TASHKENT INSTITUTE OF IRRIGATION AND
AGRICULTURAL MECHANIZATION ENGINEERS

REPORT

on study visit to Obuda University of Hungary in the frame of the Erasmus+ DSinGIS project

(January 15– March 15, 2019)

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TASHKENT, 2019

Content

- **Introduction**
- **Study Plan**
- **Time table**
- **Activities**
- **Outputs of the stay**
- **Conclusion and future plans**
- **Acknowledgments**
- **References**

Introduction

Geoinformation Science (GISc) is a new science, however, has its roots thousands of years. It integrates three traditional geosciences (firstly, geodesy as the science of precise spatial data acquisition; secondly, geography as the science of studying human and physical aspects; finally, cartography as the science of making maps. The integration of these sciences is based on the rapidly evolving computer science[1].

Today, importance of Geographic Information System (GIS) and Remote Sensing (RS) technologies in society are improving day by day. GIS and RS technologies are being looked as an important tool for key spheres and directions of Uzbekistan: water and land resources management, agriculture, cartography, geology, ecology and in other sciences, essential in decision making for sustainable development.

Numerous of young researchers and doctoral students of Uzbekistan have been thinking about applying of GIS and RS technologies in their research topics and field of studies. For implementation of those, mainly advanced knowledge of using software devices and computer technologies as well as theoretical and practical knowledge in the field of study are vital [2].

In this case, support of highly ranked foreign Higher Educational Institutions and qualification of their well-qualified teachers play crucial role. 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 [7].

So far, several researchers and doctoral 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, me, the first year PhD student of the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, Mr.Zokhid Mamatkulov also have visited for two months (January 15-March 15) as a researcher to Alba Regia Technical Faculty of Obuda University, Szekesfehervar, Hungary under supervision of Dr.Wojtaszek Malgorzata on the topic of "Applying GIS and RS technologies in precision agriculture"[2] .

Study Plan

Before the study visit to Obuda University of Hungary, Study plan had been applied with requested documents. Here, below study plan is given:

1. Introducing my Supervisor from Host Institute
2. Taking tasks and assignments from my Host Institute Supervisor;
3. Reviewing the scientific papers and articles, which are related to:

    a. Application of Remote Sensing and GIS in precision agriculture;

    b. GIS methods for land use optimization in irrigated agriculture area with ecological constraints.
4. Learning new applied remote sensing methods and GIS programs.
5. Going to library and learning new scientific books which are regarding to my field of study;
6. Learning how to write scientific papers in my research;
7. Participating to International scientific conferences or Workshops (if applicable)

Time table of all activities

Time table					
WBS	Task Name	Start	Finish	Duration	Percent Complete
1	Study the role of remote sensing methods in Adapt Possibility	16-Jan-19	22-Jan-19	5	100%
2	Remote sensing data gathering, How to collect relevant data: satellite images (free download data), UAV data gathering	23-Jan-19	31-Jan-19	7	100%
3	Data classification: Software background and Prepriparation (image enhancement, rectification, vegetation indices (VI)	1-Feb-19	7-Feb-19	5	100%
4	Classification within a field: How to map variability within a field by using unsupervised classification algorithms	8-Feb-19	14-Feb-19	5	100%
5	The role of segmentation algorithms in information extraction regarding to field heterogeneity and OBIA	15-Feb-19	20-Feb-19	4	100%
6	Investigation of the productivity of the area based on satellite images (satellite)	21-Feb-19	25-Feb-19	3	100%
7	Plant growing monitoring and Mapping Crop Status (satellite data, UAV)	26-Feb-19	28-Feb-19	3	100%
8	Identification of problems (lack of sowing, cultivation problems, stressed plants) and Soil mapping	1-Mar-19	7-Mar-19	5	100%
9	Soil degradation (erosion, other problems)	8-Mar-19	12-Mar-19	3	100%
10	Mapping potential management zones within fields	13-Mar-19	14-Mar-19	2	100%

