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Leibniz-Institut für Agrarentwicklung
in Transformationsökonomien

Report

on the teacher of department Geography Karakalpak State University Kuatbay Bekanov improvement of skills of the Leibniz Institute of Agricultural Development in Transition Economies (IAMO) (April 1st to May 31st, 2019)

PhD student: Mr. Kuatbay Bekanov
Supervisor: Dr. Daniel Muller
Scientific consultant: Dr. Florian Schierhorn

Tashkent – 2019

Content

- **Introduction**

Nowadays in our country, a lot of work is done to develop the GIS sector. One of these, several higher education institutions in Uzbekistan and the European Higher Education Institutions are implementing a DSinGIS (Doctoral science in geoinformatics) project [3].

A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts.

A GIS helps you answer questions and solve problems by looking at your data in a way that is quickly understood and easily shared.

GIS technology can be integrated into any enterprise information system framework. [2]

The main objective of the project is to promote sustainable development in Uzbekistan through Geoinformatics, which provides opportunities for Doctoral candidates and scientific researchers to practice and research in European higher education institutions. Within this project, Ph.D. students and researchers have the opportunity to gain experience for 2 months in research in European higher education institutions.

So far, several researchers and Ph.D. students from partner HEIs of Uzbekistan have been improved their skills and qualification in their research topic and field of studies at European partner universities. Among them, the researcher

from Karakalpak State University, Kuatbay Bekanov also visited for two months (April 1 - May 31) as a researcher to the Leibniz Institute of Agricultural Development in Transition Economies (IAMO) in Germany.

Study Plan

Before the study visit to Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Short research plan had been applied with requested documents. Here, below short research plan is given:

- Analysis of the references (scientific publications, periodic and monographs) on current state in land use optimization for agricultural area.
- Exploration of the current state and trends in the spatial decision support systems and land information systems use.
- Using of formal methods of spatial and topological analysis using spatial indexes and othe geostatistic approaches for Land Use Land Cover (LULC) changes in zone of intensive irrigated agriculture.
- Development of geoinformatic methods and geostatistical techniques applicable to the problem of land use optimization in irrigated agriculture area with ecological constraints.
- Participation in workshops, seminars.
- Presentation and discussion of the results of work in a progress, consultations with experts on particular issues of the research plan.

Time table of all activities

Time table						April							April							April							April							April-May							May							May							May							May				
						1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
WBS	Task Name	Start	Finish	Duration	Percent Complete	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F
1	Analysis of the references (scientific publications, periodic and monographs) on current state in land use optimization for agricultural area			10	100%																																																													
2	Exploration of the current state and trends in the spatial decision support systems and land information systems use.			8	100%																																																													
3	Using of formal methods of spatial and topological analysis using spatial indexes and othe geostatistic approaches for Land Use Land Cover (LULC) changes in zone of intensive irrigated agriculture.			10	100%																																																													
4	Development of geoinformatic methods and geostatistical techniques applicable to the problem of land use optimization in irrigated agriculture area with ecological constraints.			12	100%																																																													
5	Learning R-studio program			12	100%																																																													
6	Presentation and discussion of the results of work in a progress, consultations with supervisors on particular issues of the research plan.			8	100%																																																													

Activities and Outputs of the stay

During the 2 monthly internship, I learned the state of the terrestrial terrain of the Aral Sea region and to analyze the condition of the spatial data from Landsat and evaluate the quality of satellite images in the ArcGIS 10.1 program. For the optimal land use, should learn GIS and Remote Sensing methods. Land use/cover change information very important and useful source for creating optimal land use maps. As well as I learned the classification of land types and uses methods to analyze land use and landscapes over the years. I learned R-studio program by the help of researchers Florian Schierhorn and Max Hoffmann of the Department of Structural Change of IAMO Institute. Given below, the working process of research topic in the department of structural change (Figure 1).

Fig.1. The working process of research topic in the department of structural change.

