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Successive Steps to Organize Rational Use of Soils for Formation of Ecologically Stable Agro Landscapes.

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ABSTRACT

The stages of a comprehensive regional programme of territorial reorganization of rural locality in a modern situation of reforming of the land relations are offered. A list of algorithms on support of operation of systems of agriculture, which one will be realized with the help a GIS of agricultural assignment for the conventional system of a land-use system, is defined. The new optimization tasks, which one demand the solution, by us are detected.

Keywords: Land use, agro landscape, ecological arrangement, GIS-technologies.

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INTRODUCTION

In the steppe zone agro landscapes, the appearance of humus due to crop residues of agricultural crops makes only 30% of the value characterizing undisturbed lands [1], and soil in long-term cultivation already lost 30–50% of organic carbon [2]. Along with increasing the intensity of agriculture, the problem was the abandonment of agricultural land in Russia in the late 20th century [3].

Nowadays, it is recognized that the greening and biologization processes of agricultural intensification are required for stable growth of crop yields [4]. A strategy for space and time adaptation to the structure and development of the cultivated lands in all types of economic impacts needs to ensure the sustainability of the entire farming system (including organizational, economic, agro technical, ameliorative, and ecological subsystems) and sustainable rural development.

A new concept of organization of agriculture in space and time implies the transition from a territorial adaptation of the system of land management and land use to time, and eventually to space-time adaptation. The need for the functioning of agro landscapes to be adapted to the time rhythm is explained by external factors – agricultural climate cycles [5] and intervals of pedogenesis [6].

In the implementation of space-time adaptation, there is the prospect not only of improving the sustainability of agriculture through the use of a variable (flexible) technologies in adverse bioclimatic periods, but also the rational use of the frequency of processes of resources formation, in particular the reproduction of soils [7].

The possibilities of using a system of mutually complementary methods for analyzing time series for providing in-depth study of long-term changes in nature, determining the cyclic components of different frequencies, predicting the effect of climate on soil-forming processes in various physical and geographical zones have been justified recently [8-10].

The prevailing influence of erosion processes in areas of intensive agricultural development is due to long-term changes in agricultural loads in catchment's areas [11]. With the increasing negative dynamics of the forest, climatic changes may cause an increase in the surface drainage during spring, a decrease in the channel runoff, worsening of water quality of large river basins [12]. The total forest cover on the territory of cultivated lands can vary depending on the regional differences of forest-steppe zone and grade of the river basin from 14–18 to 19–35 % [13].

The anti-erosion control should be aimed at preventing excessive expenditure of water masses and solid runoff from the catchment's areas. This can be regarded as the initial stage in the extensive distribution of technologies for managing the biogeochemical cycle of substances within the scientific field of biogeosystems engineering [14]. Understanding and modelling of the general regularities of soil development over time and under the influence of agriculture is a fundamental challenge in soil science [15]. The transition from statistical approach to the prediction taking into consideration determines the necessity of development of genetical imitational models of soil-formation processes [16]. Although in recent years a considerable success has been achieved in solving the problems of soil and water protection [17-20], due to the use of new technologies, design solutions have become more effective.

MATERIALS AND METHODS

The modern Geographic information systems (GIS-technologies) serve as an informational basis to intensity agricultural industry. We are working out the agricultural GIS of Belgorod region.

Databases of cartographical and analytical information were formed with the help of GIS software: the cartographical editor MapProj and the data bases control system NetBase. For this purpose, GIS has a lot of possibilities to enter and edit graphic elements of the maps, and to form and enter the parametrical information for each element in the form of database.

So vector maps which were made with the help of the software are characterized by the high accuracy and informative level. We used a system of agreed signs according to the standard of digital and polygraphical cartography. It gave the opportunity to make a cartographical data base which can be used as an informational and reference system and be printed with the usage of digital apparatuses.

RESULTS AND DISCUSSION

Indispensable condition for steady rise of productivity of agricultural cultures becomes ecological and biological intensification processes, and a stability condition of systems of agriculture (with planned-economic, agro technical, reclamation and ecological inter-systems) and steady development of a countryside should become the strategy of spatial and temporal adapting of economic effects to frame and development of nature and anthropogenic landscape systems.

A macro level of spatial adapting of plant-growing is the usage of a zonal principle in a specialization, in last 20 years was supplemented by diverse hierarchical levels: meso-level (agroecological demarcation) and topological (landscape) level of "device" (accommodating) of agriculture to abiotic factors of environment. At intralandscape differentiation of agrotechnics: its useful to orientate the intrusion "of precise agriculture" on an objective function, which one, in our judgment, can become resource saving (first of all, in the attitude of land resources) and environment forming function.

The experience of an intrusion of landscape-ecosystems of agriculture convinces that the problem of security of reproduction both soil conservation and their fertility cannot be independent. It should become an integral part of the surrounding program of function reorganization of rural locality. We excrete nine milestones of such reorganization (Table 1).

The first step in the realization of the specified strategy should become recreated (with the count of varying economic and legal conditions of last ten years) agroecological geographical demarcation of the Belgorod region coordinated with the dynamics of marginal zones (Russian–Ukrainian border, interregional zones of interaction with the neighbours on Central Chernozem Regoin). In consequent it will allow on a base of economic (plant–growing–cattle–breeding proportions of frame agro-industrial complex and agroecological criteria to justify optimal frame and complement ability land of agricultural in within the limits of marked agroecological regions.