Jan-19 [W3]							Jan-19 [W4]							Jan-19 [W5]							Feb-19 [W6]							Feb-19 [W7]							Feb-19 [W8]							Feb-19 [W9]							Mar-19 [W10]							Mar-19 [W11]			
14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	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	1	2	3	4	5	6	7	8	9	10	11	12	13	14
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

Activities and Outputs of the stay

During the two months study visit to Obuda University, I have strengthened my scientific and practical knowledge on Remote Sensing and GIS. Firstly, basic concept of remote sensing, pixel and segment based classification, basic algorithms of image processing were taught by Dr Wojtaszek Malgorzata.

Moreover, under supervision of Dr. Wojtaszek Malgorzata important Remote sensing methods and tasks such as: image geometric correlation, atmospheric correlation, assessing quality of the satellite images, classifying types of Agricultural crops through segments or training areas, monitoring of land cover changes by using supervised and unsupervised methods by using Sentinel 2 and Landsat 8 satellite images (Figure 1).

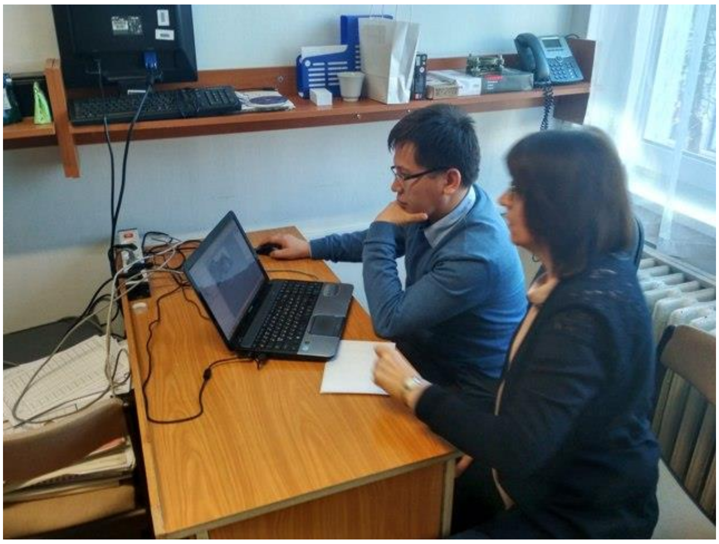

Fig. 1. Scientific research with Dr. Wojtaszek Malgorza on classifying agricultural crop types by using Remote Sensing methods

In addition, some new software's for implementing remote sensing tasks as IDRISI Selva (Figure 2) and eCognition Developer software's opportunities have been learned and have done some analyses with them on classifying agricultural crop types (Figure 3).

Before classifying crop types, process starts with land use/land cover classification.

Land cover is fundamental, because in many existing classifications and legends it is confused with land use: Land cover is the observed (bio)physical cover on the earth's surface [3].

