

## Proposed Research Topics

### 1) Temporal variations of the gravity field due to major Earthquakes

Data acquisition is a cornerstone of GISciences, which may be achieved efficiently (i.e. huge number of observations with homogeneous coverage) by satellite-borne remote techniques. Among them satellite gravimetry delivers information on mass distribution of the Earth.

The most recent GRACE gravity satellite mission has delivered monthly gravity field models between 2002-2017, which time series will be continued by its follow-on mission, the GRACE-FO to be launched in early 2018. The monthly gravity field solutions enable determination of mass varying processes over large regions. There are attempts to determine co- and post-seismic surface distributions as well, however the methodology is case dependent and not optimal so far.

The research should focus on the following related issues:

- optimal storage and advanced services using GRACE and GRACE-FO data
- spherical harmonic synthesis of monthly solutions
- surface deformations due to co- and post-seismic events
- determination of surface deformation of major megathrust events
- determination of focal mechanism parameters based on gravity data

**Expected output:** Summary presentation at the host institution, draft manuscript / academic paper.

### 2) Creating the scientific basis of cartographic ensuring of State water cadaster and managing the water resources by GIS technologies

On GIS technology the development of water resources management and its method of analysis and the creation of scientific basis for the cartography of the State Water cadastre and its mapping determine the relevance of this research.

From that point of view, it is important to identify the current state of the State Water cadastre with quantitative and qualitative indicators. Usage of cartographic methods to show a detailed analysis, and creation a systematic approach on the basis of thematic card and atlas, and to introduce them into production are very important.

With the help of pilotless flying objects or drones GIS and geo-information are widely used in mapping of amplitude and the direction of underground water throughout the season.

**Expected output:** Summary presentation at the host institution and draft manuscript

### 3) Change detection in complicated hydromorphic landscapes with remote sensing

There was disastrous regional-scale degradation of the Aral Sea region within living memory. This environment transformation cause dramatic changes at the regimes and hydroecology of the water objects in the lower course of Amu-Daria river. Ecological functions and role in the geocosystem of the lakes, oxbows, wetlands, spacious reeds had been metamorphosed under

water deficit, general climatic aridisation and anthropic pressure. These transformations don't stop or slow off and still affect the rangy delta plains with numerous water objects including Sudochie natural reserve, strategical water reservoirs as Dawtkul and regulated lakes for aquaculture. Goal of this investigation is accomplishing of remote sensing technique and methodology to increase susceptibility of interpretation approaches to small but potentially dangerous land-cover conversion using modern methods in remote sensing data interpretation including model-oriented recognition and patterns' outcrop.

**Expected output:** Illustrated presentation at the host institution, draft manuscript and scientific publication.

#### **4) Using geo participation to assess urban green in terms of young people's perception - by the example of Tashkent**

In many cities around the world urban green has been receiving growing attention due to reasons such as increasing urbanization and climate change impacts on cities. Urban green provides a number of benefits (ecosystem services) to people: provisioning services, regulating services, supporting services, and cultural services. In particular, cultural ecosystem services - related, e.g., to recreation and outdoor sport, inspiration for creative work, (environmental) education and nature experience – are difficult to identify, capture, and assess. Depending on social-demographic and ethnic/ cultural aspects urban green is used and perceived by different people in different ways. These differences provide important information for urban planning. A group for which access to urban green is of particular importance are young people. This, among others, is strongly emphasized by organizations such as UNICEF. However, knowledge on how young people use and perceive urban green is often still missing. Here, involving the youth in data collection and in the assessment of urban green has been gaining in popularity. This delivers information needed to create more child- and youth-friendly cities (as demand by UNICEF, UN Habitat, etc.).

The applicant will implement a geo participation application (using e.g. ArcGIS online/ collector app, Google Open Data Kit) that allows young people in Tashkent to contribute data reflecting their use and perception of urban green, their likes and dislikes, etc. To collect a sufficient amount of high-quality data aspects such as application publicity as well as user motivation and skills must be taken into account (e.g. building the app, throughout the data collection stage). The applicant will analyse the crowdsourced data and assess the actual situation, using also open data available from different sources such as Open Street Map.

