Karakalpak state University

REPORT

on study visit to the Leibniz Institute of Agricultural Development in Transition Economies (IAMO) of Germany in the frame of the Erasmus+ DSinGIS project
(November 7- December 30, 2018)

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Scientific consultant: Dr. Florian Schierhorn

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Content

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. The methods of GISc are widely applied in other sciences, essential in decision making for sustainable development [1].

During this period of stay he continued his research under the supervision guidance of Dr. Daniel Muller and near assistance of Dr. Florian Schierhorn in the sphere of landscape ecology and remote sensing on the research topic ***ñ****Numerical analysis of the relief for the post deltaic landscapes in the Amudarya river delta****ñ***[2].

Many scientists have proposed classification and mapping of the terrain on applied geomorphology for a comprehensive study of land resources (T.Tamura, 1980) [3]. The terrain classifications have been studied by many researchers (Tang Guo-an and Lai Fayuan, 2008), also, the last decade, many scientists have paid attention to the classification and mapping of the relief in geomorphology (L.DrŁgut and C. Eisank, 2009, 2011) [4,5,6]. In the world of the present time many researchers for the classification of methods of geomorphons (T.F. Stepinski et al., 2011, 2015), other researchers of the DEM transformed the relief using the methods of geomorphons (J. Jasiewicz et. all. 2013) [7,8,9]. In 2013, scientists presented a new method of classification and mapping of elements from the relief of the height matrix based on the principle of pattern recognition (J.Jasiewicz and T.F. Stepinski., 2013) [8]. Some researchers compared the terrain classification by height, slope, curvature

relief inputs and (TPI) topographic position index and some studies have used the classification of the relief of the DEM which has a high spatial resolution (M.Mokarrama, M.Hojati, 2018) [10,11].

Study Plan

The study plan was prepared with the required documents before the study tour to the Leibniz Institute for Agriculture Development (IAMO) in Germany. Here, below is the study plan is given:

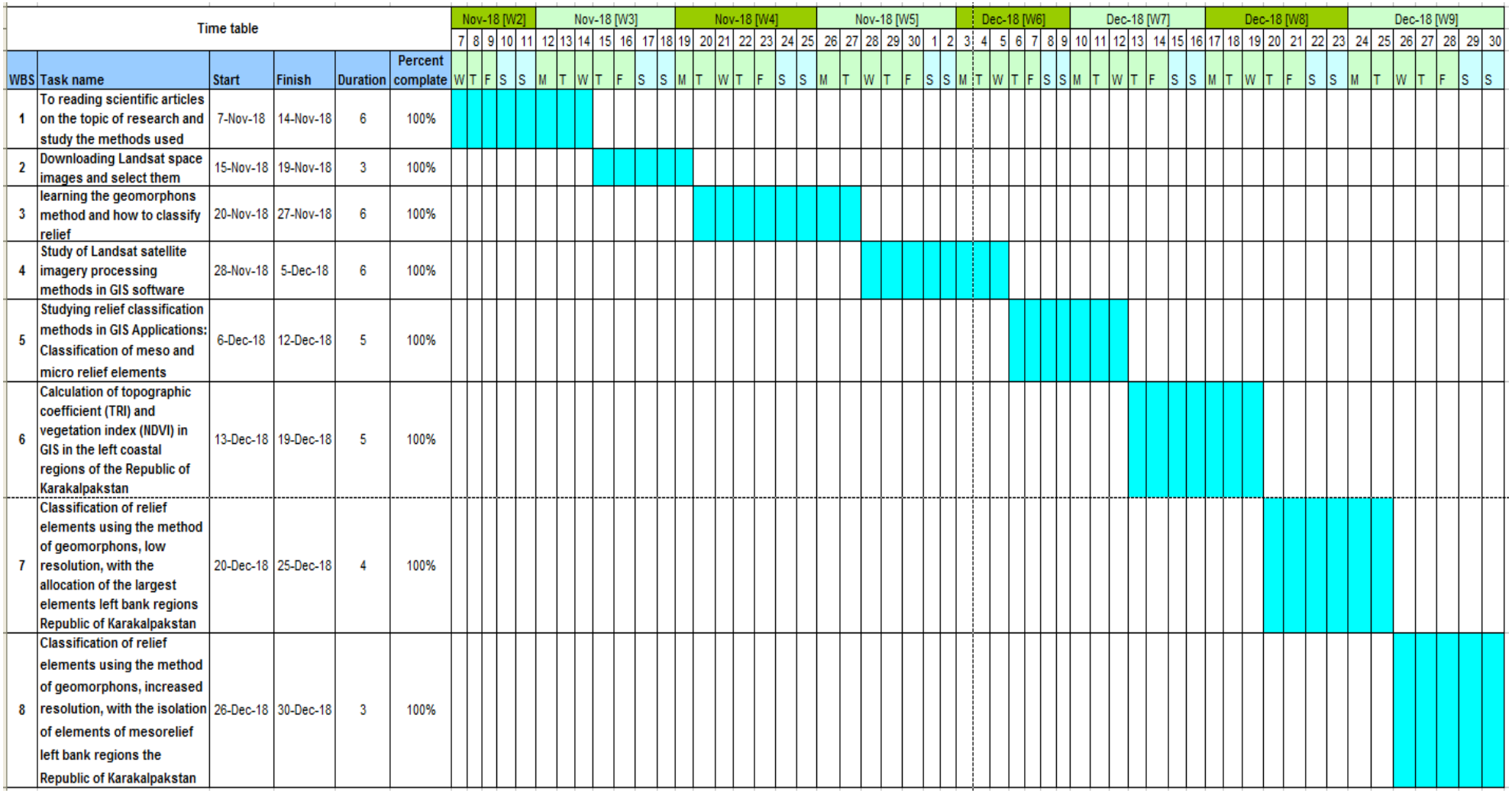
1. Introducing my boss from the Host Institute
2. Receiving assignments and assignments from the head of my host institution;
3. Review and review of research papers and articles on the topic:

a. Download space images and select the best ones;

b. Processing of downloaded area images of the study area in GIS software and comparing the results;

4. Studying new GIS programs and remote sensing methods.
5. Going to the library and researching new science books related to the field I am studying;
6. Learning to write scientific articles about my research work;
7. Participation in international scientific conferences and seminars (if necessary).

Time table of all activities



WBS	Task name	Start	Finish	Duration	Percent complate
1	To reading scientific articles on the topic of research and study the methods used	7-Nov-18	14-Nov-18	6	100%
2	Downloading Landsat space images and select them	15-Nov-18	19-Nov-18	3	100%
3	learning the geomorphons method and how to classify relief	20-Nov-18	27-Nov-18	6	100%
4	Study of Landsat satellite imagery processing methods in GIS software	28-Nov-18	5-Dec-18	6	100%
5	Studying relief classification methods in GIS Applications: Classification of meso and micro relief elements	6-Dec-18	12-Dec-18	5	100%
6	Calculation of topographic coefficient (TRI) and vegetation index (NDVI) in GIS in the left coastal regions of the Republic of Karakalpakstan	13-Dec-18	19-Dec-18	5	100%
7	Classification of relief elements using the method of geomorphons, low resolution, with the allocation of the largest elements left bank regions Republic of Karakalpakstan	20-Dec-18	25-Dec-18	4	100%
8	Classification of relief elements using the method of geomorphons, increased resolution, with the isolation of elements of mesorelief left bank regions the Republic of Karakalpakstan	26-Dec-18	30-Dec-18	3	100%

Activities and outputs of the stay.

One of the main aim of DSinGIS project is to *Enhance the scientific level of academic and research staff at UZ partner universities in the field of GISc*. Taking into account the aim of the project, DSinGIS had a call for young researcher mobility in short term period at partner universities. Young researcher Yakhshimurad Khudaybergenov from department of Geography, Karakalpak State University, Uzbekistan successfully admitted and shortlisted from the first call of the mobility and had opportunity two-month research-visit from November-December 2018 at Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Germany. During this period of stay he continued his research under the supervision guidance of Dr. Daniel Muller and near assistance of Dr. Florian Schierhorn in the sphere of landscape ecology and remote sensing on the research topic ***ñNumerical analysis of the relief for the post deltaic landscapes in the Amudarya river deltañ***.

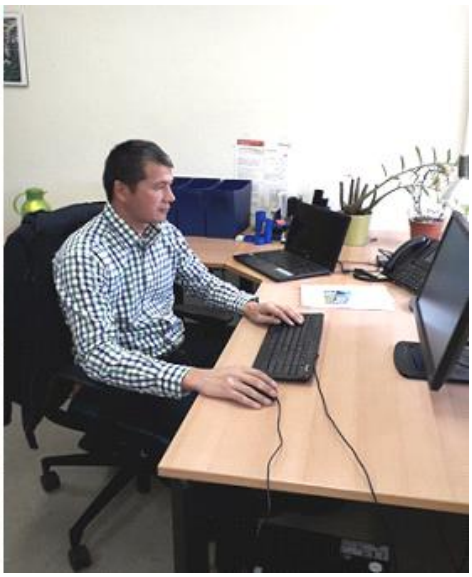


Fig.1. Researcher Yakhshimurad Khudaybergenov the process of classifying relief elements using geomorphons.