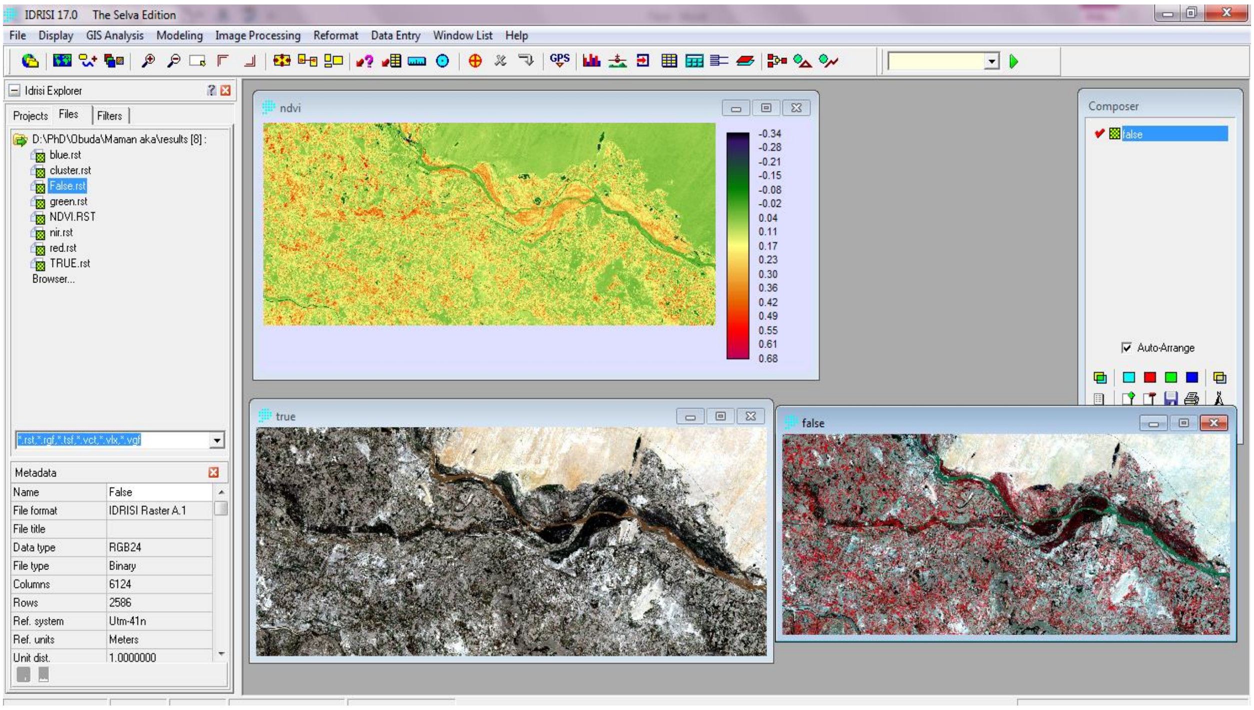

Fig. 2. NDVI, true color, and false color analyses with Selva IDRISI

Land use is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it. Definition of land use in this way establishes a direct link between land cover and the actions of people in their environment [3].

