteristics in certified labs.
- Tools for defining position coordinates points of the area in order to map the point contamination sources (geodetic and hand GPS).
- Georadar for defining the depth of groundwater occurrence.
- Digital thermometers
- Automatic meteorological stations

2.2.5 Internal and external cooperation

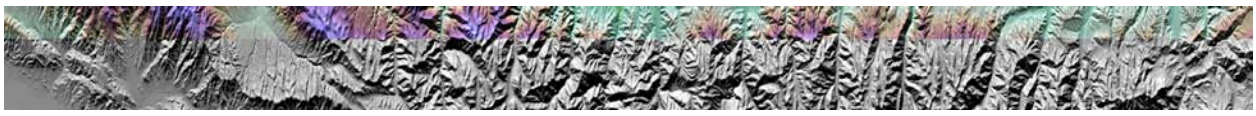
The project is planned to be implemented by the Departments 2 and 4 of CAIAG and in cooperation with the Institute of Water Problems and Hydropower NAS КR, the Institute of Geology NAS КR, the Institute of Irrigation, and the Directorate on Hydrometeorology under the Kyrgyz Ministry of Emergency Situations and with scientists from other Central-Asian countries.

2.2.6 Work plan and necessary resources

Project duration 2012-2013

2012:

- Acquisition and analysis of remote sensing data, actual data on climatic, hydrological, limnological parameters of the Issyk-Kul Lake and its basin;
- Assistance in creating a section of the geodatabase on meteorological, hydrological, limnological parameters;



- Analysis of acquired data using different data processing methods, analysis of climate change and related hydrological, limnological changes in the region and estimation of anthropogenic load on the lake and its basin, in a whole.

2013:

- Continuation of collecting the actual data on the Issyk-Kul basin;
- Field works on measuring new hydrological, ecological, GPS parameters, creation of digital maps in GIS environment;
- Installation of automatic meteorological stations on the basis of existing hydro-meteorological posts of the Hydrometeorological Agency, MES;
- Acquisition of new actual data through satellite image decoding and comparing the results within different time series;
- Study of the climate change impact and of the increase in anthropogenic load on the ecological situation in the basin;
- Development of a unified model of the climatic, hydrological and limnological systems' interaction in the Issyk-Kul basin.

Required human resources:

Department 2 - 107 person /months

Required observations/data and equipment:

- Optical and radar remote sensing data (space images of various types and details withdifferent survey time).
- Meteorological parameters: temperature and precipitation on weather station network. Historical data on groundwater level regime.
- Hydrological observation data: river discharges on hydro-post network and by current meter - Acoustic Digital Current Meter (Ott ADC) (is available). Data on the current in the lake;
- Observations of the Issyk-Kul lake level, bottom sediments by echo sounder Raymarine A50D in the water area (is available).
- Geodetic surface mapping: geodesic measurements by GPS Topcon GB-1000 (is available) and electronic tachometer (is available).

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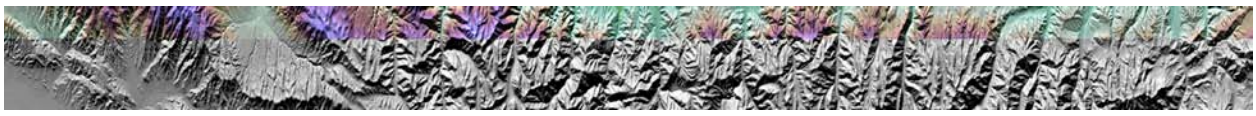

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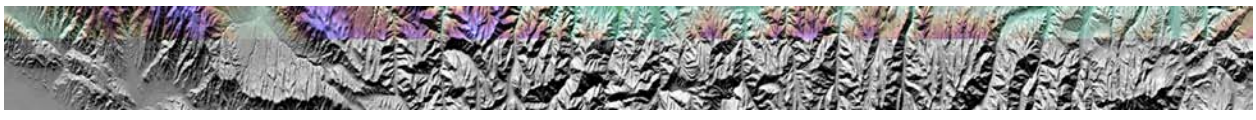


