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SIMULATION OF WATERSHED PROCESS ON UKRAINE-POLISH BORDER AREAS

Keywords: Polish-Ukrainian border area water emergency, digital elevation models, flow direction, flow accumulation, watersheds modeling.

Abstract: Main stages of the watershed modeling processes on Polish-Ukrainian border areas were considered in the article. Optimal algorithm of the watershed project processes establishing were analyzed. The two types of images expansion used for the construction of drainage basins compared, their positive and negative characteristics were obtained. Visual schema of the flow direction and flow accumulation based on digital elevation model of border areas in the watershed modeling in Ukraine and Poland were shown.

INTRODUCTION

Process modeling on Polish-Ukrainian border area watersheds – a set of interrelated activities and operations carried out for the creation of watershed modeling simulation and ranks runoff of Poland and Ukraine under flooding territory were given [1,2]. Each process is characterized by its inputs (raw data), modeling tools and techniques, and the resulting outputs can be applied. Project Manager must consider all possible measures and processes of the organization and environmental factors. They should be considered for each stage of the watersheds processes modeling. Even if they are not explicitly mentioned in the list of inputs in the specification process, especially important in this are the measures to ensure cooperation between rescue teams from both countries. Measures, means and steps of the performers give guidance and criteria for how to adapt the stages of process modeling watersheds to specific project needs. Management processes on the Polish-Ukrainian border areas in the project hazard study are emergencies presented as discrete processes with defined boundaries [3].

Formulation of the problem. Management is the integrative activity that requires every process related to the project must be properly aligned and interconnected with other processes to facilitate coordination. Actions taken during the same process usually affect the process and other related ones. Successful management of the project must include the active deals of process interactions.

Hazards that affect the processes of territories water management situations on Poland-Ukraine border are related to the 4 problems [4]:

- Lack of water (drought);
- A large amount of water (flood);
- Water quality does not meet the requirements (standards);
- Unfavorable location of water (spatial location).

The highest concern in the selected regions is the situation with extra amount of water. To avoid and prevent flooding of large areas watersheds simulation is to be carried out. This simulation is carried out with both hydrological and hydrodynamic models.

Hydrological modeling focuses on precipitation and evaporation making possible of water amount (water flow over time Q, m^3/sec) on the surface that is the answer to the question: at is the drain water? In what direction water will be directed?

Hydrodynamic modeling of water flooding gives surface, water course and determining how fast, what height (depth) water will extend and what area will be covered by the flood. These two mentioned models are based on modeled ground surface.

Process of watersheds modeling on Polish-Ukrainian border areas in general looks like a simple process of dendrites morphology. It consists of a digital elevation model (DEM) [5], the direction of wastewater area possible flooding, flow accumulation, pools and spill area (flooding).

From the beginning of the process input data are entered in the form of digital elevation model using which flow direction is determined. Output digital elevation model data are taken as "raw material" on the Internet site EarthExplorer [6], where high-altitude data can be downloaded in various formats, that may be suitable for certain types of processes.

There are two types of altitude data, which can be used in the modeling of watersheds:

– DEM: digital elevation model;

– DSM: digital surface model (with buildings and green plants).

These data are of the types GRID-file or TIN-file, the sets of data locality.

Image file are of the GRIDs type (grid) used to make digital elevation model, which is suitable for large-scale drainage analysis. Triangular irregular networks are used for of linearing objects records and for hydraulic analysis and design [7]. These formats have some advantages and some disadvantages, which are taken into account, when certain processes for project management simulation emergencies are taken into account.

The advantages of TIN-type extensions were used: samples points are adaptively fitted according to the surface; the exact values of linear characteristics; specified structural lines to determine the smoothness and continuity were specified. Samples drain points ranks located in well-defined areas have no extra (unnecessary) data. It is possible to easily increase the precision (density) of the surface, creating accurate projections and specific limits of catchment basins. Triangular irregular networks have many negative features, such as: necessity of a large amount of memory for storing points; the high cost of license computer software which is necessary to make calculation of watersheds; many functional transformations in the lattice and equivalent ranks of algebraic matrices.

For the files with the GRID-types extensions image type have more advantages compared with TIN-extensions and there for are used more frequently. These benefits include: a simple and

efficient data structure; presence of algebraic maps ranks runoff; functionality is completely open; variety of data sources can be used for the modeling. On the other hand as shortcomings point: no details of maps (points) are necessary for reserving space in memory projection problems (grid can not be overwritten by other data).

Therefore, comparing to all the above listed advantages and disadvantages of different types of expansion images on the Polish-Ukrainian border areas watersheds simulation it is better to use as input files digital elevation model (called GRID), which is shown on Figure 1 in the selected area for simulation.