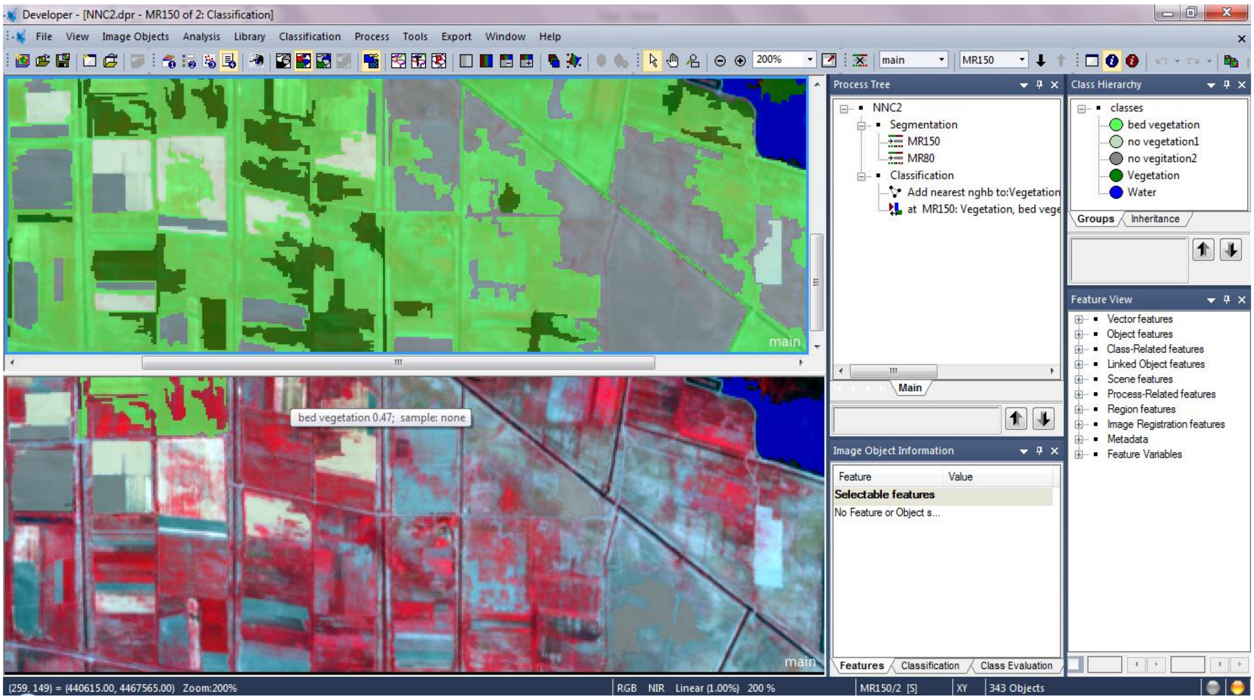

Fig.3. Creating land cover classification of small subset area of Syrdarya province of Uzbekistan using by eCognation Developer

A classification describes the systematic framework with the names of the classes and the criteria used to distinguish them, and the relationship between classes.

Classification thus requires the definition of class boundaries, which should be clear, precise, possibly quantitative, and based upon objective criteria [3]

Land use/land cover (LULC) classification is one of the most important applications in remote sensing, but is a complex procedure, because different factors, such as the spatial resolution of the remotely sensed data, availability of different data sources (e.g., field survey data, digital elevation model data), a suitable LULC classification system, availability of classification software, and the analyst's experience may affect the classification results [4].

Classification algorithm should be used for a specific dataset in a study area remained to be answered, although many classification methods, from traditional parametric algorithms such as maximum likelihood classifier (MLC), to advanced nonparametric algorithms such as artificial neural network (ANN),decision tree, and support vector machine (SVM) are available. Another challenge is to select a proper dataset for LULC classification. However, different kinds of sensor data have various characteristics in spatial, spectral, radiometric, and temporal resolutions, as well as different angles and polarizations for radar data. It is important to effectively incorporate different data features into a classification procedure for improving LULC classification accuracies [4].

There are two major categories of image classification techniques include unsupervised (calculated by software) and supervised (human-guided) classification [4].

Unsupervised classification is where the outcomes (groupings of pixels with common characteristics) are based on the software analysis of an image without the user providing sample classes. The computer uses techniques to determine which pixels are related and groups them into classes (Figure 4) [5].

Mostly for unsupervised classification Minimum distance, Maximum Likelihoods and IsoCluster methods were used.