Theme 3: Information and Monitoring Systems

Theme Supervisor: A. Zubovich

3.1 Project: Development of a dangerous phenomena monitoring system in a quasi-real time mode

Project executors: A.Shakirov, A.Sharshebaev, F.Yunusov

3.1.1 Project short title

Monitoring system development

3.1.2 Project outline

Central Asia is a region which is known for its sharp continental climate, high mountains with numerous rivers and arid deserts. High tectonic activity leads to destructive earthquakes with severe consequences. Landslides, avalanches, mudflows, floodings and droughts are typical natural disasters for this region. These disasters result in affecting the infrastructure and the living conditions of people. Therefore, creating monitoring networks to track these dangerous phenomena is most vital for the countries located in the region.

This project is aimed at developing a disaster monitoring system, on the basis of which was laid down in previous years. The system includes:

- Network of stations
- Subsystem of data transfer
- Subsystem of information collection and processing

The subsystem of data transfer is organized depending on the conditions of stations' locations. That can be a VSAT system if the station is located in remote mountainous areas, or GSM communication if its location is within the coverage area of one of the local mobile operators or Internet access if the station is located in a settlement covered by Internet communication.

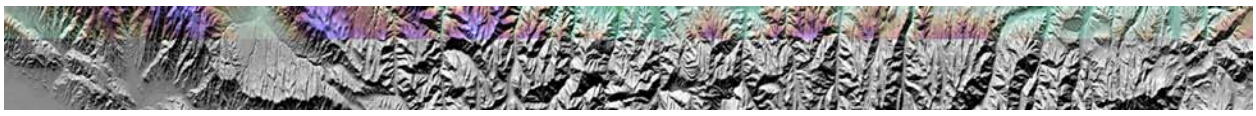
CAIAG's subsystem of information collection and processing is equipped with modern hardware, including the set of servers, storage bodies and software packages which exercise equipment control, data acquisition, processing and storage.

3.1.3 Project objectives and methods

The objective of this project is to develop the CAIAG monitoring system, as a basis of the early warning system.

The project will include:

- Installation of new stations;
- Upgrading of existing stations;



- Inclusion of the stations installed under the other projects into integrated monitoring network;
- Expansion of hardware and software, as well as managerial components of the information acquisition and processing center.

During the project implementation it is proposed to create a small network consisting of 4 GNSS stations connected via radiolink with the main station which will be equipped with a VSAT terminal for the data transfer to the data acquisition and processing center. The probable location of the network is a zone of intersection of Pamir and Tien-Shan in the western part of the Alai valley. The given area is one of the most active ones in the region; the velocity of Pamir thrusting on Tien-Shan is no less than 10 mm per year.