Environmental and socio-economic problems and their negative consequences that result from a high level of science-intensive technique, increasing population mobility, and the adverse effects of natural and social relationships have led to the disruption of ecological balance in nature. Nowadays, one of the most urgent tasks is studying and researching the ecological problems of the Aral Sea region, which are of concern to the Central Asian countries, assessment of the future of the region, forecasting and solving ecological problems.

Remote Sensing (RS) has been used to classify and map land cover and land use changes with different techniques and data sets. Landsat images in particular have served a great deal in the classification of different landscape components at a larger scale (Ozesmi and Bauer, 2002). Recently several change detection techniques have been developed that make use of remotely sensed images. A variety of change detection techniques and algorithms have been developed and reviewed for their advantages and disadvantages. Among these unsupervised classification or clustering, Supervised classification, PCA, Hybrid classification and Fuzzy classification are the most commonly applied techniques used in classification (Lu et al., 2004; Rundquist et al., 2001; Zhang et al., 2000).

A variety of supervised classification methods have been applied extensively for the land use change analysis throughout the world. This technique depends on a combination of background knowledge and personal experience with the study area to a greater extent than other areas. Thus per-pixel signatures are taken and stored in signature files by using this knowledge and the raw digital numbers (DN) of each pixel in the scene are therefore converted to radiance values (Jensen, 2005; SCGE, 2011).

We decided to analyze the change of agricultural lands by space photographs. In this study, the 2008 and 2018 space images of the Kegeyli land, located at the bottom of the Aral Sea, were obtained by using Remote Sensing and

GIS (Landsat 7, 2008, and Landsat 8, 2018), and satellite images were used to assess the degree of ground cover by classifying ratios. In addition, the main reasons for land degradation and land use status were analyzed. The classification results revealed a significant reduction in land degradation to the agricultural areas in these regions and the increased number of shrub-free deposits.

- *Study area*

The area is the Kegeyli district of the Republic of Karakalpakstan with the area of 2.21 thousand sq. Km, and as of January 1, 2015 the population is 85.8 thousand people. Kegeyli district is located on the lower right bank of the lower Amu Darya River. The district borders Kungrad district in the north, Muynak district in the north, Chimbay district in the north-east, Karaosak district in the east, Nukus from the south and Kanlikul district in the south and 62-67 m above sea level consisting of plains and plains in the upper elevation.

The climate is sharp continental. It is hot and winter is cold. Average temperature in summer is 26.9 °, in winter - 6.7 °. Vegetation period is 188 days. In the western part of the district, primarily farming, livestock breeding in the south-east, in Kyzylkum. Dovudkol, located in the northern part of the district, is used as a reservoir. The Kuvanishjarma canal runs through the district. Aktobe, Beskuduk, Sassikshiyel, Karaoy lakes. Ground soils are grassland, mud-grass soils. The Dovudkul area is a good hay and grassland. In areas where sowing is not cultivated, the reed, the grass, the hawthorn, the dwarf, the apricot, the corabox, the vulture, the fiber, the gill, the juniper, and other plants grow. From wild animals there are hogs, umbrellas, foxes, horses, rabbits; birds, grass, brown, geese, and wild birds. The lakes are clayey, cypress, jacket, cumin, cumin, lacquer, white, hawthorn, white amorphous, leopard, baskets (http://kegeyli.rk.uz/uz/rayon-haqqinda/).