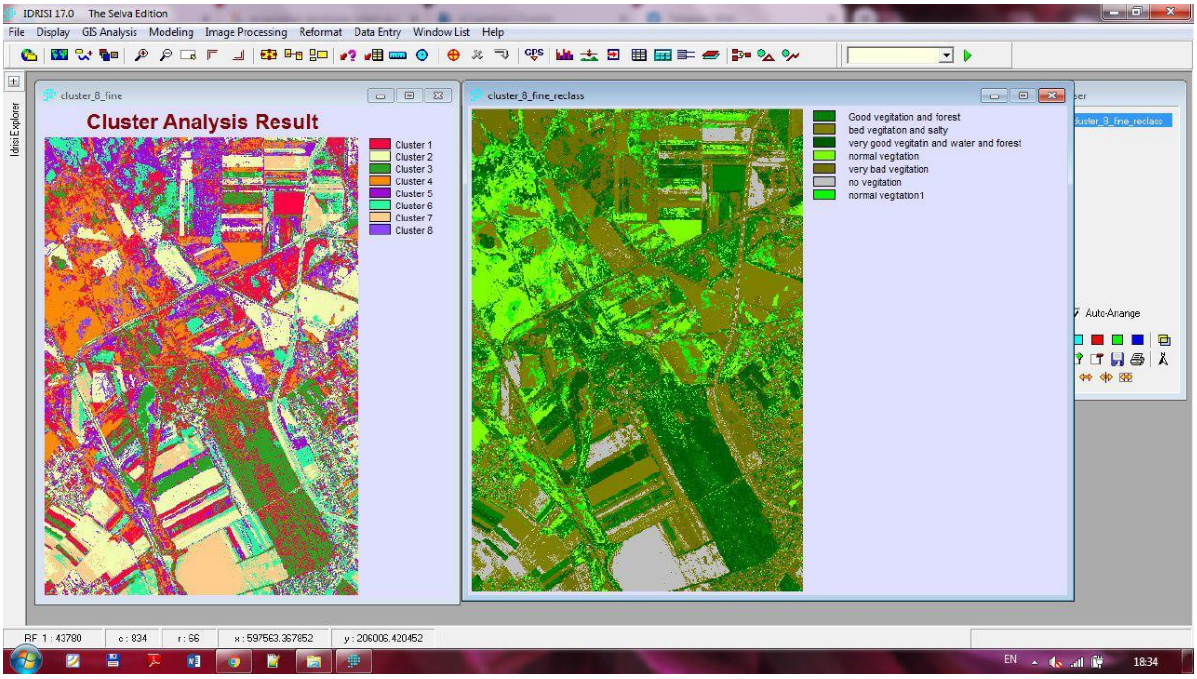

Fig. 4. Unsupervised classification of subset area with Idrisi Selva

Supervised classification is based on the idea that a user can select sample pixels in an image that are representative of specific classes and then direct the image processing software to use these training sites as references for the classification of all other pixels in the image. Training sites (also known as testing sets or input classes) are selected based on the knowledge of the user. The user also sets the bounds for how similar other pixels must be to group them together (Figure 5) [5].

These bounds are often set based on the spectral characteristics of the training area, plus or minus a certain increment (often based on “brightness” or strength of reflection in specific spectral bands). The user also designates the number of classes that the image is classified into. Many analysts use a combination of supervised and unsupervised classification processes to develop final output analysis and classified maps [5].