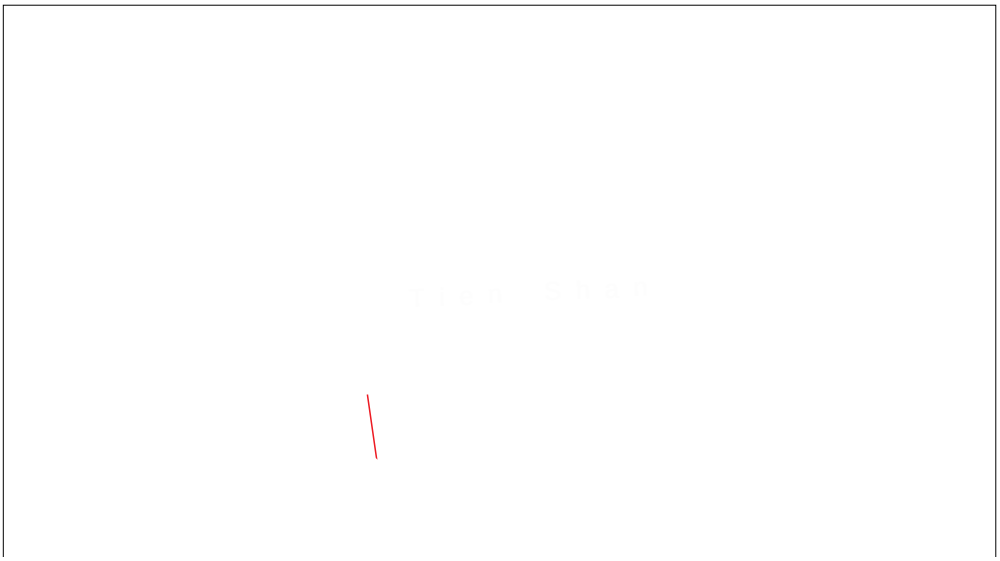
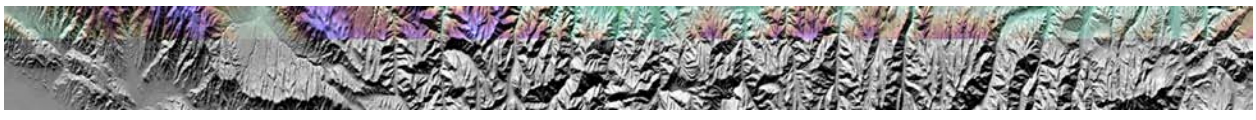


Fig. 3.1.1. The area of Alai valley – the place of proposed installation of GNSS stations network. The red line is a profile along which the stations can be installed

Operational experience in monitoring system design has shown that existing stations require modernization. Thus, it is necessary to additionally equip the GNSS stations with minicomputers to control these stations. The reason is that under low storage batteries the GNSS receivers Topcon GB-1000 work improperly and they can get into working state only through their switching off/on. The “TinyPC” developed by Markus Ramatchi (GFZ) on the basis of PC-104 boards is an ideal option for the minicomputers to be equipped at the GNSS stations. These computers have a low power consumption (2,5 W), "WatchDog" mode and 4 controlled feeding ports.

Existing smart-stations also require improvement. It is necessary to change the feed system and replace the SeisComp computer. This computer also works improperly under the low voltage. Only its restart can bring it to operating state. It is the “WatchDog” mode that is used for restarting computer in case of its hang, but unfortunately SeisComp is not equipped with it.

The implementation of different projects provides an opportunity to extend the monitoring system if they are aimed at the installation of stations or network establishment. The main problem can emerge in case of incompatibility of new formats and interfaces with the existing system. This project component is aimed at providing the relevant conditions to



integrate new stations into the CAIAG's monitoring system which includes the software development, additional supply of required equipment, and different organizational measures.

3.1.4 Current status and special requirements

Currently, CAIAG's monitoring system includes:

- 6 own stations (4 GNSS stations with Topcon GB-1000 receivers and GSM communication, 2 smart-stations which consist of a broad-band seismic station ST-2, meteorological station Vaisala WXT520, GNSS, Topcon GB-1000 receiver and VSAT satellite terminal);
- 3 stations of the CAWa project, one of them has been installed on the base of CAIAG's third former smart station;
- 2 permanent and 5 temporal stations on the Inylchek glacier area, installed under the Global Change Observation programme;
- 1 seismic station within CAREMON network provided under InWent project.

The stations have different sets of sensors, but are arranged according to a unified scheme: the control system, supply and communication are in the center installation. Locations of monitoring stations are shown in Fig.3.2.2.

