LARGE SCALE GIS MAPPING RECOMMENDATION MAPS FOR SOLVING LAND MANAGEMENT ISSUES

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Abstract
The article shows results of compiling recommendation land use maps for land use and land resources management of the university experimental farm "Velykosnitynske". Large-scale GIS mapping of experimental farms allows to improve land use and decision making, prepare recommendations to solve land management issues, planning of technology processes and efficient crop growing technology. Compiled recommendation maps are aimed to assist in rational land use planning and sustainable development of the territory.
Keywords: land management issues, GIS mapping, electronic maps of land use, land resources management, recommendation maps.

Introduction

Since the 1990s atlas electronic mapping of natural resources has become a perspective approach for both theoretical Earth science and natural resources' management practice. Methodologies for creating electronic atlases for sustainable nature use were developed by E.M.Siekierska (1986), F.J.Ormeling (1993), V.S. N. Ulugtekin (1999), Xie Chao (2005), Tikunov, F.Ormeling, M.Konecny (2008), J.Kaufmann (2014). Ukrainian scientists performing their studies in this field include: I.Levytskyy, V.Razov, A.Zolovskyy, G.Parkhomenko, L. Rudenko, V. Peresadko, T.Kozachenko, S.Poznjak, E.Bondarenko, I.Kovalchuk, Yu.Andreychuk, as described in (Bogdanets, 2016) and (Kovalchuk, Bogdanets, 2016).
Creation of the concept in addition to the development of science-based structure and the electronic atlas of land use permit: to assess the state of land resources to ensure their sustainable use, the requirements in respect of crop rotation, fertilizer application; to determine the intensity of degradation processes in soils, ground system of conservation measures for agricultural lands; to ensure the functioning of agricultural enterprises on the basis of balanced (sustainable) development areas (Kovalchuk, Bogdanets, 2016).
In this scope, recommendation maps for solving land management issues of different origin are essential.

Methodology of research and materials

QGIS software was used to process vector and raster data and compile electronic maps. Satellite imagery of territory from USGS geoservice including Landsat, EO-1, ALI, Orbview, and spatial data from ESRI, OSM and Google accessible via QGIS Quickmap services plugin, combined with existing paper cartographic materials of different scales were the basis of the maps compiled. Also the public cadastral map of Ukraine and cadastral documentation supplied by the university land resources management office were used. The research by Kurylo V., Bogdanets V., Kurylo L. (2014) may serve as methodological basis in the area of comparative territory analysis using GIS as a powerful tool (Kurylo V., Bogdanets V., Kurylo L., 2014).
The atlas itself comprises 7 chapters. Recommendation maps were included in the last chapter of the atlas. They cover such issues in land management and agricultural practice as use of eroded lands, environmentally friendly use of fertilizers, land afforestation, land use planning issues.
Thus, *the aim of our research* was to compile a series of recommendation maps within a large scale electronic atlas of land resources' current state and land use, as well as prepare materials and modern tools to assist decision-makers in their everyday activities in land management.

Discussion and results

Characterization of the object of research
The national university of Life and Environmental Sciences of Ukraine (former Ukrainian Agricultural Academy) has its experimental farms. Experimental farm "Velykosnitynske" is located in Fastiv district of Kyiv region (Fig.1). Its total area is 2,961 ha, most of it is occupied by arable land covered by fertile chernozem soil.

Fig. 1. Location of experimental territory

The farm is located in moderate humidity (about 500-550mm annual precipitation) of the forest-steppe zone of Ukraine; the main crops grown include wheat, barley, maize, fodder and vegetable.
The location of agricultural crops and territory organization in 2016 are shown in Fig.2. The territory of the experimental farm consists of two parts or subdivisions: the northern (main) and the southern, as shown in Fig.2. Most of the territory account for arable agricultural land, where different crops are shown by different colors, as seen in the legend, some part of the territory belongs to settlement, small part is covered by water, and other part are individual land parcels.