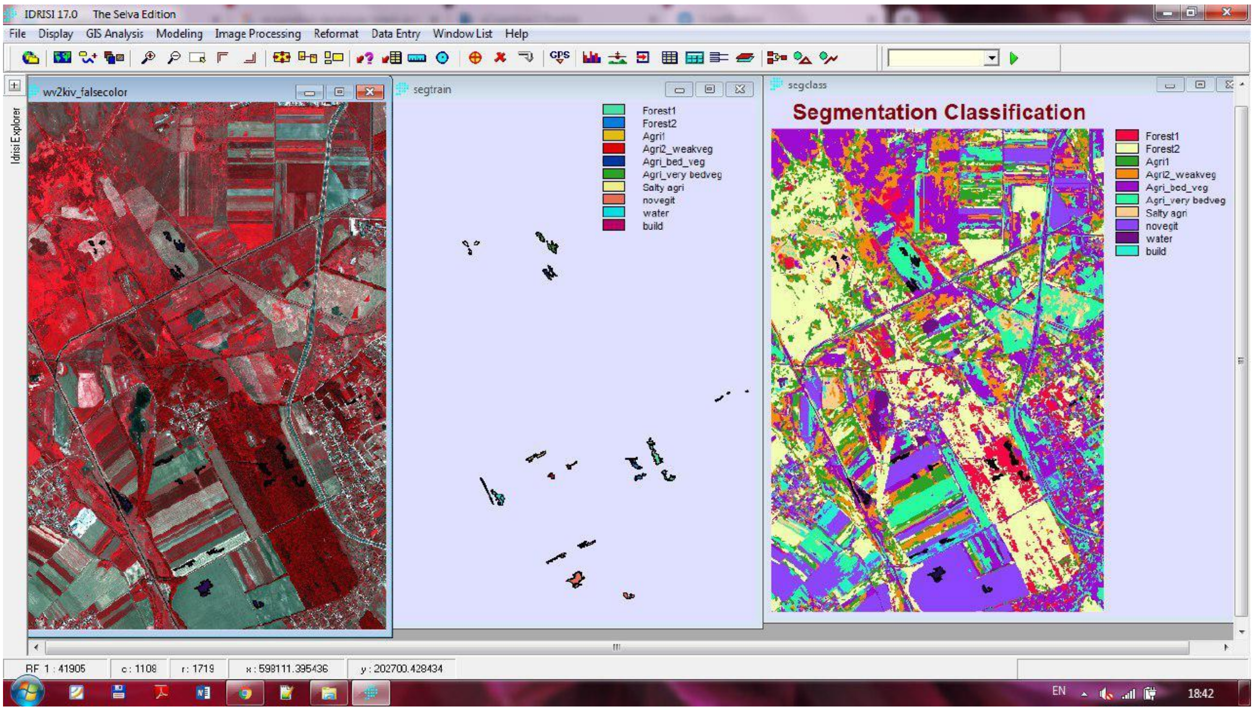

Fig. 5. Supervised classification process with Idrisi Selva

Laboratory and field works results compared and created land use and cover maps (Figure 6).

Fig.6. Field research for getting actual data for crop type maps

At the end of the research, for evaluating supervised classification results Accuracy Assessment analyse had done. Here, below overall results are given in the Table 1 and 2 which were created by Idrisi Selva program.

Accuracy assessment is very important process for any remote sensing activities.

Ground truth (reference data)

Classification

Class	Forest_1	Forest_2	Agri1	Agri2_weak_veg	Agri3_bed_veg	Agri4_very_bed_veg	Salty_agriculture	No_vegetation	Water	Building	Total	User Accuracy
Forest_1	5342	0	0	0	0	0	0	0	0	0	5342	100.0
Forest_2	0	3037	0	0	0	0	0	0	0	0	3037	100.0
Agri1	0	0	1861	867	0	0	0	0	0	0	2728	68.2
Agri2_weak_veg	0	0	0	682	0	0	0	0	0	0	682	100.0
Agri3_bed_veg	0	0	0	0	2192	0	0	0	0	0	2192	100.0
Agri4_very_bed_veg	0	0	0	0	0	3198	0	0	0	0	3198	100.0
Salty_agriculture	0	0	0	0	0	0	1255	0	0	0	1255	100.0
No_vegetation	0	0	0	0	0	0	0	7258	0	0	7258	100.0
Water	0	0	0	0	0	0	0	0	4006	0	4006	100.0
Building	0	0	0	0	0	0	0	1235	0	648	1883	34.4
Total	5342	3037	1861	1549	2192	3198	1255	8493	4006	648	31581	
Producer Accuracy	100	100	100	44.0	100	100	100	85.5	100	100		29479

93

Table 1. Land cover classification accuracy assessment

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KAPPA INDEX OF AGREEMENT (KIA)
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Using SEGCLASS as the reference image ...

