The modern state of methodology transition to adaptive-landscape system of agriculture (on the example of the northern slope of the ILi Alatau Mountains')

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To cite this article:

Kerimbay N. N., Mamutov ZH. U., Kakimzhanov E. H. Kerimbay B.S.. **“The modern state of methodology transition to adaptive-landscape system of agriculture (on the example of the northern slope of the ILi Alatau Mountains')”**

The article discusses the principles of drawing up the soil-geomorphological and landscape maps adaptive landscape cropping system northern slope Ili Alatau mountains’ of the GIS technology.

Currently topical issue of fundamental change in the process of formation of agronomic solutions through the introduction of environmentally sustainable farming systems with extensive involvement of the capabilities of modern techniques and technologies, including geographic information systems and computer technology.

Scientific novelty. For the first time in Kazakhstan held a territorial analysis of the classification categories of landscapes and issue of soil, geomorphological and landscape map using GIS technology to create adaptive-landscape system of agriculture. In this case, the methodological approach the use of GIS technology.

1. Assessment of the Current State of Scientific and Technical Progress Being Solved

By analyzing the status of the issue on ALSZ around the world , we have come to the conclusion that the researchers of the Russian Federation since the 1990s deliberately and thoroughly conducted deeper differentiation of farming systems in relation to agro-ecological conditions. In the framework of these elaborations put ALSZ design methodology and agricultural technologies developed by Academician of the RAAS V.I.Kiryushins [1]. It has been tested in a variety of natural and agricultural areas and provinces of Russia (Novosibirsk, Moscow, Vladimir, Yaroslavl, Voronezh, Orenburg, Tambov regions). The results of these extensive works A series of research papers , recommendations, Manuals, handbooks, etc. The final work is a generalized guidance "Agri-environmental assessment of land, designing adaptive- landscape systems of agriculture and agro-technologies",ed. FGNU" Rosinformagroteh ", Moscow, 2005 . [2].

We have carefully reviewed the scientific and methodological sources and used in the general direction , content, trends State approach to the problem of Russian colleagues. Clarified and assessed the scientific work and the assumptions put forward in the Kazakh research and development looking for the drafting ALSZ in our Republic. They are: the fourteen volume monograph on "The soil of Kazakhstan (by area)", issued under the editorship corresponding member KazSSR U.U.Uspanova , the study of the problem of anthropogenic landscape science professor K.M. Dzhanaleeva, numerous developments made under the guidance of Academician V.M. Borovsky for reclamation zoning of Kazakhstan; abundant materials for the study of plant and animal Institutes of Botany and Zoology, Kaz SSR library materials Kazgiprovodkhoz and KazGIPROzema; works KazNIIZ them V.R.Vilyamsa, studies of various higher education institutions, and more. etc. On the basis of these materials composed "The concept of adaptive agricultural technologies in agriculture and landscape south- east of Kazakhstan for the period up to 2010 " and published in the press. [3]

2. The Purpose and Objectives of Research

Purpose - to conduct spatial analysis using GIS technology Ili Alatau Almaty region with the preparation of the electronic versions of the landscape map, soil, geomorphological, a map of the surface water. To achieve this goal, the following tasks were:

- To conduct spatial analysis of hydrological networks of surface water resources and irrigation system to make the

area a scale of 1:100 000;

- The composition of soil and geomorphological map in the scale of 1:100 000;

- To carry out a detailed and comparative analysis of the available fund of different maps drawn up on the basis of soil and geomorphological maps to make an electronic version of a landscape map Ili Alatau Almaty region on a scale of 1:100 000 .

3. Methodological Framework for the Creation of Territorial Analysis ALSZ

The concept of "farming system" is complex and controversial history. There are many different definitions. As an official, entered into the textbooks used the following definition: "The system of agriculture - a set of interconnected farming, land reclamation and organizational measures aimed at efficient use of land and other resources, the preservation and improvement of soil fertility, getting high and stable yields of crops. "It is too general and completely unaddressed in ecological terms.

Taken only as a result of 80 years of the course on the differentiation of Agriculture in accordance with the natural conditions, there address environmental farming systems, although very rough - zonal. In the GOST 16265-89 zonal system of agriculture is defined as "a system that links all of which take full account of and implement soil and climate, logistical and human resources specific natural area. "Such a "peg" system of agriculture is not adequate, because the natural area covers an extremely diverse conditions. In fact, the degree of differentiation of farming systems differ in the level of natural and agricultural provinces.