Moreover, during this mobility Ya.Khudaybergenov had great opportunity to be familiarized with new ideas about model-oriented remote sensing

analysis, vegetation density dynamic research and new approaches to potential rangeland productivity assessment in changing climatic conditions which are very useful for applying in nowadays global problem of Aral Sea.

ñThe main cause of my choice is the negative natural changes in the region, including the Amudarya delta, as a result of the drying up of the Aral Sea, and I think it will have a great impact on the study of modern GIS technologies. In recent years, more than 100 lakes in the delta have dried up due to poor access to the Amudarya River. As a result, the desertification occurred in the Amudarya delta and the landscape changed in the area. Studying and assessing trends in landscapes in the Amudarya delta through studying and analyzing these changes in modern GIS programs. Landsat satellite images can be identified using the GIS programs to determine the landscape change and vegetation index (NDVI) in the Amudarya delta and now I am ***working on scientific article and will make the first results in annual GI conference in Samarkand in October 2019ò*** states Yakhshimurad Khudaybergenov [2].

Object and study area.

Objects the post deltaic landscapes of the northern part of the Amudarya river delta. We want using the geomorphons method of classifying and mapping the northern part of the Amudarya river delta. Because in this territory present time the landscape is changing rapidly. From this point of view, the methods of geomorphons give us very good results.

J. Jasiewicz, P. Netzel, T.F. Stepinski (2013) proposed a new alternative approach for mapping elementary relief forms that differs significantly from other modern methodologies, based not on visual assessment of topographic features of the terrain, isolation of negative and positive forms using traditional methods of differential geometry, but using methods of computer recognition [10]. In part, this method repeats certain features of

visual classification, but is free from possible errors caused by a priori representations of the geomorphological researcher about the territory under study. To do this, it is suggested to use methods for classifying textures, in particular, content-oriented image processing. In this case, the elements of the relief are considered as specifically spatially distributed heights in a certain region of the digital relief model. Within the framework of such a representation, the means of texture classification were adapted. In particular, an approach based on local ternary structures (LTS) can be used to identify relief elements. The set of all LTSs is finite, taking into account the symmetry of rotation and the reflection of their total 498 types. A geomorphic map is a thematic topography map, it shows the spatial structure of the ten most common relief elements: 1 ï flat, 2 ï peak, 3 - ridge, 4 ï shoulder, 5 ï spur, 6 ï slope, 7 ï hollow, 8 ï footslope, 9 ï valley, and 10 ï pit (Fig.1). In the article, we used the algorithm implemented in GRASS 7 as a GRASS r. geomorphons module (Geomorphons App is a web interface for the r. geomorphons).

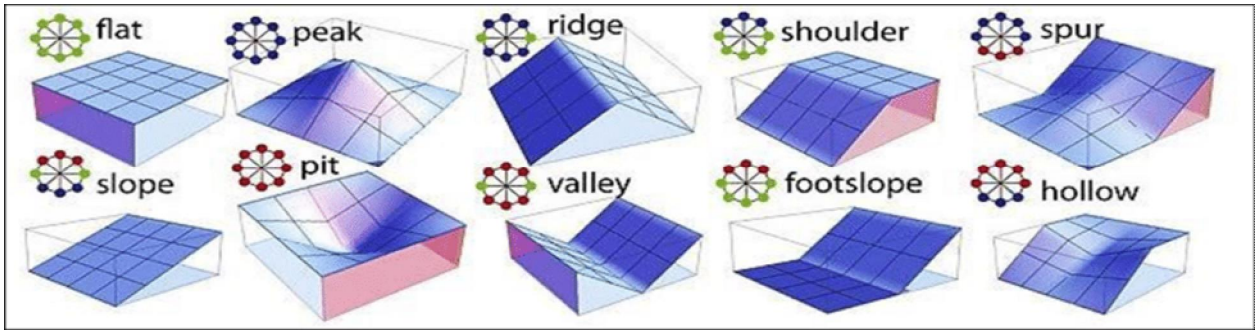


Fig.2. Main geomorphons known for the analysis of the landforms (Jasiewicz, Stepinski, 2013).