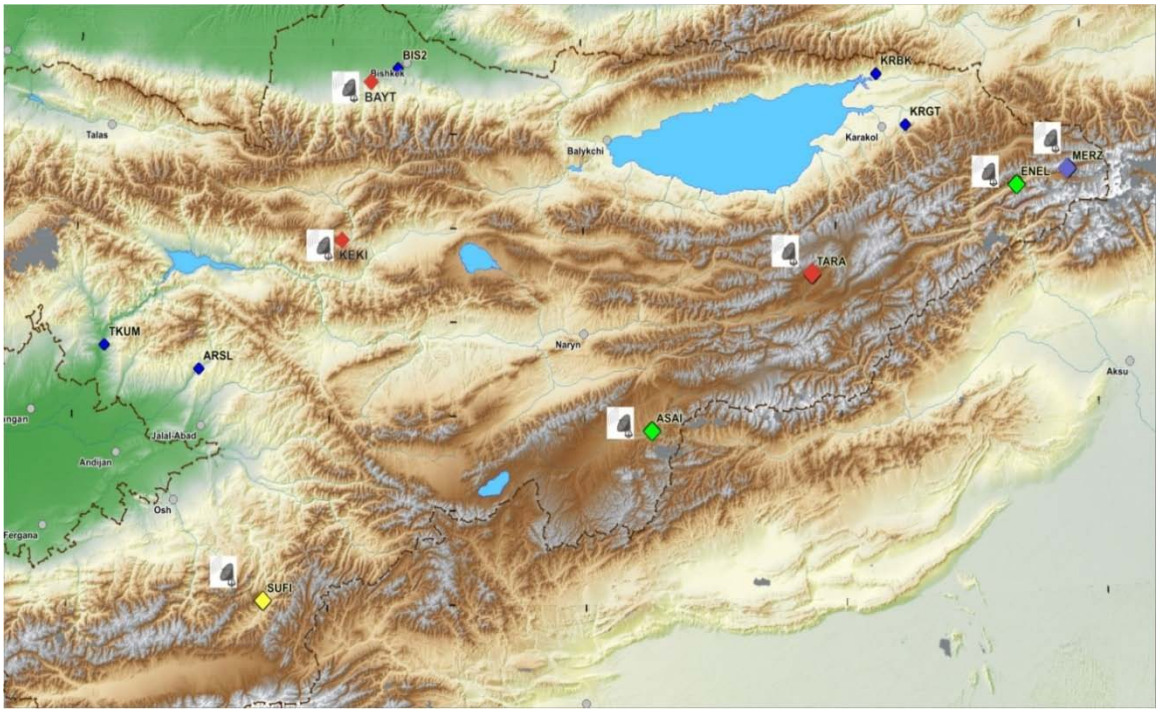


Fig.3.1.2. Layout of CAIAG's monitoring stations

3.1.5 Internal and external cooperation

The project is carried out by staff of Department 4. In some cases specialists of the Departments 1 and 2 are involved. It is expected to maintain close cooperation with experts from GFZ Potsdam, Germany. The cooperation with Kyrgyz and Central Asian institutions, as well as with experts from Europe, Asia and North America will be continued.

3.1.6 Work plan and necessary resources

Required labour:

- Installation of new stations - 24 man/month;
- Upgrading of existing stations – 24 man/month;
- Integration of new stations from other projects into the monitoring system – 24 man/month;
- Improvement of hard-, software, managerial components of data acquisition and processing center – 36 man/month.

Fig. 3.1.3. Smart station in Aksai (AKSA) and Hymet station in Taragai

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3.2 Project: Geo- Data Base of Central Asia

Theme executors: M.Jantaev, V.Savin

3.2.1 Project short title

Geo-data base of Central Asia

3.2.2 Project outline

The Geo-Data Base (GDB) of Central Asia is the basic data and information system of CAIAG. The main purpose of the GDB is to store data in the form of bit-mapped and digitized topographic and thematic maps, satellite images and aero-photos, radar scenes and different geophysical and geodetic data (e.g. topographic, gravimetric, electro-magnetic, seismic, meteorological, remote sensing data and derived data products) in the form of binary records or tables, to provide services on quick data searching, basic parameter preview, generation of selected information catalogue and its downloading using FTP access.

The Geo-database includes all data required for the research and development undertaken by CAIAG and its partners, as well the results of completed studies and information of interest for perspective projects in future. All data are systemized by thematic directions, creation date, and spatial location. Each kind of data refers to metadata, which contains the description of data.