In 90 years as a result of increased research to deepen the adaptation of agriculture to natural conditions have been actively appearing new language in which to develop different aspects of the problem, complementing each other. However, cropping systems were not perceived as an integral phenomenon of nature of business. In addition to environmental uncertainty and lack of alternative addresses they do not reflect the socio -economic, market incentives , the relationship with production potential, the economic order .

In view of these shortcomings V.I.Kiryushin developed a methodology that allows to build models of farming systems, suspended not only in the physical space, but also in the socio -economic considering a certain set of factors [4,5]:

1) public (market) needs (food market, the needs of livestock product processing requirements);

2) agro-ecological requirements of crops and their environment-modifying effect;

3) agro-ecological parameters of land (natural resources potential) ;

4) production and resource potential, levels of intensification ;

5)economic structures, social infrastructure ;

6)the product quality and the environment, environmental restrictions.

Based on this approach, formulated the definition of agriculture: the adaptive- landscape system of farming - a system of land use certain agri-environmental group, focused on the production of economically and environmentally due to the quantity and quality in accordance with the public (market) needs, natural and productive resources, providing stability agricultural landscape and reproduction of soil fertility.

A special place in agricultural science today is the development of adaptive- landscape systems of agriculture (ALSZ), taking into account:

- social needs in agricultural production ;
- agro-ecological parameters of land (natural resource properties);
- agro-ecological requirements of crops, their adaptive capacity, environment-modifying effect, etc.

The essence of adaptive- landscape system lies in the fact that the effective economic use of land is the basis of their differentiation by agro-ecological groups according to market conditions, the availability of natural and industrial resources to ensure the sustainability of agricultural landscape and reproduction of soil fertility.

The term "adaptive" means farming systems adaptable to the full range of designated conditions, but "agrolandscape" means that it is designed for the specific category agrolandshaft transformed through the prism of agro-ecological assessment of agro-ecological group.

Stages of building a real ALSZ include agro-ecological mapping of land on the same conceptual basis, the development of the project land, the creation and implementation of a data bank, as characterizing agrobiocenosis, the account in an integrated optimization model all the constraints and the adequacy of the model solutions for the manufacturing implementation [6,7, 8] .

Adaptive-farming landscape at the national level are solved following basic methodological and technological issues:

- functionally-targeted structuring assessment framework and the introduction of common system of spatial-temporal organization, as well as the classification agrolandscape;
- develop basic criteria, factors, the main diagnostic measurements (ODPO) and the creation of uniform rules of the quantitative quality-ranking ODPO, basic list of classification schemes;
- creation of a unified framework metro logo-analytical, information and methodical support the evaluation and establishment of a framework baseline-standard data, the basic algorithm analysis, integration and interpretation of information;

• develop model forms initially and regulatory information, basic information and analytical modules and results;
• define the list of platform-sharing between the basic and specialized software.

We have attempted to account for all these rather diverse requirements within a verbal and then a mathematical model that ensures optimization of cropping systems on a specific economic example.

4. The Object of the Study of the Northern Slope of the Ili Alatau Mountain's

4.1. The Result of the Study

The work was carried out on the basis of RSE on PVC Kazakh National University . Al- Farabi on the DGP PVC "Research Institute of Ecology " (Almaty), located on the lands of the northern slope of the Ili Alatau. Work to develop an automated scheduling system acreage includes the development and construction of an automated data-processing system, which consists of the following functional blocks:

- e soil and geomorphological map of the entire landscape of the northern slope of the Ili Alatau, which includes information on agri-environmental resource areas, information on transportation routes , buildings, etc.;
- electronic database associated with the objects of an electronic map, which includes the required attribute information , and provides statistical data on crop yields over the past few years;
- expert module, which provides support for decision-making on short-term land-use planning resources and agro-ecological landscapes of the northern slope of the Ili Alatau;
- interface module data-processing system that provides interaction with the end user and does not require support from the developer of information-analytical complex .

In the development and implementation of each unit conducted a detailed analysis of its conformity with the actual conditions to ensure high quality of the entire system .

It is based on agro-ecological land classification of the groups on the main soil- geomorphological factors and sub-groups - the intensity of their display. The main differentiating factors are the degree of erosion and land hydromorphism. The differences between subgroups may be so large that they should apply different cropping systems .

