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DETERMINATION OF POTENTIAL HAZARD OF EROSION PROCESS USING GIS TECHNOLOGY MANIFESTATION

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Statement of the problem

The Land Code of Ukraine states that the land use purpose is to ensure the rational use and protection of land, creation of the environment and improvement of natural landscape.

The main cause of degeneration (degradation) of natural systems is water erosion. This problem is exacerbated especially under conditions of unreasonable anthropogenic pressure.

Determination of potential hazard of erosion processes manifestation and its incorporation in land use projects will reduce the power and the ravages of erosion, and in some cases even prevent their development.

Land use designing including the area organization is known tube a complex multifactorial process that primarily has to take into account natural conditions of the area, including the danger of erosion manifestation, which, in turn, is also determined by several factors. In addition, the design is complicated by a possible multi-option solution that is made at a spatial basis. These conditions, as well as high requirements of Land Management designing to the quality in the present conditions of land reform lead to the use of GIS technologies.

In determining the potential hazard of erosion manifestation geoinformational mapping is assigned with the following tasks: data converting into a unified format for further processing of spatial data; the automated creation of thematic maps; the implementation of information - cartographic modeling of land resources on the basis of natural and anthropogenic influence factors; mapping based on the results obtained in forecasting, providing mapping support in decision making.

Connection with important scientific and practical problems

The urgency of the problem is undeniable due to the following factors:

1) one of the main objectives of land management is to protect soil from degradation processes [2], so land development projects should be prepared in such a way as to best take into account all the factors and prevent the development of land degradation;

2) maximum consideration of natural and other factors is only possible at the availability of high-quality cartographic material and the use of information technology;

3) current legislation of Ukraine requires digital data on land resources . In particular, the present-day State Land Cadastre is automated and is filled with digital data on land and other facilities. Taking it into account, information about the development of erosion processes and their potential manifestation can complement the database of the State Land Cadastre concerning the soil quality.

Analysis of the latest research and publications related to the solution of this problem

A wide range of scientific works by: P. Chernyaha, A. Liashchenko, D. Timchenko, A. Svitlychny, S. Corny and others, establishment and improvement of GIS technology in land use on degraded lands.

Remaining part of the general problem

Development of land management projects on land use with erosion hazardous soils classic ally is based on traditional cartographic materials, taking into account the contour-reclamation principles of the area organization. Under these conditions, especially in cases where the mapping database is outdated, it is not possible fully take into account all the factors of erosion because they are not included in the classical plans.

The accuracy of such projects is low because it is impossible to clearly determine the boundary changes of the basic parameters of design. So separate tracts of eroded soil often enter the field rotation and vice versa.

We should also highlight the problem of fragmentation of land fund between landowners and land users and emphasize the fact that small farmers in most cases don’t even think of the development of erosion processes and do not struggle them.

Given the above said, it could be argued that the use of GIS mapping will by most helpful in accounting the factors of water

erosion and their potential development in working out land management projects, and suggesting a set of recommendations for small land users to protection of their land from water erosion.

Problem setting

To achieve the goal of developing GIS, with which one can identify potential dangers of water erosion, processes manifestation, you should solve the following tasks:

1) to describe the main factors determining the risk of water erosion;

2) to generate the relevant set of geospatial data forming the basis of GIS ;

3) to develop a set of thematic maps which can determine the main factors of soil erosion, and ultimately determine the potential hazard of water erosion process manifestation.

The main material of the research

At present, there is a significant amount of factual information about the development of erosion on the lands of Ukraine. This information can be divided into two groups:

1) Information about the actual erodibility which is used in the basic regulations.

2) Information about the factors of erosion: rainfall, wind, topography, vegetation, forest cover, soil conditions, etc.

The information of the first group is mainly subjective because it is made up for outdated materials of soil surveys which do not reflect the real state of the soil. In addition, there is a doubt as to the methods for determining soil erosion.

On the basis of the second group of data, we can predict the development of erosion processes and consider these forecasts in the development of land use documents. It should be noted however, that this group is not provided with regulations, and, therefore, it is difficult to identify the most important factors determining the intensity and danger of erosion manifestation. Therefore, the following factors must be determined on the basis of logical and mathematical modeling, in particular, by Saaty method, that has been done before [6, 7, 8].

The previous studies indicate that in addition to generally recognized factors of water erosion (such as slope, precipitation power, etc.) play a significant role is played by the factors that determine the development of erosion, i.e. soil conditions of that area, which manifest themselves in undulating terrain. There are three groups of factors that occur at different stages of erosion:

1) soil properties affecting the destruction of soil aggregates:
- structure and water resistance of soil aggregates,
- grain size,
- content and composition of humus,
- connectivity,
- composition of absorbing complex;

2) soil properties influencing soil aggregates transportability:
- the size and weight of individual soil particles,
- density,
- density of solid phase of soil,

3) Soil properties influencing on water infiltration into the soil (preventing erosion of soil) :
- density,
- porosity,
- moisture content at the beginning of rainfall,
- moisture capacity,
- non-availability of waterproof layers in the soil profile;

As a result of calculations [6,7,8] , we have determined that among all the soil properties the greatest influence on the development of water erosion is exercised by strong soil structure, which, in turn, is determined primarily by humus content and density, aswellas initial soil erodibility.