**Expected output:** Presentation at the host institution, draft manuscript/ academic paper (to be submitted, e.g., to GI\_FORUM)

#### **5) Spatial Simulation of land-use change**

Land-use has changed significantly in many parts of the world. This change can be attributed to a range of different natural and anthropogenic reasons. Drivers of changes through environmental conditions include climate change, salinification, erosion or flooding, whereas direct anthropogenic drivers relate to urban sprawl, forest clear cuts, or automation of

agricultural management practices. Some of these changes contribute to sustainable land use practices that secure good and healthy living standards for the human populations that live in these areas. However, many changes are detrimental to the well-being of the local human population and the state of natural ecosystems. Spatial Simulation modelling can help to assess the impact of policies as well as management and mitigation practices on land-use change.

In this research, the applicant will review existing land-use change models. He or she will integrate and modify these models to address a specific land-use change driver of interest. With the help of scenario-based research, alternative management options shall be implemented to test their impact on the land-use of the case study area. The software environment will be GAMA and the respective model development language GAML. An introductory tutorial to program with GAMA will be provided. However, a general interest and preferably prior experience with programming is a prerequisite.

**Expected output:** A working model with a related report that documents the results, as well as a presentation of outcomes at the host institution.

## **6) Synthesis of observed historic and expected future climate changes**

Climate change has already substantially impacted Central Asia, and future challenges for the region loom large because the past temperature increase will likely continue, and the volatility of precipitation may rise further. Unfortunately, there are few studies that have systematically assembled existing evidence of climate change in the region and the effects it may have on agricultural production. During this research stay, we aim at synthesizing existing spatial data on observed historic changes and available future projections in temperature and precipitation for the entire region. The applicant will then use the quantitative evidence to evaluate the likely impacts of historic changes and of alternative future pathways on agricultural production. The results are expected to shed light on the areas where climate-related changes have already exerted the largest impacts and allow pinpointing where future hotspot of expected climate may emerge.

**Expected output:** Summary presentation at the host institution and draft manuscript

## **7) Impacts of climate change on crop production**

Climate change jeopardizes future crop production in Central Asia through alterations in temperatures, changing precipitation patterns, and more frequent extreme weather events. Therefore, it is important to understand the potential effects that climate change may have on crop yields to adapt farmers in Central Asia to climate change. During this research stay, we will support the applicant in using crop growth modelling or statistical approaches to assess historical, current, and future impacts of climate change on crop production in Central Asia. We will also assess effective adaptation measures in the agricultural regions of Central Asia to address the effects of climate change on agricultural productivity. For example, the applicant will use crop growth modelling to test adaptive crop varieties that are tolerant to likely future

climate conditions, such as heat stress and temperature-induced water stress. This research is extremely timely and relevant as impacts of climate change on crop production and adaptation in Central Asia remains extremely a vastly under-researched field.

**Expected output:** Summary presentation at the host institution and draft manuscript

## **8) Comparison and assessment of available land-cover and land-use maps**

Accurate and credible information on the state of land use and land-use changes are cornerstone for many questions that are of high ecological, socioeconomic, and political relevance. Unfortunately, existing land-use products derived from satellite imagery for Central Asia differ in terms of thematic depth, temporal resolution, spatial coverage, and accuracy. The aim of this research stay is to take stock of global, regional, and national land-cover and land-use products that exist for Central Asia and to assess their accuracy and validity, including a systematic validation of these products. The results will include a harmonized land-cover maps for the region, which is expected to provide insights into the value of existing land-cover products and provide a better basis for approximating land-use changes in Central Asia. Moreover, the results facilitate to pinpointing research gaps and a priority lists for future assessments of land-cover change.