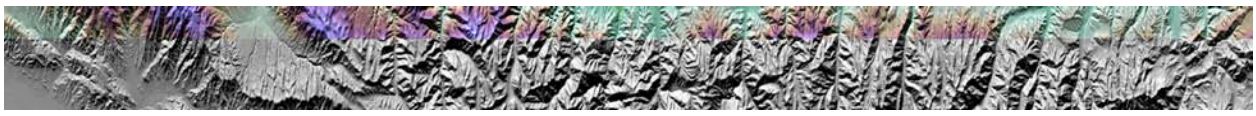
In previous years the GDB’ basis has been developed. Fig.3.1.1 shows the conceptual scheme. In the given project the further development and improvement of the GDB is planned. Generally, it will concern the following activities:

- Improvement of GDB structure and methods of access to it;
- Development of software tools for the various options of the GDB access;
- Continuation of GDB filling.

One of the major requirements to it is to handle vast amounts of multi-user-oriented data. It is essential to structure and index the heterogeneous information in a correct manner. Authorized access to the data base, information search and visualization, partly operating in real-time mode, will be performed using advanced web technologies, different GIS and other software. Altogether, the GDB will become a basis for analysing and interpreting information about endogenous and exogenous processes in the Earth system, with special emphasis on natural hazards and early warning in the Central Asian region.

3.2.3 Project objectives and methods

The objective of this project is the development of a geo-database for Central Asia, as a basis of informational system of CAIAG. The GDB development will be implemented in the following directions:



- Improvement of GDB internal structure and data access methods, enhancement of its functionality;
- Development of web-interface for access to GDB;
- Design of interface modules and programme applications aimed at the maximal use of data from GDB;
- Design of access methods, based on SOS (Sensor Observation Service);
- GDB filling up.

The relational database using for the purpose of spatio-temporal information storage requires prior data standardization. On the one hand, it results in effective reduction of useless data redundancy, on the other hand, it leads to the increase of the number of elementary units of storage – tables. All associated data will be structured by means of assets available in DBMS PostgreSQL.