Thus, the relevant set of data forming the basis of GIS should contain the most optimal and mathematically reasonable set of factors of water erosion with the background of common components of the classical land management.

The main requirements to create a set of profile geospatial data are formed on the principle of capacity of all the necessary information for the system to function property.

To provide geospatial land development on agricultural lands with erosion hazardous soils a set of geospatial data shown in Figure 1 is proposed.

Having examined the flow of necessary data one can be distinguish between the following main classes of spatial data: soil properties, land, precipitation, restrictions and encumbrances, topography and anthropogenic factors.

Thus, the main problems to be solved by the created GIS include the following:
- index of precipitation causing eroding effect;
- forecasting the amount and intensity of rainfall;
- evaluation of the quality of soil;
- the soil erosion resistance determining;
- supplying software design organizations, landowners and land users with the necessary information on soil conditions;
- prediction of erosion development;
- modeling schemes and projects of land use and protection.

Based on the established GIS, we have built a number of thematic maps able to determine the necessary parameters to any point on the surface. Imposing such maps as layers

will determine the potential danger of the manifestation of water erosion processes on a given plane.

Figure 2 shows the thematic maps reflecting the humus content in the soil (Fig. 2a), soil density (rys.2.b), soil erodibility (Figure 2b) and predicted soil erosion (Fig. 2 g), calculated by Z. Mirtshulavy and M. Kuznezov model [4]. These maps wore drawn up for the area of Novosilki village council in Zdolbuniv district of Rivne region.

Conclusions:

1) the key factors causing the risk of water erosion have been outlined;

4) the relevant set of geospatial data forming the basis of GIS has been determined;

5) a set of thematic maps determining the major factors of soil erosion and the potential danger of water erosion process manyfestation have been developed.

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Determination of the potential dangers of erosion manifestation using GIS technology

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A profile set of geospatial data which was the basis for the creation of GIS to identify potential hazards of water erosion manifestation on agricultural land has been developed.

The main aspect of GIS development of GIS is the consideration of the factors of soil erosion.