**Expected output:** Summary presentation at the host institution and draft manuscript

## **9) Determination of a precise geoid model for Uzbekistan**

The concept of the geoid plays an important role in geosciences, such as definition of modern geodetic reference systems, realization of height systems in national and global levels, understanding sea level rise and global climate changes. With the widely use of GNSS positioning, accurate geoid models become a practical necessity for land surveyors and geospatial data collection.

This project proposes studies on the feasibility and practical realization of determining a precise geoid model for Uzbekistan. The research may contain, but not limited to, the following issues:

- a) existing geoid models in and around Uzbekistan
- b) existing and available ground gravity measurements
- c) existing high quality GNSS and precise levelling data
- d) theoretical studies of geoid modelling, such as combination with global models, treatment of effects of the topography in Uzbek mountain regions
- e) computation of a precise Uzbek geoid model and validation against GNSS/levelling data
- f) practical implementation of the geoid model in GNSS field survey

**Expected output:**

- theoretical knowledge on KTH's method for geoid modelling
- relevant ground and satellite measurement data
- preliminary geoid model derived from global models
- a work plan for further studies and research work

## **10) Geodetic reference systems in Central Asia and their transformations**

Different types of geodetic reference systems have existed and been used in Central Asia for long time period. But a deep understanding of the theoretical basis and all practical details of the systems is very limited. This project proposes a systematic investigation of existing geodetic reference systems in Central Asia, including unifying and transforming between different systems.

The proposed research work may address, but not limited to, the following issues:

- a) definition and practical details of Soviet systems, Pulkvo 43 and SK 63, in Central Asia
- b) existing GNSS based 3D reference systems, comparison and integration
- c) transformation between Soviet systems and GNSS based systems, using different models (2D, 3D with 3 or 5 or 7 parameters)
- d) practical application for mapping, cadastre and construction

### ***Expected output:***

- relevant coordinate data sets from Central Asian countries
- identified problems related to geodetic reference systems in Central Asia
- knowledge on different methods for coordinate transformation
- preliminary numerical results obtained from available data sets
- a work plan for continued research work

## **11) GIS methods for land use optimisation in irrigated agriculture area with ecological constraints**

One of the vexed problems of the land use and crop management in the irrigated agrolandscapes is a proper ecological control for agricultural land use to guarantee sustainable development of the agriculture production and to prevent negative consequences, such as soil quality degradation, soil salinization, environment pollution with fertilizers and plant protection chemicals. In the South of Aral Sea Basin these challenges are multiplied with consequences of Aral Sea natural disaster. The applicant will realize empirical, theoretical, applied and institutional analysis of state cadastre service functioning and critical evaluation of GIS implementation. Goal of this study is optimization of land use in a water scarcity and soil salinization conditions using land information system and geospatial backgrounds establishing for sustainable agriculture under strict ecological constraints.

***Expected output:*** Summary presentation at the host institution, draft manuscript and prototyping land-information system with regional extensions.

## **12) Specific maps in the city and improving the methodology of compiling the plan**

A special map in the city and perfects the methods of drawing up in terms of plan, the present time is a result of the increase in the city's machinery, the mobile street in the city having reasons for the amplification of noise, the structure of the plan. A special map in the city, we are going to cartographic materials. The place of residents in the city is separated from the site and

delineated. It takes industrial, household services and a park. Here there is an impact of noise in the morning, lunch and evening. Which streets in the city okovisya settlement of dicibals noise in the map creates a horizontally. In this work, we see human health and the impact of noise in the building.

**Expected output:** Summary presentation at the host institution and draft manuscript

### **13) Scientific bases of system mapping of the regions of Uzbekistan for the purposes of tourism (on the example of the Samarkand region)**

The thesis is devoted to the development of the scientific and methodological foundations of the system mapping of the regions of Uzbekistan for tourism purposes. Based on their own research, analysis of numerous literary sources and cartographic works of tourist subjects, the essence, directions, peculiarities of regional system tourist mapping are determined, the principles of creating a system of cartographic works, their list and content are grounded.