Table 1: The stages of the all-up regional program of territorial reorganization (function zoning) of rural locality

No	The contents of a stage	Parameters of ecological and social and economic efficiency
1	The substantiation of a social-ecological optimum of frame of land, fund reflective in the specifications natural features, extent of economic mastering and long-time priorities of steady development	Rational interrelation of the floor spaces agro zones (tillage's, meadows and perennial grasses), pools and ecological fund of lands, including forests. Achievement of territorial ecological balance
2	Function-target zoning of region: industrial zone, including lands of agricultural purpose and operated forests, recreational terrains and ecological framework complementary a system apart of guarded natural terrains	"Development" of the normative floor spaces of lands in the schema of the optimal territorial device of region
3	Projection by engineer and geographical methods of a framework of soil protecting and ecologically planned agro landscape – the system of land-arrangement on principles of a contour and reclamation agriculture	Observance of the resources and ecological specifications to ground and water of use, intensifying of environment regulation of functions of a landscape
4	The adaptive strategy on a base biological structural analysis of agro landscapes, providing placement of agricultural cultures according to the meso– and micro– climatic variations of agro-climatic potential and count of the limiting microzonal factors	Heightening of productivity of agro landscapes by more complete usage of bioclimatic potential
5	Ecological construction of lands, which one adjoin to	Ecological safety of water currents and (water

	a hydrographic net, by binding of riversides and saved zones, in by filtration in the mouth zones of active ravine	storage basins, ponds), heightening of their biodiversification and fish productivity
6	The substantiation at a regional level of a rational web of guarded natural terrains providing conservation of a landscape diversification, possibility of study of representative and unique ecosystems, steady reproduction of a gene pool of alive organisms	Achievement of appreciable influence of environment forming of efficiency of the built ecological framework on immunity of regional development
7	Projection of biocentralized network frame of terrain coordinating agro landscape to adjoining lands with the help of biological corridors, of a continuous or discrete type	Ecological web, connecting through biocorridors "entered" in a plastic of a landscape, the keys natural terrains, bordered by bumper zones
8	Ecological rehabilitation of lands: dislocated, blasted by processes of an anthropogenic degradation, door natural lands (sand, place of yields and close burial of bedrocks)	Blockade of the centres of potential development of a degradation of landscapes, building for lands with potentially dangerous development of processes of the rules of nature management
9	Fissile politics of detection and incorporation of landscapes of historic and cultural purpose(appointment) in regional and aboriginal planning for security of conditions of conservation of complexes and plants of cultural inheritance in their natural or artificial environment. Development of architectural solutions creating aesthetically attractive appearance of a landscape	Shaping of uniform legal space for conservation of natural and cultural inheritance. Conservation of beauty both character of landscapes and terrains, exclusion for change of valuable terrains with the historically usual landscape – source of national collective memory(remembrance)

Besides GIS have a lot of functional opportunities for keeping up these database and developing the information and reference cartographical system:

- ⇒ automotives entering the cartographical data on the base of scanned pictures and geodesic survey;
- ⇒ making and interactive editing the system of agreed signs for the map;
- ⇒ making a free structure of analytical database, adding, editing notes and connecting them with the cartographical information;
- ⇒ making and interactive editing the electronic tables within the map;
- ⇒ giving the answers to the documents with the pieces of cartographical information in 3D regime;
- ⇒ using of intra-program language for solving non-standard tasks;

The software was worked out on the base of a core of GIS-system, Delphi – language in the operation system Windows95/XP.

Created program modules were connected with the core of GIS-system and were tested on the real database.

The theory of methods and algorithms of modelling is working out on the base of the methods of adaptable landscape agriculture and the balance of ecosystems of agriculture (Table 2).

Table 2: The tasks, which one are decided with the GIS-technology for main subsystems of agriculture

Subsystems	Aims
Economic	➢ planning of agricultural crops productivity; ➢ calculating of the yield level; ➢ optimization of the structure of agricultural lands and crop rotation; ➢ spatial analysis of agricultural lands.

Agrotechnical	➢ spatial analysis of plants growing; ➢ the yield forecasting; ➢ spatial analysis of harvesting; ➢ spatial analysis of preparing soils for winter, sowing winter crops; ➢ spatial analysis of soil fertility
Reclamation	➢ ecological and coil valuing of soil for agricultural crops; ➢ valuing of necessity of anti-erosion reclamation for a particular field with a settled system of land use; ➢ determination of need for organic fertilizers; ➢ determination of site and features of shelterbelts to stop water flow; ➢ reproduction of soil resources of degraded and low-yield lands.
Ecological	➢ heavy metal control of quality of agricultural production; ➢ creation of ecological infrastructure of land use territory; ➢ valuing of erosive danger and other natural phenomena; ➢ calculation of erosive soil waste; ➢ calculation of admissible erosive soil waste; ➢ calculation of the features of maximum hillside water flow; ➢ calculation of ant erosive hydro technical edifices; ➢ determination of optimal ecological and economic version of land use for each plot.

The aim of our technology is the usage of GIS-technologies which provide the monitoring of land conditions and farm technical equipment, their full exploitation, the crop forecast, to intensity agricultural industry and lower (reduce) its negative influence on the environment.

CONCLUSIONS

The current planning of erosion control for 1–5 years showed low efficiency due to the inconsistency of the formal duration of the rhythms of reclamation activities with genetic (internal) time, weather, erosion and soil recovery processes. Therefore, in the long-term management of processes at cultivated lands it is more reasonable to use a more rational approach to formation of erosion protection compared to strict standards of mean annual estimates. This requires a mandatory program aimed to increase the soil-amelioration efficiency of farming systems in bioclimatic forecast periods that are the most favourable for soil fertility recovery. GIS is mainly orientated towards the settles system of land use. Another class of tasks appears with its orientation towards rationalization of territorial arrangement of agro landscape.

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