Agri-environment sub- divided into classes according to the nature of the parent rocks and into subclasses - in their size distribution. Classification includes divisions of land on the specifics of mezo, steepness of slopes and exposures that can identify the selected path with the same microclimatic conditions .

Given all these indicators was compiled comprehensive detailed map of the test area .

Electronic map of the northern slope of the Ili Alatau was built on the basis of maps of areas of soil and planted areas, containing information about the basic agro-ecological landscape habitats (AEL). Under each such habitat is understood homogeneous soil contour plot on the mezo-element, characterized by the same geological, lithological and microclimatic conditions.

From elementary ranges agricultural landscape formed agri land types, which, in contrast to the spatially fixed habitats due to natural conditions, constitute a system that depends on the adaptive capacity of crops, intensification of cultivation conditions. In turn, all areas of graded according to the possibilities of overcoming constraints of crop protection.

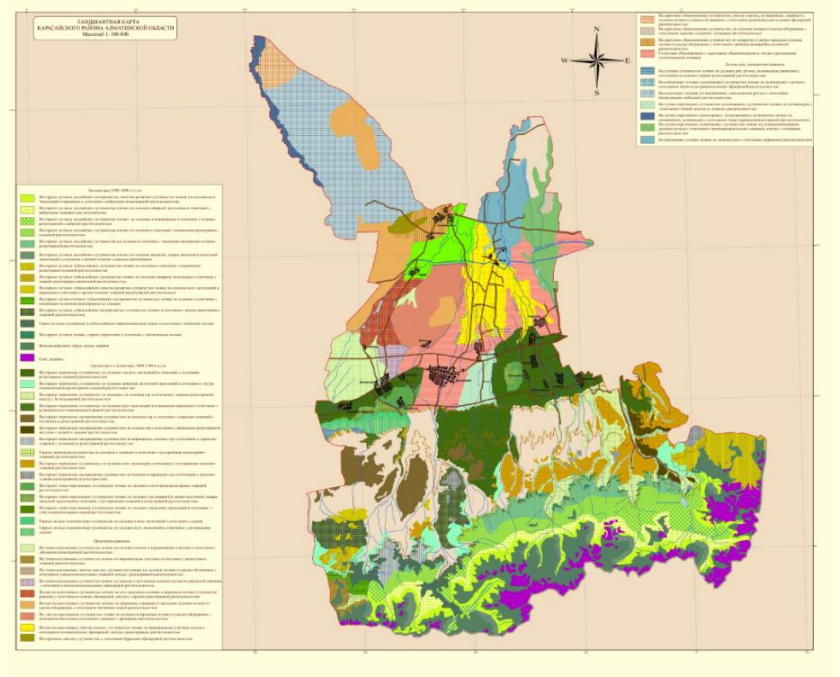

Fig. 1. *Map of areas of elementary soil.*

Electronic map includes seven independent layers:

- Landscapes - to store information about the basic agro-ecological landscape habitats (Living Room);
- Soils - to store information about the Living Room , for which information is not received or is not accurate enough (secondary layer);
- Geomorphology - to store information about the Living Room, the information on which the mezo, and the steepness of the slope exposure (secondary layer);
- Roads - to store information about traffic routes , which is essential in the planning of cultivated areas;
- River - to store information on watercourses;
- Others - to store information about the objects of other categories;
- Reservoirs - to store information about watersheds .

Electronic version of the map is implemented by means of software Arc GIS 10.1 [9,10].

The main map layer contains about a thousand regional elements, each of which corresponds to an elementary areal (Living Room) with the same agro-ecological parameters (Fig. 1).

It is natural that the formation of large areas of cultivated limiting influence not only elements of the natural topography (rivers, ravines, ponds), but also the location of settlements , roads , etc.

The next step in creating an electronic map of the northern slope of the Ili Alatau consisted in the formation of an information layer card. To uniquely identify each individual Living Room on the electronic map , that is, to each object layer "Soils", have been assigned a unique number (ID) and the parameter string (EALCODE).

EALCODE contains complete information on the agro-ecological parameters of the elementary area. EALCODE line structure generally be represented as 1.2.3.4.5.6.7.8 where each numeral denotes the following:

1.2 - zoning
3 - soil type,
4 - particle size distribution of the soil,
5 - inclination of the slope ,
6 - exposure of the slope ,
7 - hypsometry ,
8 - geomorphology,

Such a set of characteristics of each elementary area in the GIS map allows different perspectives to analyze the suitability of the selected site for the planting of a crop.