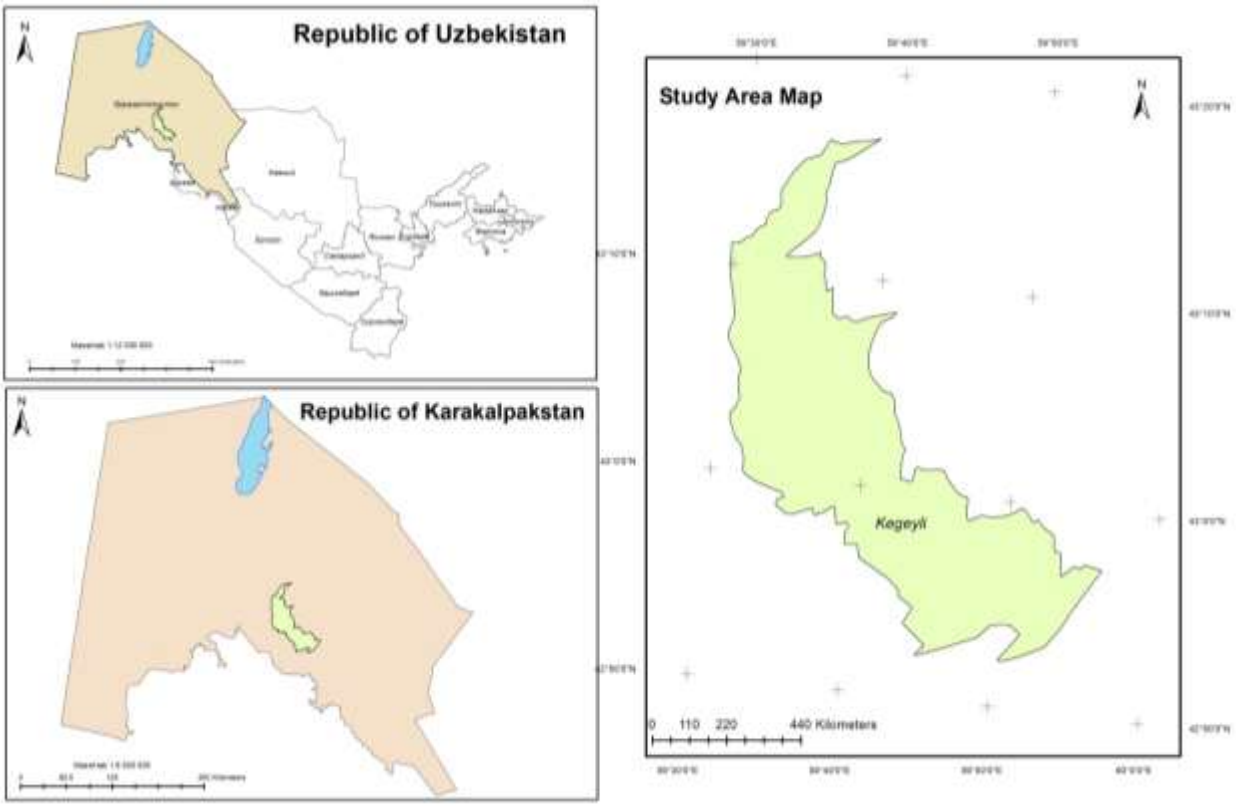

Fig.2. Study area map showing Kegeyli district.

Data collection

The data used in this research were divided into satellite data and ancillary data. Ancillary data included ground truth data for the land cover/use classes, aerial imagery of watershed and its surrounding area, topographic maps. The ground truth data were in the form of reference data points collected using Geographical Positioning System (GPS) from june to july 2018 for 2018 image analysis, used for image classification and overall accuracy sessment of the classification results. Satellite data for 2 years on the other hand consisted of multi-spectral data acquired by Landsat satellite for the month of July provided by USGS glovis. Specifications of the satellite data acquired for change analysis are given in Table 1.

Table 1. Satellite data specifications.

Data	Year of acquisition	Bands/color	Source
Landsat 7 ETM	2008	Multispectral	USGS glovis
Landsat 8 OLI/TIRS	2018	Multispectral	USGS glovis

Image pre-processing and classification

All satellite data were studied by assigning per-pixel signatures and differentiating the district into four classes on the bases of the specific Digital Number (DN) value of different landscape elements. Description of classes of district land use is given in Table 2. For each of the predetermined land cover/use type, training samples were selected by delimiting polygons around representative sites. Spectral signatures for the respective land cover types derived from the satellite imagery were recorded by using the pixels enclosed by these polygons. A satisfactory spectral signature is the one ensuring that there is 'minimal confusion' among the land covers to be mapped. After that maximum likelihood algorithm was used for supervised classification of the images. It is the type of image classification which is mainly controlled by the analyst as the analyst selects the pixels that are representative of the desired classes. The features of land types classes are given in the table 2, and flowchart of the study methodology is are given in the figure 3.