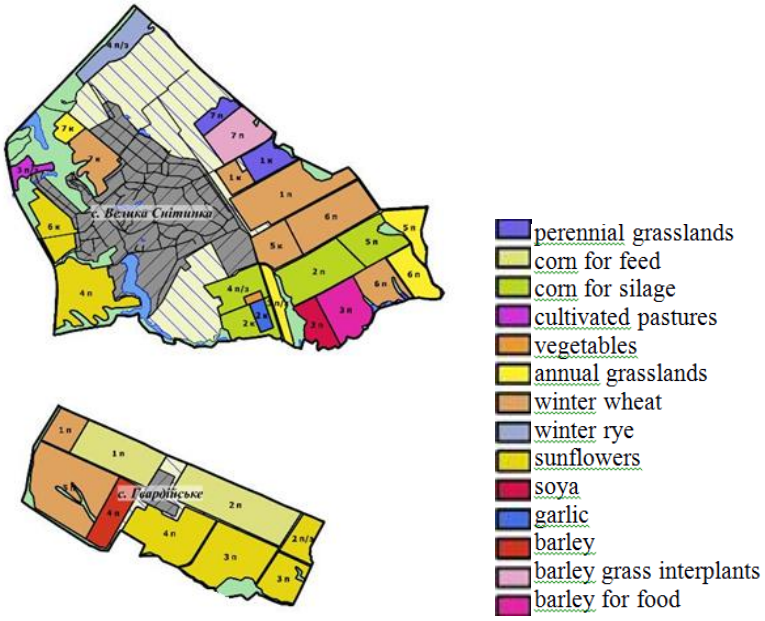

Fig. 2. Organization of territory and location of crops in 2016

Land management issues and compiling recommendation maps.
Most of farms in Ukraine are interested in application of precision agriculture technologies as well as in the use of electronic maps and tools to monitor farm's assets, however, most cartographic data were outdated, therefore it was important to develop electronic recommendation maps to serve as the basic for such activities in future.
A special part of our work was devoted to development of electronic maps for solving land administration issues, problems of management of agricultural land of the enterprise.
In our research all the issues which should be mapped are divided into *several categories.*
The first category consists of problems related to agricultural practice, e.g., use of fertilizers. It is important to maintain environmental balance of agricultural landscape when high rates of organic and mineral fertilizers are used. In this case protection zones around water bodies should be defined.
The second focuses on soil properties and regimes with taking into account soil heterogeneity. Fig. 3 shows microdepressions on fields, the places with different moisture regime due to differences in microrelief which look like small black circles visible over fields. Such heterogeneity in soil cover is widespread in this climatic zone of chernozem soils, therefore it should be considered in agronomy practice. A way to avoid crop yield heterogeneity in such fields is to provide precision agriculture machinery by maps of heterogeneity spots and precision soil properties maps.

Fig. 3. Satellite image of southern part of experimental territory, part of QGIS work project.

The third category of issues focuses on land value, land degradation and sustainable land use. The most common degradation here on sloped areas land is water erosion. Fig. 4 shows the map for eroded land management. Less than 30% of agricultural land of the territory belong to slopes. These areas are recommended to transfer to growing fodder crops, some part of this land have been already covered by perennial grasses.