Research history, analysed the current state and trends of cartographic support for tourism, its needs for the development of new types of cartographic works in the recreational and tourist areas of Uzbekistan. Taking into account the needs of different groups of consumers (tourists, excursionists, recreators, tourism organizers, etc.), a wide range, general geographical and thematic content of tourist plans, maps, maps, atlases, as well as the methodology for their creation were proposed. The tourist and recreational potential of the Samarkand region is considered from the point of view of its mapping by a regional system of cartographic works of tourist subjects. In the course of the experimental work, the main part of the system of cartographic works of the Samarkand region was developed (in traditional and electronic versions) using the programs of illustrative graphics PhotoShop, geoinformation systems ArcGIS, Panorama and MapInfo, multimedia technologies. Cartographic works of tourist subjects of different purposes are created: a comprehensive tourist map of Samarkand region, a comprehensive tourist plan of Samarkand, maps of recreational zones of individual tourist routes, a regional advertising tourist map, a series of maps of tourism resources of administrative districts of the Samarkand region, a complex regional tourist atlas, GIS of tourism resource potential.

**Key words:** regional system mapping for tourism purposes, cartographic works system, tourist map, tourist atlas, a series of tourist maps, cartographic work for tourism purposes, classification of tourist cartographic works, geoinformation technologies.

**Expected output:** Summary presentation at the host institution and draft manuscript

### **14) Time-series analysis of satellite imagery for monitoring grazing impact in a rangeland ecosystem**

The vegetation changes of semi-desert and desert landscapes are temporally and spatially heterogeneous. Vegetation indices derived from remotely sensed data have long been proposed as a source of information for predicting green biomass levels. The overall objective of this research is to assess vegetation status via remote sensing techniques using various vegetation indices for specific period to monitor grazing impact in a rangeland ecosystem.

**Expected output:** Summary presentation at the host institution and draft manuscript

### **15) Use of GIS technologies to improve the management of irrigated land**

**Purpose of the research:** To support GIS technologies in elimination of deficiencies in the implementation of the irrigated lands accounting system and its improvement.

**Expected Outcomes:** Implementation of research results. The existing problems in accounting for irrigated lands, as well as elimination of unnecessary exploitation of land, increase the quality and efficiency of work using GIS technologies.

### **16) Scientific justification of the geospatial systems, providing the state cadastral geoportal of the territories at the national level.**

The dissertation is planned to make research on creation and scientific justification of the 3d geospatial system, providing the implementation of the geoportal of state cadastre at national and international level.

### **17) Scientific justification of the creation methodology of the spatial data model of thematic sections of the state cadastre of buildings and structures.**

Buildings and structures usually consist of storeys containing the data base with specific topics. For example: trench, hydroisolation, foundation, walls, floor, ceiling, roof, the system of gas, water, electricity, sewerage and others. The dissertation is focused on scientific justification of creation methodology of the spatial data model of thematic section with the help of GIS technologies.

### **18) Creating of the concept on developing the ecological status of the territories.**

Ecological situation of the territory usually differs from the ecological situation of other territory. The main aim of the dissertation is to develop the ecological geoportal through using the data base with the modern technologies, in order to constantly monitor the ecological situation.

## **19) Improvement of Ameliorative Hydrogeological Monitoring of Irrigated Lands by GIS Technologies**

**Importance of the topic:** nowadays, the development of irrigated farming is also important in agriculture and this is because of irrigative and meliorative actions taken in the irrigated fields.

Uzbekistan is situated in arid climate. It means that summer is hot, dry and continues long. But winter is cold. The fields, where irrigated farming is implemented, are in desert zones of the Republic (Mirzacho'l, Kyzylkum, Karshi, Karakum Deserts and Bukhara, Navoiy regions) and the rate of precipitation in Winter and Spring is less than the rate of evaporation in Summer in these zones. Therefore, the lands contain certain primary amount of salt due to the underground waters, which are close to the ground and have minerals. The expected results can only be achieved by irrigated farming based on scientific meliorative actions in these zones.