Table 2. Classes delineated on the basis of supervised classification.

Class name	Description name
water	*River, open water, lakes, ponds and reservoirs*
Law vigetation	*Salty lands pastures, industry lands and settlement areas*
Bar land	*Non-agricultural land desert lands*
High vegetation	*Crop fields, fallow lands and mixed forest lands*

Methodology

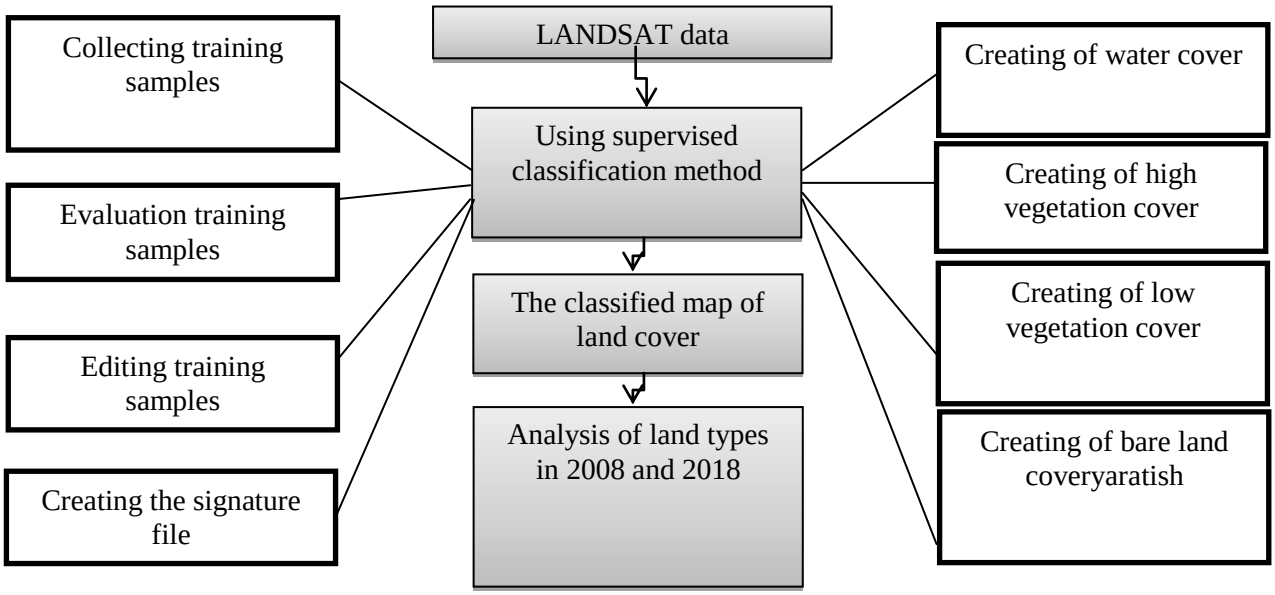

Fig.3. Flowchart of the study methodology.

Results and discussion.

The classified land use\land cover map of Kegeyli district of years 2008 and 2018 is given in Fig.3. The achieved overall classification accuracies were 95.32% and 95.13% and overall kappa statistics were 0.9237 and 0.9070 respectively for the classification of 2008 and 2018 images. According toLea and Curtis (2010), accuracy assessment reporting requires the overall classification accuracy above 90% and kappa statistics above 0.9 which were successfully achieved in the present research.

The classification results for 2008 and 2018 are summarized in Table 3. Percentage of classes based on these results show the land cover/land use practices observed in the district area during 2008 and 2018. Resultant land cover/land use and overlay maps generated in ArcGIS 10.1, indicated a significant shift, the bare lands grew from 64 % to 75% respectively. These land cover/use transformations posed a serious threat to district land resources. Hence, proper management of the

district land is required or else these resources will soon be lost and no longer be able to play their role in the socio-economic development of the area.