One of the most important parameters of the relief is the slope. The slope expresses essential characteristics of the earth's surface and is widely used in landscape analysis, land use planning and land use optimization. It is important to correctly choose the scale of the grid on which this

parameter is calculated, since the slope calculated by the single minimum cell of the digital relief model in a raster form may not be able to reveal the most important features of the terrain of the studied territory. This is especially important for the post-deltaic plains, where a complex picture of the technogenic transformation of the surface is superimposed on the natural dissection of the channel system, the river banks and inter-river depressions. And, although the averaged slope is widely used as a topographic ruggedness index (TRI), revealing the unevenness of the earth's surface on an average scale, it cannot be applied directly to the geomorphological assessment of post-deltaic landscapes and their classification as a single functional parameter. Thus, it is obvious that for post-deltaic landscapes with a high degree of anthropogenic fragmentation, more subtle and sophisticated methods of analysis are needed. In particular, Tang Guo-an, Li Fayuan, [4] for the first time formulated new promising approaches to the analysis of the spectrum of this parameter. In this case, there is the possibility of statistical study of the surface gradient within the boundaries of the corresponding facies or larger landscape units. At the same time, the slope spectrum of the surface reflects the type of relief more fully and efficiently in comparison with other topographic indices, and the transition of slope compositions from positive to negative skewness depends on the dimensionless value reflecting the processes of relief formation-accumulation and denudation. In a number of cases, the distribution of slopes is an important means of research, for example, slope processes and the slope spectrum can characterize the topographic profiles of inhomogeneous relief more effectively than traditional qualitative classifications [12].

We have made the classification of geomorphons left-bank regions Republic of Karakalpakstan. Also, the basic topographic ruggedness

indexes widely used in modern geomorphometry are also quite informative. This is the topographic ruggedness index (TRI), which is the average difference between the value of the central cell of the sliding window and adjacent cells, and also the TPI (topographic position index) calculated as the difference in the values of the central cell from the average surrounding cells.

It should be noted that a variety of topographic ruggedness index (TRI) systems based on hydrographic reconstruction of the territory does not always give an adequate picture due to the great degree of transformation of the relief in agro landscapes (irrigation canals, dams, collectors) and superposition in post-deltaic landscapes of mesoscale geomorphologic elements of different genesis, in particular, the remnant elevations and intra-oasis sand massifs. Using this method, we made the topographic ruggedness index (TRI) of the left-bank regions Republic of Karakalpakstan (Fig.3). There are many different filters for texture analysis of images, in particular, local binary encodings are widely used to describe and classify textures. The local ternary structure can be considered as a binary modification in order to operate with images with lower contrast levels. The operation is based on assigning to the neighboring cell of the sliding filter a value of 1 if its value exceeds the value in the central cell by at least a predetermined threshold value. In the opposite case, if the value of the neighboring cell is less than the value centrally to the threshold value, then it is assigned the value -1. In all other cases, the calculated value is zero. From a practical point of view, the ternary coding of the relief type in the vicinity of the central point is determined not just by the height difference, but by the derivative value for the local surface using the principle of the observed neighborhood.