    Category          KIA
  -----------     -----------

          1       1.0000
          2       1.0000
          3       0.6623
          4       1.0000
          5       1.0000
          6       1.0000
          7       1.0000
          8       1.0000
          9       1.0000
         10       0.3304
```

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SEGTRAIN

    Category          KIA
 -----------   -----------

          1       1.0000
          2       1.0000
          3       1.0000
          4       0.4279
          5       1.0000
          6       1.0000
          7       1.0000
          8       0.8112
          9       1.0000
         10       1.0000

 Overall Kappa =          0.9226
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Table 2. Land cover classification Kappa Index Agreement

It is clearly seen from the tables that, classification accuracy is equal to 0.93 (Table 1) and Kappa Index of Agreement is 0.9226 (Table 2), which is almost perfect agreement.

Classification error occurs when a pixel (or feature) belonging to one category is assigned to another category. Errors of omission occur when a feature is left out of the category being evaluated; errors of commission occur when a feature is incorrectly included in the category being evaluated. An error of omission in one category will be counted as an error in commission in another category [6].

With a help of gotten knowledge from Obuda University, two articles were published. One of them published in Conference Proceeding of TIIAME and the second one was published in International Journal.

Fig.7. Digital photogrammetric laboratory work with doctors:Balázsik Valéria and Jancsó Tamás

Furthermore, I have worked on practical and laboratorial assignments under supervision of professors of the Remote Sensing and Photogrammetry department – Balázsik Valéria and Dr.Jancsó Tamás. During the laboratory tasks, he learned how to create orthophoto plans from airborne imagery, mosaicking of aerial photography's, projecting and setting control points by analytic methods, creating 3D models by stereo effects and their scientific theories (Figure 7) [2].

Fig.8. Prof. Dr. habil. Levente Kovács, vice rector for education is representing Obuda University

Fig.9. Group photo after fruitable meeting with authority of Obuda University

Moreover, there were meeting was organized with vice rectors of TIIAME and Obuda University on March 1st, 2019. From TIIAME side Prof. Bakhadir Mirzaev vice rector of academic affairs, Dr. Narbaev Sharafatdin Kengeshovich, dean of Faculty of Land Resources Management, Ilhom Abdurahmanov, head of International Department, Mamanbek Reimov, manager of the DSinGIS project and I participated. There were discussed to organize trainings for staff and MSc students in sphere of “Smart Agriculture”, “Geoinformatics”, “Land Management” and "Mechatronics" in framework of joint program between the Tashkent Institute of Irrigation and Agricultural Mechanization Engineers and Obuda University (Figure 8, 9) [8,9].

Figure 10. Practical classes on Geodesic Surveying

Furthermore, on 20th of February 2019, doctor of Salzburg University (Austria), Hennig Sabine and doctor of Alba Regia Technical Faculty of Obuda University, Pödör Andrea organized short course on Open Source Map (OSM). Dr Hennig Sabine taught 3rd course students about basic concepts of GIS, some new plugins of QGIS and reprocessing and updating OSM.

Besides, I have participated to some practical classes of Dr. Toth Zoltan on Geodesic Surveying (Figure 10).

Fig. 11. The processes of getting acquainted with sphere based literatures and certificate submission of course completion

During two months period, I have read many sphere based literatures and analyzed lots of article sources related to my dissertation topic at Information Resource Centre of Alba Regia Technical Faculty of Obuda University. At the end of the 2 months study visit at Obuda University, I have awarded completion of certificate (Figure 11).

Conclusions 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 Alba Regia Technical faculty of Obuda University in Szekesfehervar, Hungary.

Living and studying at Szekesfehervar 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 Szekesfehervar.

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 application of RS and GIS in agriculture.

Acknowledgements

I gratefully acknowledge for great opportunity and financial support by Erasmus + "DSinGIS – Doctoral Studies in Geoinformatics" project, DSinGIS project coordinators Dr Lorant Foldvary and Ilhom Abdurahmanov, professor Markus Bela project manager – Mamanbek Reimov, Supervisor from Obuda University - Dr. Wojtaszek Malgorza, as well as Dr.Balázsik Valéria, Dr.Jancsó Tamás, Dr. Toth Zoltan and international relations department of TIIAME for moral and technical support before and during my study visit in Szekesfehervar, Hungary.

References

1. http://geoinformatics.uz/
2. http://www.dsingis.eu
3. http://www.fao.org/3/x0596e/x0596e01e.htm
4. D. Lu and Q. Weng, “A survey of image classification methods and techniques for improving classification performance”. International Journal of Remote Sensing, 28(5): 823 - 870 · March 2007.
5. https://mapasyst.extension.org
6. https://www.e-education.psu.edu/geog883/node/524
7. http://tiiame.uz/
8. http://www.amk.uni-obuda.hu
9. http://news.uni-obuda.hu/en/articles/2019/03/06/visit-of-the-tashkent-institute-of-irrigation-and-agricultural-mechanization-eng