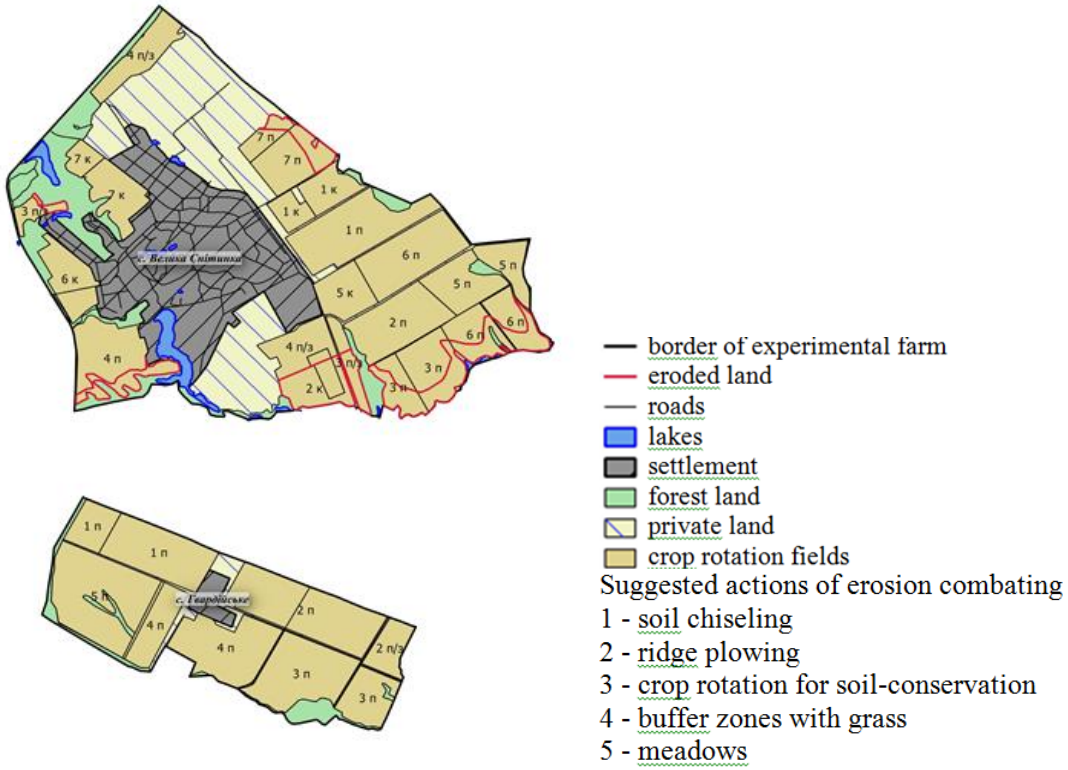

Fig. 4. Recommendations for management of eroded land

Another important problem in land use planning is disappearing of forest stripes constructed in the Soviet times in the time period of 1950-1970. Now most of them are not maintained, they have lost their structure and thus the effect; some of them have disappeared altogether. These forest stripes should prevent the so-called “wind corridors” which may cause soil loss due to wind erosion. The renewal of such forest stripes at fields’ borders with taking into account the predominant wind direction is the aim of the recommendation map shown in Fig.5.