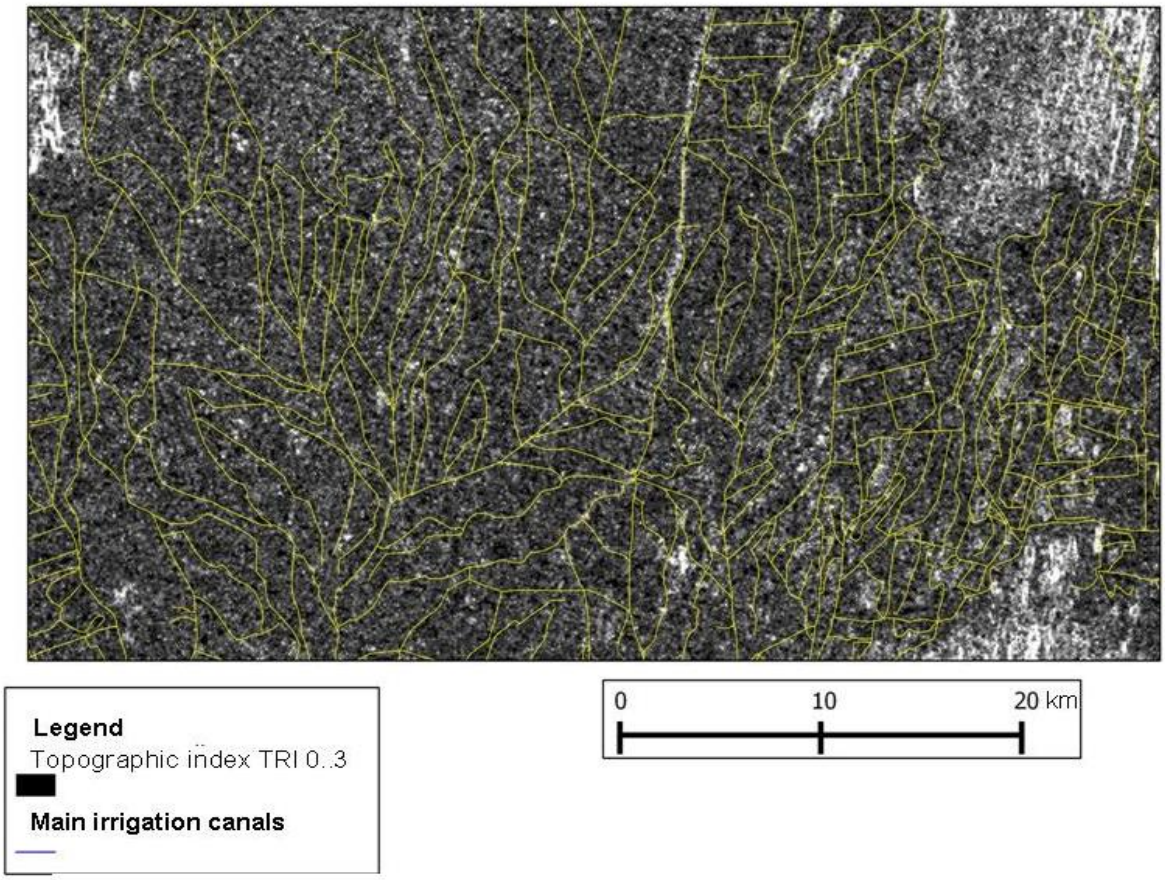


Fig.3. Topographic ruggedness index (TRI) of left-bank regions of the Republic of Karakalpakstan.

There in this method we made Vegetation index of left-bank regions of the Republic of Karakalpakstan with superimposed primary irrigation systems (yellow lines), August, 2013 (Fig.4) and you can see Fig.5. Space image of the northern part of the delta Amudarya (2013, Landsat) with the imposition of isohypses made by these methods.

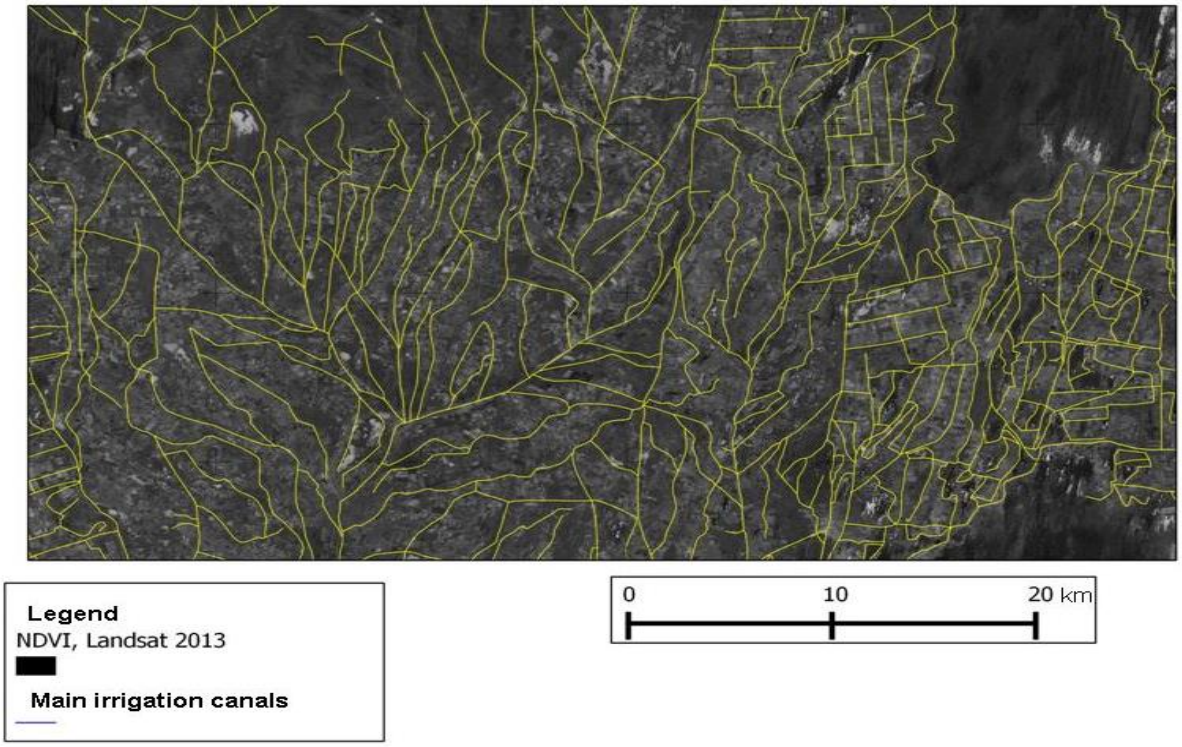


Fig.4. Vegetation index (NDVI) of left-bank regions of the Republic of Karakalpakstan with superimposed primary irrigation systems (yellow lines), August, 2013.