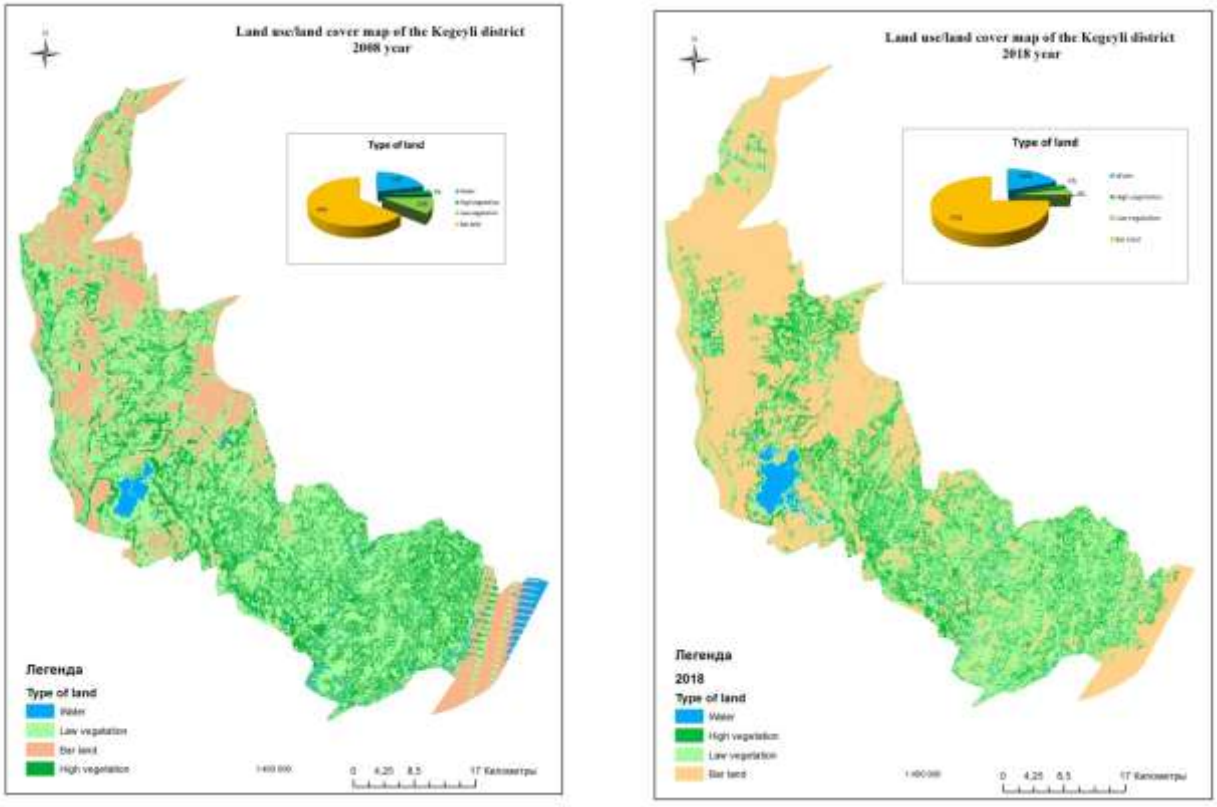

Fig. 4. Classified maps of Kegeyli district (2008 and 2018).

Table 3 Land cover/land use classes and areas in hectares.