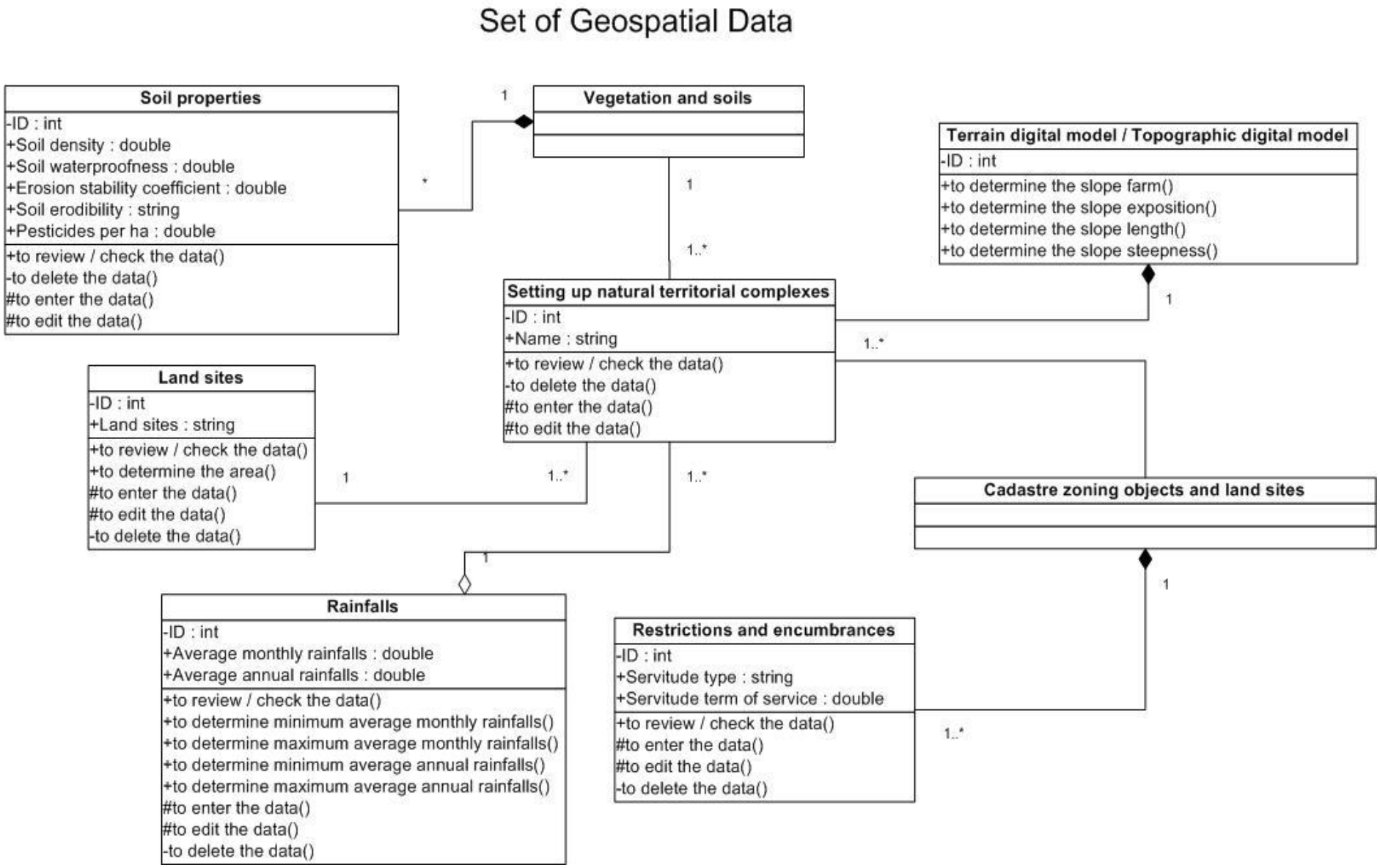

Fig. 1. The structure of geospatial data set for GIS land management on agricultural lands.

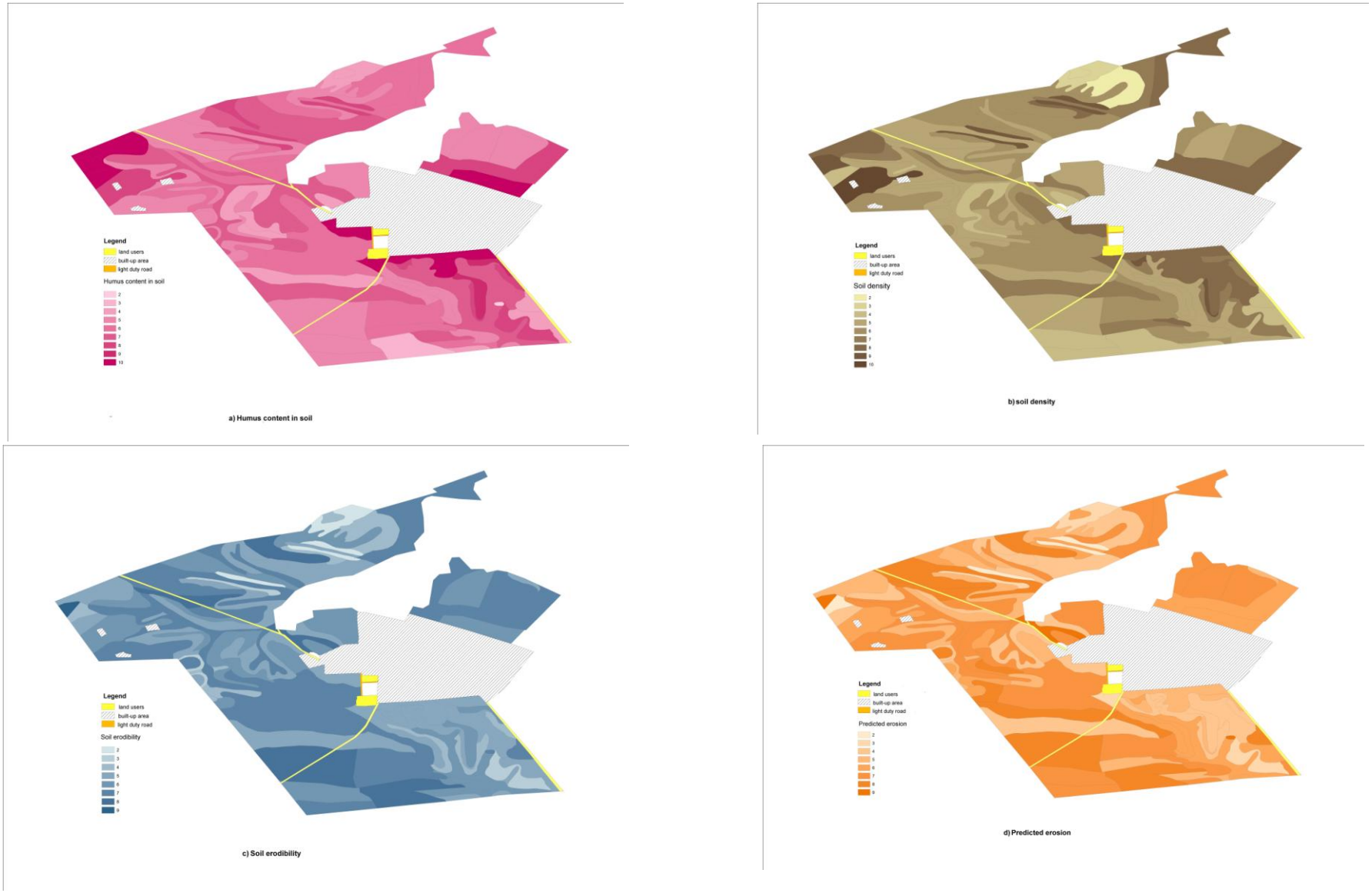

Fig. 2. Thematic maps built with GIS:
а) humus content in soil; б) soil density; в) soil erodibility; г) predicted erosion