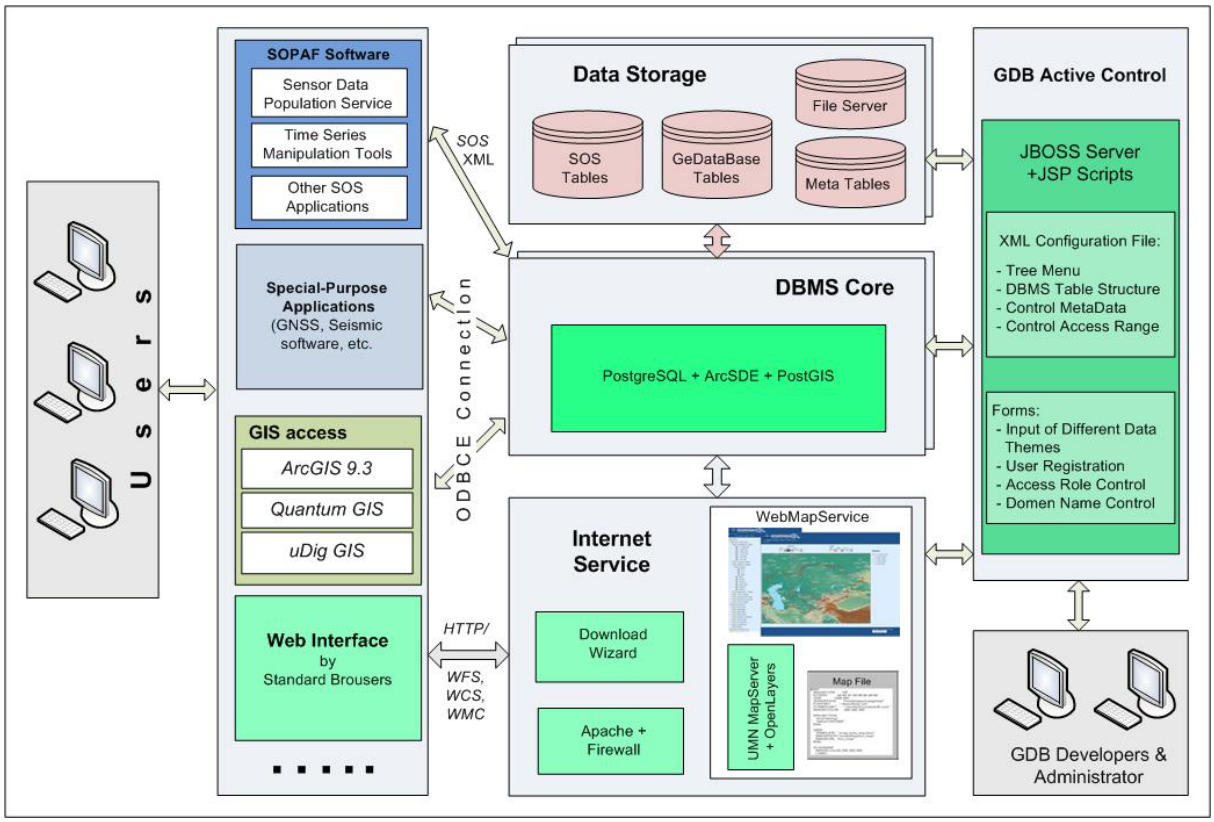


Fig.3.2.1. Conceptual scheme of Database

The value of information depends on quick and easy access to it, as well as on the availability of suitable tools for data manipulation and for presentation of results in the required form. Within this project, the development of such software will be continued. Also, the improvement of server software for the advanced access to DB through web-interface and introduction of OWS technologies for the creation of distributed web-GIS databases will be continued. In-depth utilization of data storage and application methods is expected in a SOS format (Sensor Observation Service) and SOPAF system developed by GFZ on the

SOS basis.
It is proposed that GDB filling will be implemented on the basis of specific activities on the mass digitalization of topographical and thematic maps within the subject area of CAIAG, as long as various projects dealing with GIS application and data of temporal series are implemented.

3.2.4 Current status and special requirements

Up to date, the following activities have been completed:

- Conception of geo-database, methods of storage, modification and access provision have been developed;
- Software components have been justified, selected and installed, the requirements to complementary modules have been defined;
- Basic procedures of all system functioning have been tested;
- Partial filling of GDB has been performed;
- GDB has been converted in a mode of test functioning.

Basic components of GDB:

Hardware:

- GDB Server for geo data storage and management;
- Data storage disk of 24 Tb capacity*;*
- Internet Server for external users of GDB;
- Network Infrastructure, to which GDB Server and Internet Server are connected;
- Client computers.

Software:

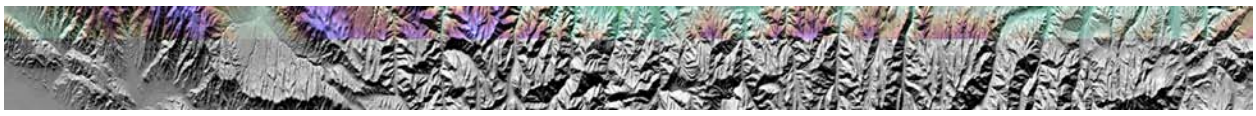
- Relational PostgreSQL database with combined support of PostGIS and ArcSDE spatial data;
- Tools to create and support Internet portal for external access to data of the GDB on the basis of OWS and OpenLayers libraries;
- Tools to elaborate the structure of GDB, to input and support the actuality and unity of spatial data connections on the basis of PgAdmin III;
- Different programs to input the data of monitoring systems and auxiliary utilities.