Create a GIS map data layer and link attribute information to each of the objects layer "soil" allows you to play different variants of for paints thematic maps to facilitate visual assessment of the prevalence of elementary ranges with various sets of agro-ecological parameters (Fig. 1).

The analysis was carried out relief in 3 stages:

1. digitizing circuit topography and points with elevations from the map scale of 1:100 000;
2. TIN-layer construction of relief with the coats of characteristics of land in ArcView;
3. construction of GRID-surface topography in ArcView c module 3D Analyst.

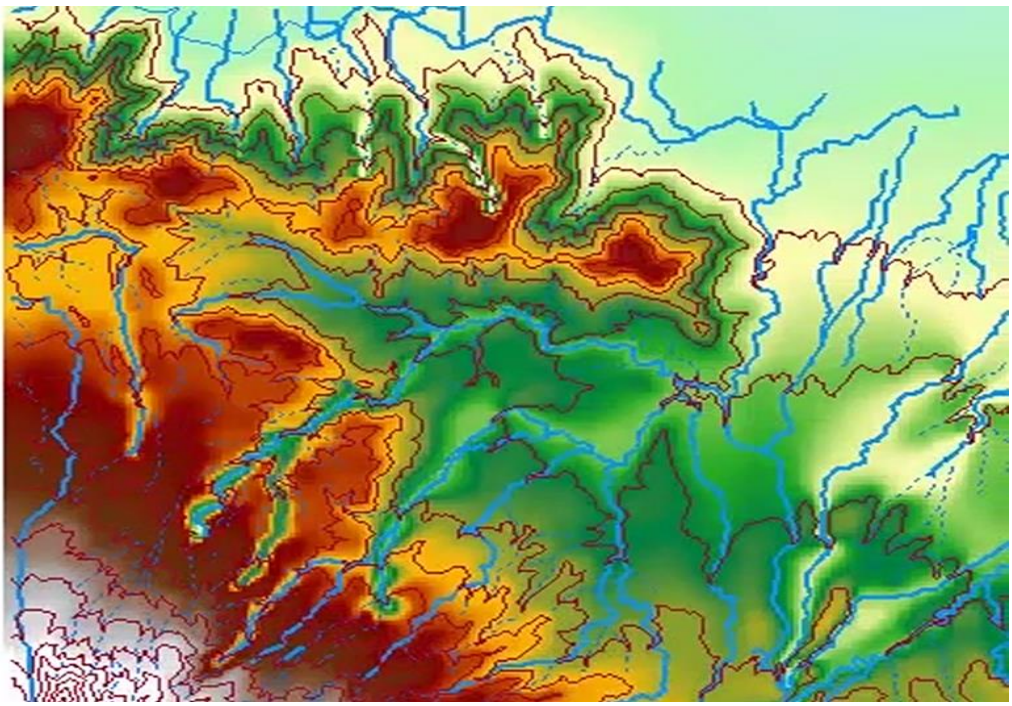

Fig. 2. *Map location of drains in relief (Layers: line drains, relief, roads).*

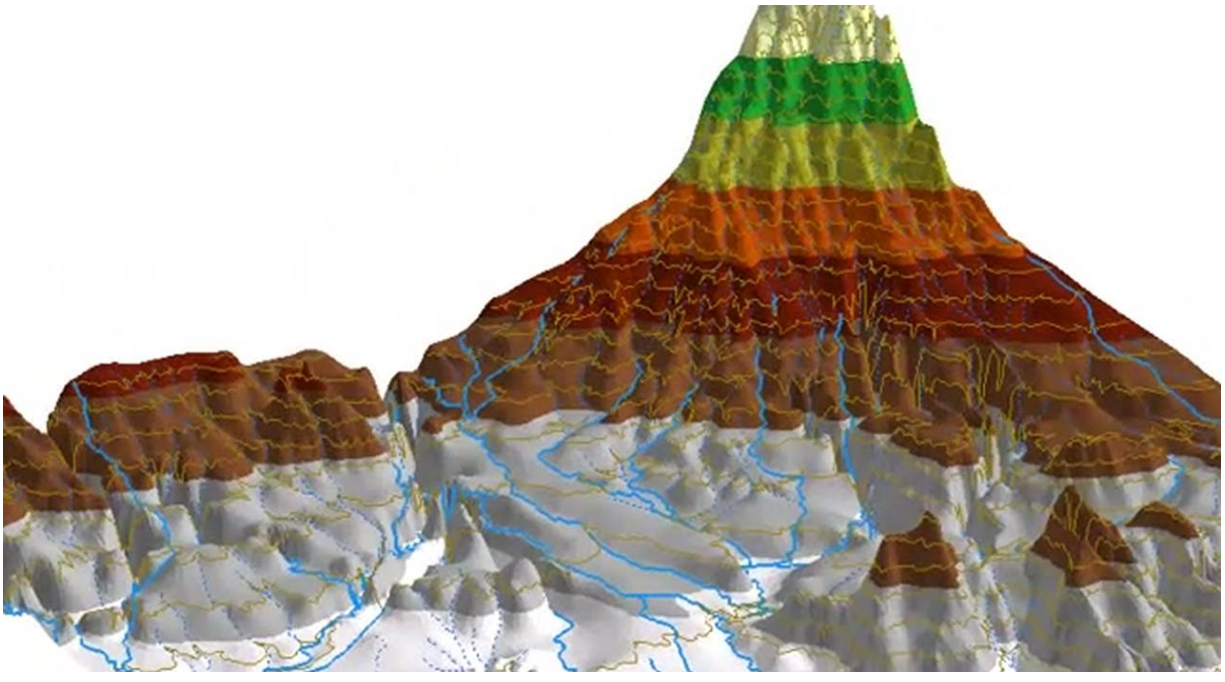

Fig 3 . *Three-dimensional map with Living Room (Layers : GRID- surface , roads, river basins, Living Room) .*

The adequacy of elementary habitat lands was checked by the construction of flow lines using the module Spatial Analyst (an example is shown in Fig. 2). By GRID- surface elevations were tied all the major layers (roads , watersheds, water bodies, human settlements) and superimposed layers with the characteristics of land (an example is shown in Fig. 3).

Expert Module Information Management System

As mentioned earlier , information- analytical complex includes analytical analysis modules cultivated areas and to support decision-making in planning the distribution of crops in different industrial areas :

- expert module for short-term planning ;
- expert module for long-term planning.

Their separation is due to the fact that the tasks of planning for the long term requires consideration of a number of additional parameters, for example, a more detailed analysis of crop rotations for both annuals and

perennials.

Each of the expert module has access to a database containing the results of the analysis provided statistical data on crop yields for different crops over several decades. The analysis data were obtained indicative for different crops productivity depending on soil type, intensification technologies, crop species previously growing on the production site, as well as meteorological parameters.

The result of each of the expert modules of information-analytical system is the optimal distribution of crops for production sites. In this case , the user is offered a complex quantitative estimates of crop yields, as well as a number of economic parameters.