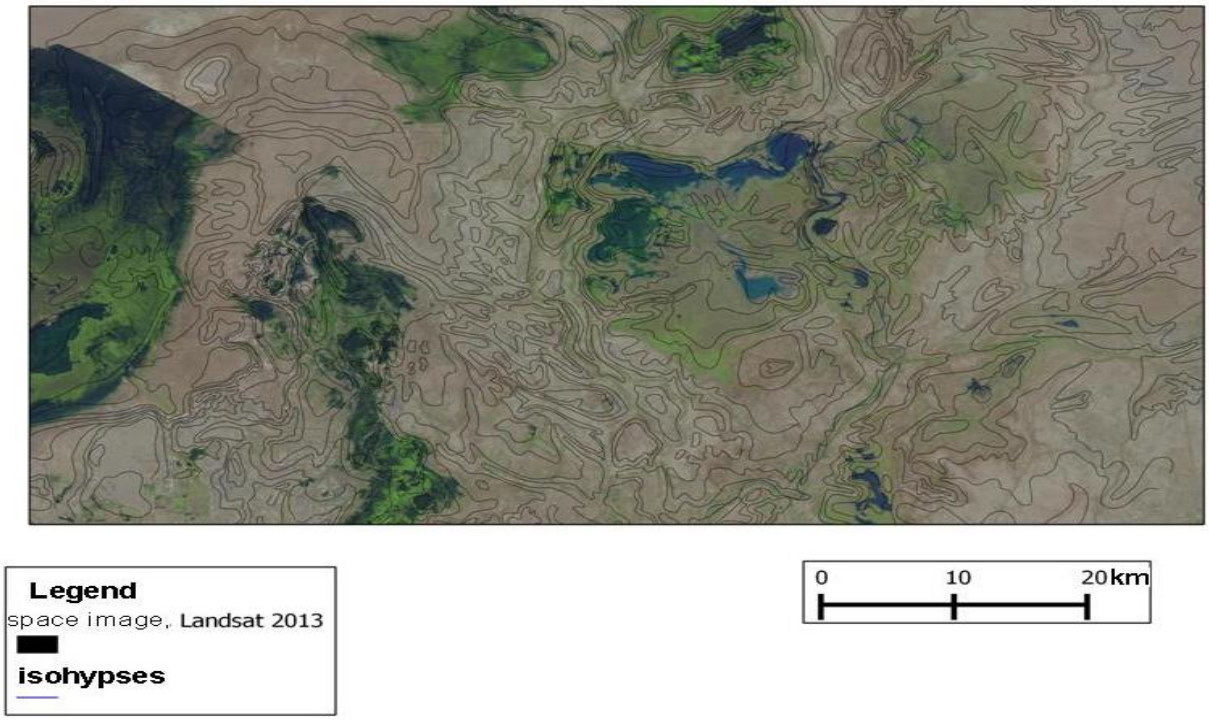


Fig.5. Space image of the northern part of the delta Amudarya (2013, Landsat) with the imposition of isohypses.

J. Jasiewicz, P. Netzel, T.F. Stepinski propose to call these elementary "atoms" of the geomorphological structure geomorphic, by analogy with textiles, elementary units in the analysis of textures [9]. Texts reflect the fundamental features of the microstructure of images and, thus, form the basic elements of visual perception. Similarly, geomorphons can be represented as elementary constituents of the geomorphological structure of a territory. Geomorphons can be obtained by processing a digital terrain model with relatively small computational costs. In this case, instead of a sliding window with a constant scale factor, you can use a LTS with the automatic size and shape that is automatically adaptable to the local topography for the transformation operator of the digital terrain model. This approach uses the idea of the line of sight and ensures that all forms of relief are identified in the most appropriate scale for them. At the same time, single expressed relief elements consist of a set of geomorphons, and it is possible to generate geomorphological maps consisting of ten generally recognized elements of a relief (peak, ridge, slope, valley, plain, ledge, bottomless drop, etc.). The process of generating such a card reduces the reclassification of geomorphic maps using cross-matching tables. It should also be noted the extensive flexibility of this method, which is especially important for delta plains, including small elevations, outcrops and ridges. With this method, we have made classification of relief elements using the method of geomorphons, low resolution, with the selection of the largest elements, of the Republic of Karakalpakstan (Fig.6).