Data:

- Remote sensing LandSat data;
- Geodetic and geophysical data (climatic, seismic and other measurements) from monitoring stations;
- Raster Maps and vector layers;
- Metadata for unique identification of data units and search.

3.2.5 Internal and external cooperation

The project is implemented by staff of Department 4. Specialists of Dept. 1, 2 and 4 will contribute in filling the GDB. It is planned to cooperate on an equal footing with experts of the Ministry of Emergency Situations of the Kyrgyz Republic, the State Cartography Service,



research institutions of the Academy of Sciences of the Kyrgyz Republic and organizations of Central Asia. The cooperation with GFZ and other institutions from Europe, Asia and North America will be continued.

3.2.6 Work plan and necessary resources

Duration of the project: 2010-2013

2012

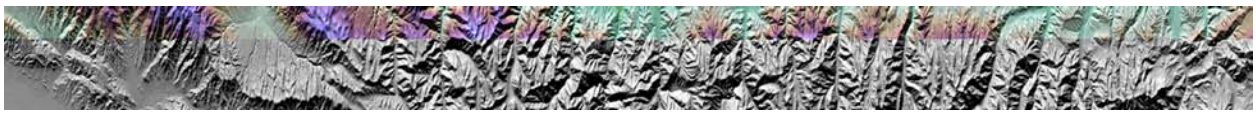
- Development of a scheme of the client-server multi-user GDB organization;
- Expansion of GDB access capabilities for the external users;
- Preparation of vector and raster topographical maps of 1:500000 and 1:200000 scale and their input into GDB;
- Analysis and improvement of GDB structure, development of GDB web-access functionality

2013

- Application of OWC (OGC Web Services) technologies in GDB that makes possible to create distributed Web – geo-databases and corporate Web-GIS projects.
- Activity on GDB filling will be continued.

Required Manpower:

- Improvement of GDB structure and its access methods - 32 man/months;
- Development of software for the various access to GDB – 48 man/months;
- Continuation of filling GDB with data – 106 man/months.



Theme 4: Capacity development

Theme supervisor – L.Joldubaeva

4.1 Project: Capacity development and education for disaster risk reduction

4.1.1 Project short title

Capacity building and education for disaster risk reduction

4.1.2 Project outline

During the last three decades scientific knowledge about natural hazards and the capability to manage them has considerably improved. Yet despite availability of knowledge and expertise, communities remain vulnerable to disasters that are more destructive than ever. While a number of barriers prevent the widespread adoption of disaster reduction techniques, these can be overcome through better use of science and technology as well as through more effective education, capacity building and public awareness programmes where various disciplines and sectors come into play.

Advancement, transfer, sharing and application of knowledge are key foundations for disaster risk management. Achieving disaster resilience is essentially a process of using knowledge and learning at all levels.

The proposed research topic will cover several levels of education:

1) Provide an opportunity to get the highly specialized skills in e.g. GIS, risk and vulnerability assessment for experts of state agencies, such as Ministries of emergency situations, seismological institute and earthquake engineering, water related institutes and departments, etc.;

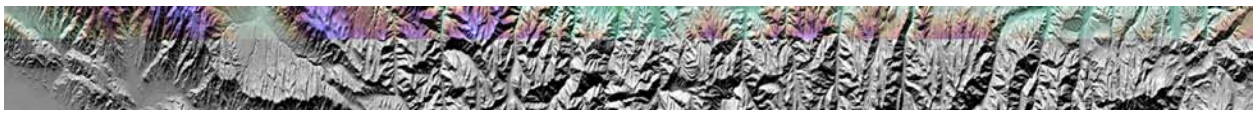
2) Support the qualified young scientists from scientific centers in Kyrgyzstan and other Central Asian countries by launching and proposing the educational PhD programs for CA students in Germany, together with DAAD, Volkswagen Fund, UNESCO;

3) Increase of awareness of the local authorities and communities in natural disaster risk management at the local level, and training on technical skills of risk assessment and mitigation.