In a report with the results of each of the expert modules updates the electronic map of the territory, which in turn displays a map layer manufacturing sites, the grain optimally.

5. Conclusion

Thus, a detailed mapping of the multi-component agricultural landscape that allowed the identification by the combination of different features over a thousand elementary soil habitats. The latter, in turn, were completed in the agro-ecological land types for evidence-based planning and distribution of crops chosen level of technology. Created block GIS system was the base for the further development of the technology packages crop cultivation zoned for three possible levels of intensification of production. This allowed the inclusion of "Agronomy block" in the economic- mathematical model of optimization of the agricultural enterprise as a subject of a market economy.

As a result of the work of the expert modules of information- analytical system agronomist is actually ready to plan the distribution of the available crop production areas and yields a prediction separately for each area, and the sum over the entire northern slope of the Ili Alatau mountains'. All this information is displayed on a computer screen at any scale in the form of e-card with the color accordingly received better placement cultures. With the appropriate equipment (printer, plotter) can be a hard copy card with any combination of layers and at any scale.

Joint testing and implementation of the established system into production on the example of activity showed that the system not only provides great storage capacity and processing statistical data on crop yields, but also serves as a powerful tool to support decision making in the planning of the use of agro-ecological resources of the area.

Thus, the application of GIS technology in the adaptive-farming landscape of Kazakhstan opens up new possibilities of using knowledge to address the pressing challenges of development and deployment of agrolandscapes, agro-ecological zoning, the choice of adaptive management, landscape farming systems, to provide the required a meliorative treatment of crops, the rationale for Natural Resources Exploration recovery of activities within the agrolandscapes, and at a higher hierarchical level, address specific management tasks.

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