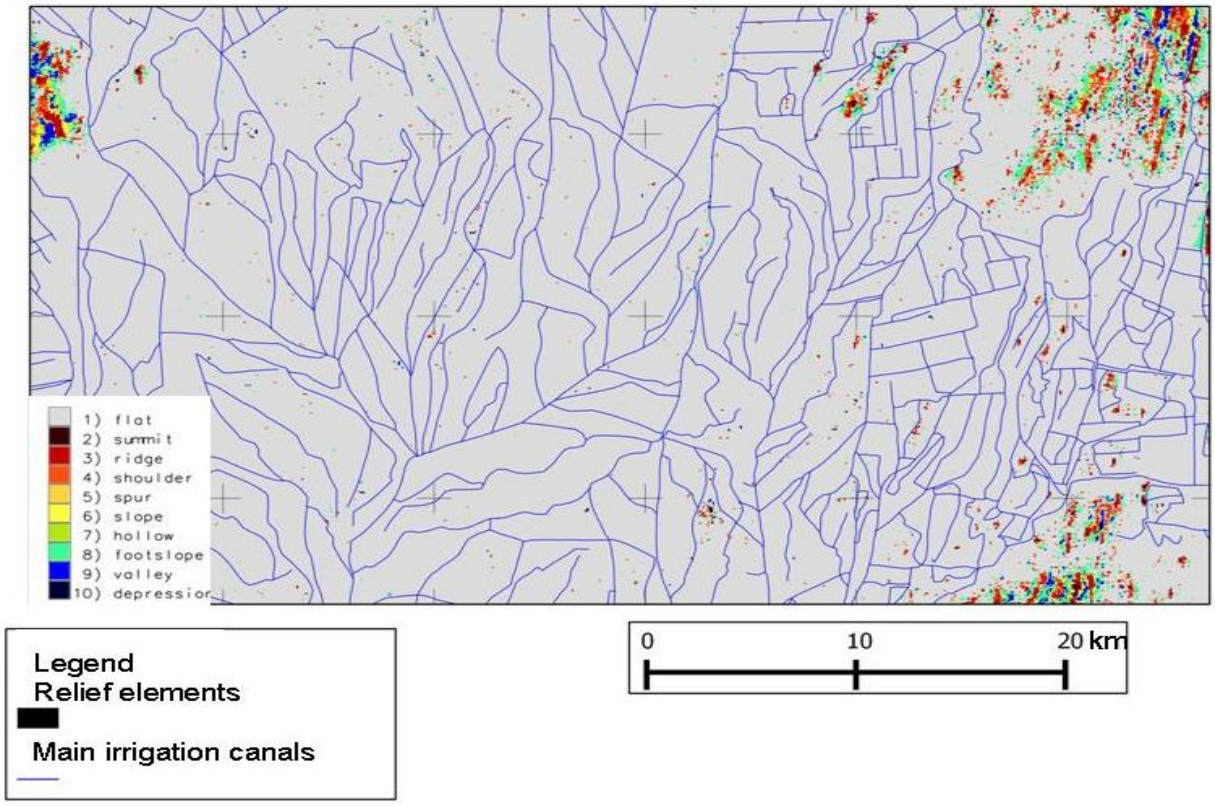


Fig.6. Classification of relief elements using the method of geomorphons, low resolution, with the allocation of the largest elements left bank regions Republic of Karakalpakstan.

This principle, first proposed by Yokoyama and Shirachava in 2002, relates the surface relief and horizontal distance by means of the so-called zenith and nadir angles along eight main directions. To calculate the corners from the digital elevation model, eight local profiles are created starting from the central point and propagating along the main directions up to the distance of visibility. The analytical details of this operation are set forth in the works [13].

As well as with the metods we have made classification of relief elements using the method of geomorphons, increased resolution, with the isolation of elements of mesoreliefs the Republic of Karakalpakstan (Fig.7).