4.1.3 Project objectives and methods

The project purpose is to disseminate knowledge, to provide professional staff training and to create a network for promotion of capacity development in the field of disaster risk reduction in Central Asia.

The purposes will be achieved through the creation of a resource group which will be engaged in developing projects, curricula and programs for various target groups, as well as



participate in preparing the strategies and concepts, regarding the disaster risk management, environmental changes and institutional development. The resource group will work together with the donor organizations (DAAD, GIZ, SDC, ISDR, Aga Khan Foundation) which provide grants for educational activity and capacity building, and with Central Asian and German universities and scientific centers, state agencies, NGOs and local communities.

4.1.4 Current status

Nowadays, many research centers in Central Asia extremely lack for young specialists in the field of geosciences. For example, the universities in Central Asia do not have master diploma for specialists in the field of seismology. It is necessary to close this gap and to start retraining of graduates in closer and relevant technical specialities.

Besides, there is an essential interdisciplinary rupture between specialists studying disasters and socio-economic specialists studying economic and social impacts of disaster consequences or mitigation activities. For the purpose of integrating mitigation and preventive measures in a context of the development, various disciplines of geosciences and social and economic sciences should combine their efforts in an educational and communicative field through interdisciplinary work to find a solution for complex problems of risk assessment and reduction.

CAIAG as a research centre possesses the sufficient competence to share knowledge among other scientific centres and public groups and has got a wide experience in the implementation of capacity building components within the various projects as CASCADE, PALM, CAWa, LUCa, in cooperation with the partner organizations – GFZ, InWEnt, GIZ, ISDR, UNU, SDC, with various universities of the Central Asia and Germany. CAIAG has collected sufficient training materials both for experts of narrow specialities and representatives of local administrations and communities.

4.1.5 Internal and external cooperation

The topic is planned to be oriented on the staff requirements of Departments1,2 and 4.

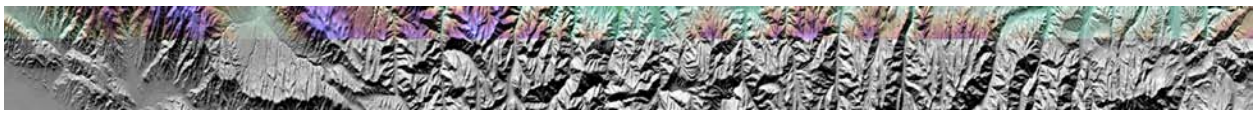
The scientific plans will be developed for PhD students involved in the implementation of R&D programme.

During the realization of regional projects the sound partner network, including research centres, universities and individual scientists from Central Asia, Germany, Russia, USA, China, Japan and other countries, has been established.

4.1.6 Work plan and necessary resources

Duration of project 2012-2013

2012:



- Development of project concept and detailed plan;
- Recruitment of employees with relevant qualification;
- Preparation of project proposals to be submitted to the donor organizations for carrying out training activities and an educational program aimed at PhD students;
- PhD students selection on the R&D programme themes;
- Planning of trainings for the state agencies and local authorities and local communities: drawing up of a curriculum, systematization, updating and adaptation of available training materials, selection of lecturers;
- Work with universities, identification of gaps, assistance in improvement of syllabus and curricula on profile specialties of universities, provision of teaching and practical base in CAIAG/GFZ for educational practice of senior students.

2013:

- Carrying out of trainings for relevant state departments and local authorities and communities;
- Carrying out of social-economic studies,facilitation to replenish the social-economic data into the geodata base;
- Carrying out of seminars, workshops, summer schools for PhD students;
- Participation in conferences, seminars in area of disaster risk management;

Required Manpower:

Department 5 - 72 person/month

- Preparation of project proposals, planning of training activity, communication with funding organizations and beneficiaries, development of content of trainings – 48 man/month;
- Promotion of PhD programmes, cooperation with universities – 24 man/month;
- Social-economic studies supplementary to the research projects of the R&D programme – 24 man/month.

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