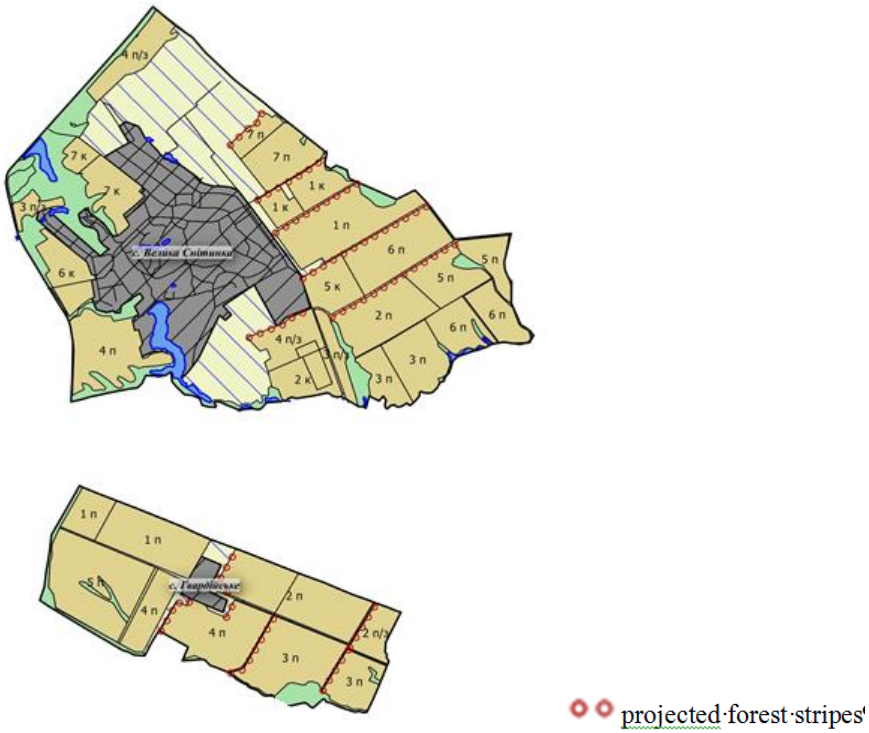

Fig. 5. Recommendations for location of new forest stripes

Now most of the forest stripes require renovation, these measures refer to long-term improvements and require a lot of costs. It may be a separate project on soil conservation measures against wind erosion.

Water protection zones should be of high importance when planning crop growing and fertilizer use. For that purpose, the recommendation map of water protection zones was compiled. The calculations were done in GIS according to water body type and area (Fig. 6). As it can be seen, corrections to field borders should be made to avoid water pollution by fertilizers or pesticides.

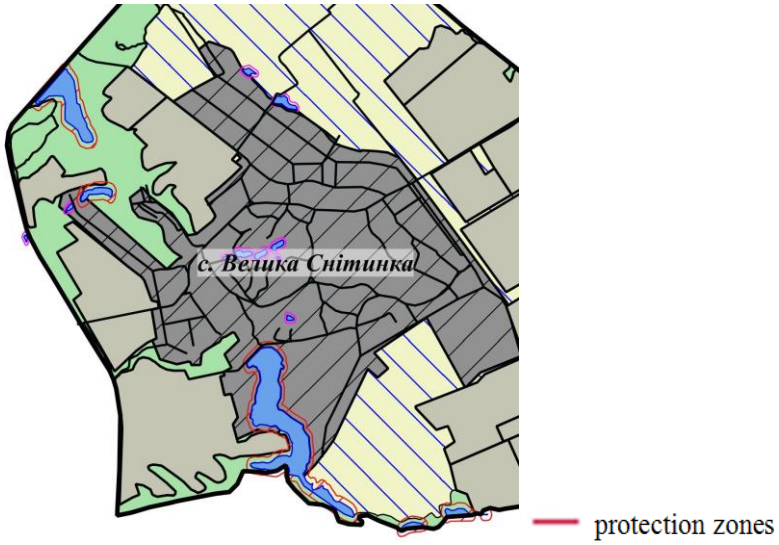

Fig. 6. Location of protection zones along the coast of water bodies

All recommendation maps were implemented in farming practice, they were probated by the enterprise's staff, some of them will become the basis for the new plan of territory organization of the farm and planning of the location of farm fields to make local agriculture more efficient and environmentally friendly.

Conclusions and proposals

Agricultural mapping of the university experimental farm was based on interpretation of up-to-date remotely sensed data of different spatial and temporal resolution, their import along with other geospatial data, including traditional paper large-scale maps, GIS, and renewal of current land organization plans as needed.

The main issues in land management and agricultural practice at the object rely on soil erosion, rational environmentally friendly use of fertilizers. These issues require change of current land management and borders of some agricultural fields.

Series of maps related to crop productivity, degradation processes, climate conditions, water-protective measures, etc. will help managers to organize agricultural production process and technological operations.

These maps are useful large-scale instrument for decision-making in agricultural practice at the university research farms. The developed maps will serve as information and analytical base for monitoring and management of land resources for development of land conservation measures.

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