This scientific research is dedicated to solve the problems of steep and horizontal drainage systems and improve its function.

Syrdarya region is chosen for this scientific research, and mainly it will be carried out in new reclaimed lands of Mirzacho'l desert.

In this scientific research:

- Climate, geomorphologic, hydrologic, soil and hydro geologic data are gathered and analyzed.
- To assess hydrogeological and meliorative condition of irrigated lands according to gathered information and its analysis.
- Studying, analyzing and assessing the factors, which affect meliorative condition of lands.
- Improving the assessment of the factors, which affect meliorative condition of lands, by GIS technology.
- Improving the method of GIS information analysis by land experiments

## **20) Geomatic provision for extended mineral resources exploitation.**

Kyzylkum phosphorite-containing minerals mining has a good perspectives as a local source of competitive mineral fertilizers. This minerals form extended layered deposits under a sand covers and its economically well-grounded mining needs complicated geotechnology. To improve economic attractions of these deposits for investments one needs geoinformatic approaches for resource base estimation, delineation of phosphate field contours, deposit mapping, numerical evaluation of removal bulk, burrow planning, general optimization of mining and transportation scheme using spatial analysis and integration of geoinformatic approaches with geochemical mapping. Also, implementation of geoinformatic approaches can decrease environment damage and mitigate consequences of the mining activity for desert ecosystem. Scientific importance of this applied study consists of integration of multiple spatial data representation in general GIS, use of varied-accuracy data for spatial optimization procedures and utilization of multispectral remote sensing data for sub-surface predictions.



During short fellowship in EU young researcher from Uzbekistan will explore modern practices in environmental monitoring of open pits with remote sensing, 3D-GIS for mining and geological investigations and some modern approaches to optimization problem in spatial economics of mineral resources.

### **21) GIS in historical studies of ancient land use in deltas of Central Asia rivers**

The study will deal with geoinformatic representation of land transformation and land use evolutions in low-course of great CA rivers, where during milleniums various civilizations blossomed. There is an imperative need in omnifarious geoinformation support for archaeological researches including mapping, object-oriented analysis of space and aerial images to detect buried archaeological objects, stratigraphy interpretation and 3D restoration of cultural layer etc. But really geoinformatic can much more. Implementation of spatial science techniques in the historical discourse can shift general research paradigm from inductive program to deductive reasoning using spatial models for ancient societies developments in environmental constraints. So, scientific value of the study will be introducing of spatial modeling methods into historical investigations using GIS as universal visual, ontological and evincive framework.

Thorough flush fellowship in EU young researcher from Uzbekistan will explore modern practices in historic reconstruction of delta transformation , 3D-GIS for archaeology and stratigraphy and some modern approaches to spatial modelling of nature management and land use evolution during a time.

### **22) Uzbek National Park Management: Identification of management opportunities and challenges and suggestions of measures based on the use of open data and VGI**

Protected areas are crucial for nature protection, conserving biodiversity, sustainable development, etc. Due to the International Union of Nature Conservation (IUCN) in particular national parks (designated as IUCN management category 2) have a variety of objectives. This includes among others nature protection, research, environmental education, and the support recreational purposes. In order to meet these objectives, the management of these sites requires the availability of (spatial) data. The application will research for open data (incl. volunteered geographic data VGI) giving insight into natural conditions as well as the (extent of) existing uses of one or several Uzbek national parks. The usefulness of the existing and accessible data to identify use conflicts and support the elaboration of appropriate measures will be assessed. For this different protected area management approaches such as ecosystem services (ESS), carrying capacity (CC), and Limits of Acceptable Change (LAC) should be taken into account.

**Expected output:** Presentation at the host institution, draft manuscript/ academic paper (to be submitted, e.g., to GI\_FORUM)

### **23) Determination of surface deformation using InSAR**

Geoinformatics relies on data acquired by satellite-borne remote techniques. Surface deformation over large region can be efficiently determined by interferometric processing of SAR images, which gets an improved relevance due to the emergence of the Sentinel missions.