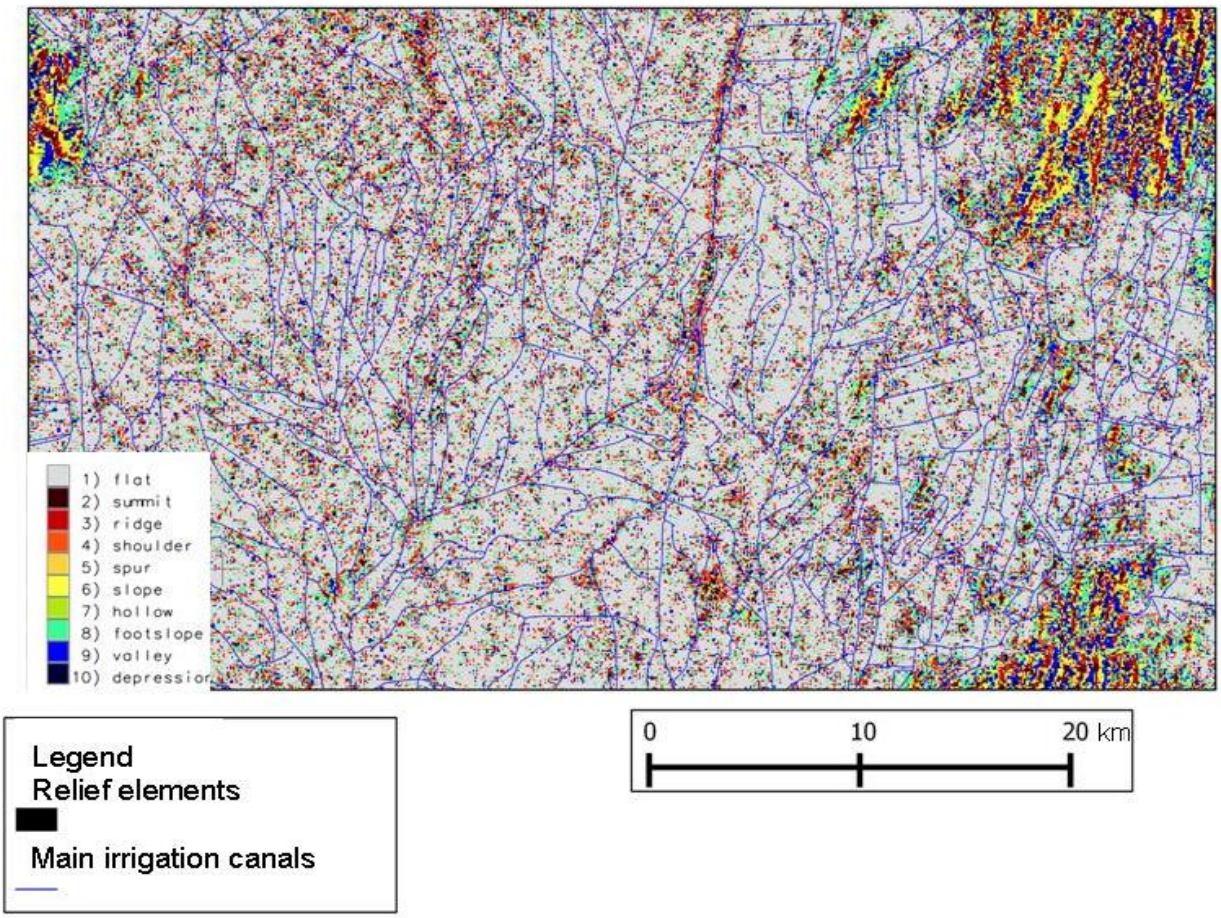


Fig.7. Classification of relief elements using the method of geomorphons, increased resolution, with the isolation of elements of mesorelief left bank regions the Republic of Karakalpakstan.

The geomorphological analysis of the Southern Aral Sea in a survey scale is consistently shown using the method described above, a fragment of a digital geomorphological map obtained by classification of local ternary structures and topographical indices for this section of the study area.

We used so-called geomorphons approaches proposed and developed by T.F. Stepinski, and J. Jasiewicz [8]. This approach reveals more complicated details of the relief structure and allows studying modern processes of the relief genesis and landscaping transformation in comparison with traditional topographic indexes or ñrelief plasticsò

Conclusion and future plans

In conclusion, during my 2 month research internship at IAMO, I learned how to describe a relief using GIS software and applied it in my research. Thus, it can be seen from the presented illustrations that the use of traditional topographic indexes for post-delta territories is extremely complicated by the complexity and "noisiness" of the relief caused by both the development of the territory and various natural processes, in particular, the previously discovered phenomenon of geoecological interference [14]. At the same time, the use of analytical methods based on ternary coding and subsequent classification (the method of geomorphons), even in the complex situation of a developed agrolandscape, gives the possibility of classifying and isolating the essential elements of the terrain. The study of relief is important both from the point of view of formulating the geoecological foundations of modern soil formation and describing geochemical flows in the post-delta ecosystem, and, in the long term, as a method for regional monitoring of the transformation processes of landscapes due to desertification.

Acknowledgments

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