Land use/land cover classes	*2008*		*2018*		*Gain*		*Loss*	
	Area (ha)	*(%)*	*Area (ha)*	*(%)*	*Area (ha)*	*(%)*	*Area (ha)*	*(%)*
water	48620	*22*	41990	*19*			4420	*2*
Low vegetation	24310	11	8840	*4*			15470	*7*
Bar land	141440	64	165750	75	24310	11		
High vegetation	6630	3	4420	*2*			2210	*1*

Conclusion

Based on the results obtained by the employment of GIS and RS applications to achieve the specific research objectives, it is concluded that the land cover/land use practices in the study area have altered significantly in 10 years. The land use shift in the district indicated a significant shift, the bare lands grew from 64 % to 75% respectively. The water classes decreased from 22 % to 19 %

respectively and the low vegetation areas decreased from 11 % to 4 % respectively, as well as the high vegetation areas decreased from 3 % to 2 % respectively. The haphazard expansion of the bare land area in the district was mainly due to lack of proper management and land use planning since no satellite monitoring and GIS are generated before land development in the study area. Based on these results, we give some recommendations.

- Creating a land information system (LIS) about the district.
- Regularly to make monitoring over the land cover of the district using methods remote sensing.
- To create a plan of the optimal land use in the district.

With a help of gotten knowledge from the Leibniz Institute of Agricultural Development in Transition Economies (IAMO) in Germany, two articles were published. One of them published in international Conference Proceeding of KSU and the second one was published in OAK Journal of Uzbekistan.

When I was the 2-monthly internship, every week we discussed with my supervisors Professor Daniel Muller and Florian Schierhorn about the process of my research. They taught me more methods of my research and they created conditions to work my research topic and they gave many pieces of advice over my scientific research topic.

Fig.5. After the discussion, we took a picture together with my supervisors from IAMO.

During the two months, I have read many spheres based literature and analyzed lots of article sources related to my dissertation topic at the Information Resource Centre of the Leibniz Institute of Agricultural Development in Transition Economies (IAMO) in Germany. At the end of the 2 months study visit at the Leibniz Institute of Agricultural Development in Transition Economies (IAMO) in Germany, I received a positive recommendation letter from the Leibniz Institute of Agricultural Development in Transition Economies (IAMO) in Germany (Figure 6).

IAMO
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May 28, 2019

To Whom it May Concern,

Kuatbay Bekanov has completed a two-months internship in our department Structural Change at the Leibniz Institute of Agricultural Development in Transition Economies (IAMO). This internship is financed by the EU-project Doctoral Studies in Geoinformation Sciences (DSinGIS). I, as deputy head of the department, oversaw the supervision of Kuatbay Bekanov during his stay at our institute.

During his two months at IAMO, Kuatbay Bekanov learned how to download satellite images from Landsat covering the Aral Sea region in Uzbekistan. In addition, Mr. Bekanov made the first steps in processing and statistically analyzing the Landsat images in ArcGIS. To better analyze the Landsat TM images, Mr. Bekanov started an introductory tutorial in R, an open-source statistical software. In addition, he worked on improving his research skills, including in literature search and data collection.

I hope that Kuatbay Bekanov benefits from this internship at IAMO. I believe the collected data, information, knowledge and scientific-practical experiences will greatly contribute to his future scientific work. I would like to recommend Bekanov Kuatbay to continue to study his Ph.D. research at his University.

I wish Kuatbay Bekanov all the best for his future career.

Sincerely,

Leibniz Association

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Fig. 6. Recommendation letter

Conclusion and future plans

Erasmus+ “DSinGIS –Doctoral study in Geoinformatics” project has been giving good opportunity for doctoral students and young researchers of Uzbekistan in case of organizing 2 months scientific and practical training courses to improve their knowledge and skills in Geoinformatics and remote sensing.

So far, several young researchers and doctoral students from partner HEIs of Uzbekistan have been and improved their skills and qualification in their research topic and field of studies at European partner universities. Among them, I had a great chance to visit to one of the highly ranked Leibniz Institute of Agricultural Development in Transition Economies (IAMO) in Germany.

Living and studying at Halle (Saale) (Germany) is very nice. Historical buildings, friendly population, delicious meals and warm weather are breathtaking. Infrastructure is well developed. Briefly, every facilities exist for studying and staying at Halle (Saale) (Germany).

I had achieved very important and crucial knowledge on my dissertation topic during two months. In the future, I will more develop my knowledge on land use optimization in ecological conditions, using methods of RS and GIS.

Acknowledgments

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