Sentinel-1A and Sentinel-1B satellites provide SAR images over any region with a repeat period of 6 days. Even 'small' surface deformations, i.e. in the range of cm, can be detected under certain conditions. The student will be involved in the practice of processing Sentinel data, including downloading images, co-registration of the images, formation of the interferograms, deburst of the images, removal of the topographic phase, the Goldstein phase filtering, determination of the phase displacement, georeferencing and removal of the ellipsoidal correction, using the SNAP software. The investigation would concentrate on relevant surface deformations, which may be related to major megathrust events or volcanic eruptions.

**Expected output:** Summary presentation at the host institution, draft manuscript / academic paper.

### **24) The impacts of climate change on water resources and agriculture in Central Asia**

Climate change and its impacts on water resources and agriculture is a major force that Central Asia has to cope with in the coming decades. Over-extraction of water for irrigation is already a widespread and massive ecological problem in Central Asia, but it may become even more problematic under climate change. Climate change jeopardizes future agricultural production in Central Asia through alterations in temperatures, changing precipitation patterns, and more frequent extreme weather events. Lower snowpack and accelerated glacier melt is expected to drastically change river runoff and thus water availability for irrigation. During this research stay, we will support the applicant in using crop growth modeling, hydrological modelling, or statistical approaches to assess historical, current, and future impacts of climate change on agricultural production in Central Asia. We will also support the applicant in assessing effective adaptation measures in the most important agricultural regions of Central Asia. For example, the applicant could use crop growth modelling to test adaptive crop varieties that are tolerant to likely future climate conditions, such as heat stress and temperature-induced water stress. Such research is timely and relevant as impacts of climate change on water resources, agricultural production and adaptation in Central Asia remains under-researched to date.

**Expected output:** Summary presentation at the host institution and draft manuscript

## **25) Synthesis of observed historic and expected future climate changes**

Climate change has already substantially impacted Central Asia, and future challenges for the region loom large because the past temperature increase will likely continue, and the volatility of precipitation may rise further. Unfortunately, there are few studies that have systematically assembled existing evidence of climate change in the region and the effects it may have on agricultural production. During this research stay, the candidates are expected to synthesize existing spatial data on observed historic changes and available future projections in temperature and precipitation for the entire region. The applicant will then use this quantitative evidence to evaluate the likely impacts of historic changes and of alternative future pathways on agricultural production. The results are expected to shed light on the areas where climate-related changes have already exerted the largest impacts and allow pinpointing where future hotspot of expected climate may emerge.

**Expected output:** Summary presentation at the host institution and draft manuscript

## **26) Assessment of land-cover and land-use change**

Accurate and credible information on the state of land use and land-use changes are cornerstone for many questions that are of high ecological, socioeconomic, and political relevance. Unfortunately, existing land-use products derived from satellite imagery for Central Asia differ in terms of thematic depth, temporal resolution, spatial coverage, and accuracy. One aim of this research stay could be to take stock of global, regional, and national land-cover and land-use products that exist for Central Asia and to assess their accuracy and validity, including a semi-systematic validation of these products using, e.g., Google Earth. The results could then consist in a harmonized land-cover map for the region, which is expected to provide insights into the value of existing land-cover products and provide a better basis for approximating land-use changes in Central Asia. Another aim of the fellowship could be to assess changes in land cover or land use using one existing land-cover change product, and analyze the determinants for the changes using auxiliary GIS and statistical data. The results facilitate to pinpointing research gaps and a priority lists for future assessments of land-cover change or could shed light on the processes that led to observed land-use change.

**Expected output:** Summary presentation at the host institution and draft manuscript

## **27) Integration of multispectral and LIDAR data for mapping urban environment.**

## **28) Object-based classification (OBIA) of urban land cover extraction using high spatial resolution imagery.**