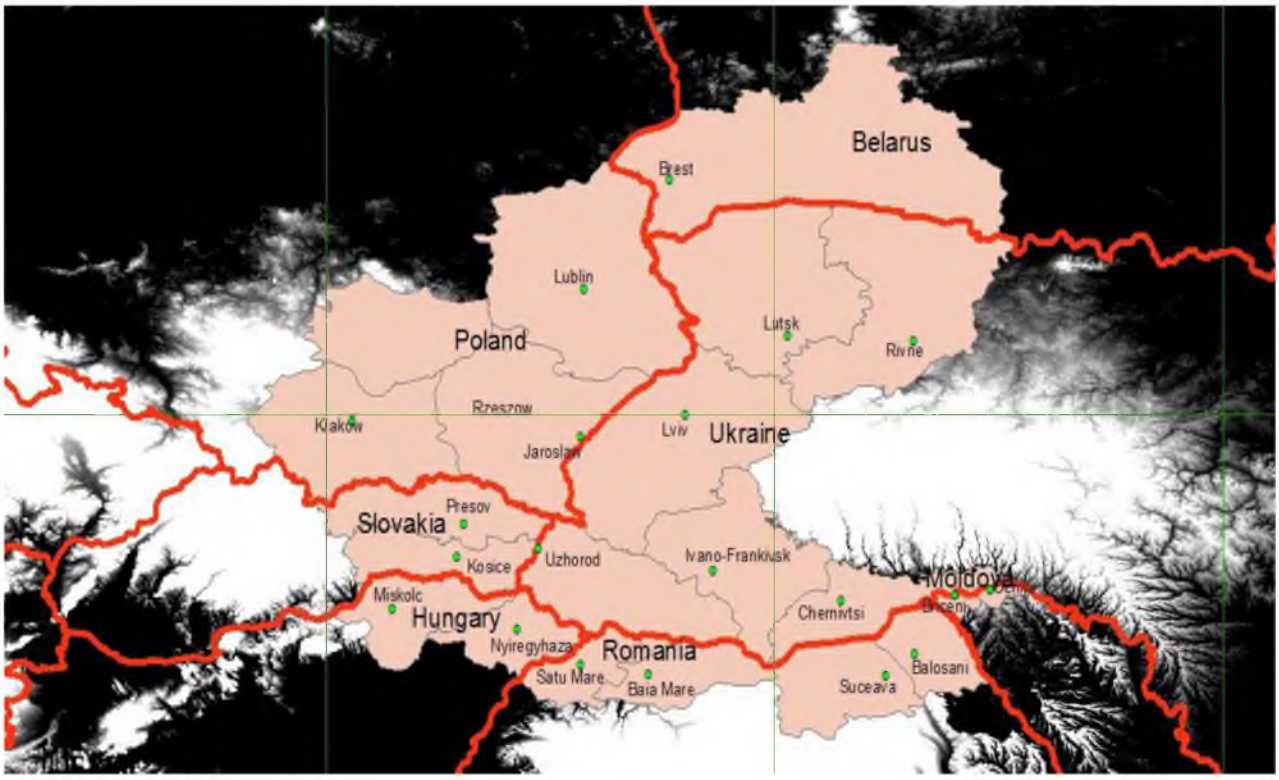

Fig. 1. Digital elevation model on the Polish-Ukrainian border areas.

Determining of the direction flow was conducted then. Determination of flow direction based on DEM [8] by converting data into digital terrain matrix with the corresponding code values was carried out. These code values to the appropriate flow direction used in the process are assigned.

Next is a conducted accumulation of runoff [8] by defining digital flow direction and the corresponding numerical determination of fullness flow in different parts of research that will help in understanding, which more and which less drains will be filled.

After that modeling of the area possible flooding and about whether the area is really flooded the decision was made. If flooding is possible, we get the raw data in the form of area flooding, which as a result of catchment area modeling process will continue to be used. Catchment areas of accumulated flow are depicted on Figure 2.

If flooding is predicted while using less crisis DEM data, the accumulation of runoff including the determination of the order flow, flow lines and sources of runoff is carried. Next,

individual stages of the length of the stream and bind to the flooding area are determined. In this case, as a result watersheds will be used in subsequent stages and processes of the project.

Fig.2. The resulting catchment of the accumulation of water at the selected areas on Poland and Ukraine.

As a result of the conducted phase of flow direction determining and flow accumulation, watersheds received from DEM data water flows are depicted on Figure 3.

Modeling the process on Poland and Ukraine watershed border areas in the management study of water hazards emergencies in solving the optimized model of reducing flooding areas will help.

The main objectives of the modeling are:

- Drawing up the list of floods, that occur and consider their differences;
- Identification and monitoring of hazards associated with floods;
- Drawing up the list of meteorological, topographical and human factors contributing to floods;
- Description of the incidence and mortality associated with floods;
- Explaining the difference between flood damage and diseases, in different phases of the flood;
- Description of the demographic groups, that have the greatest risk of suffering from flood, explaining reasons;
- Making a list of specific actions, that can be taken to reduce flood risks;
- Explaining, why immediate action can reduce the risk during floods.

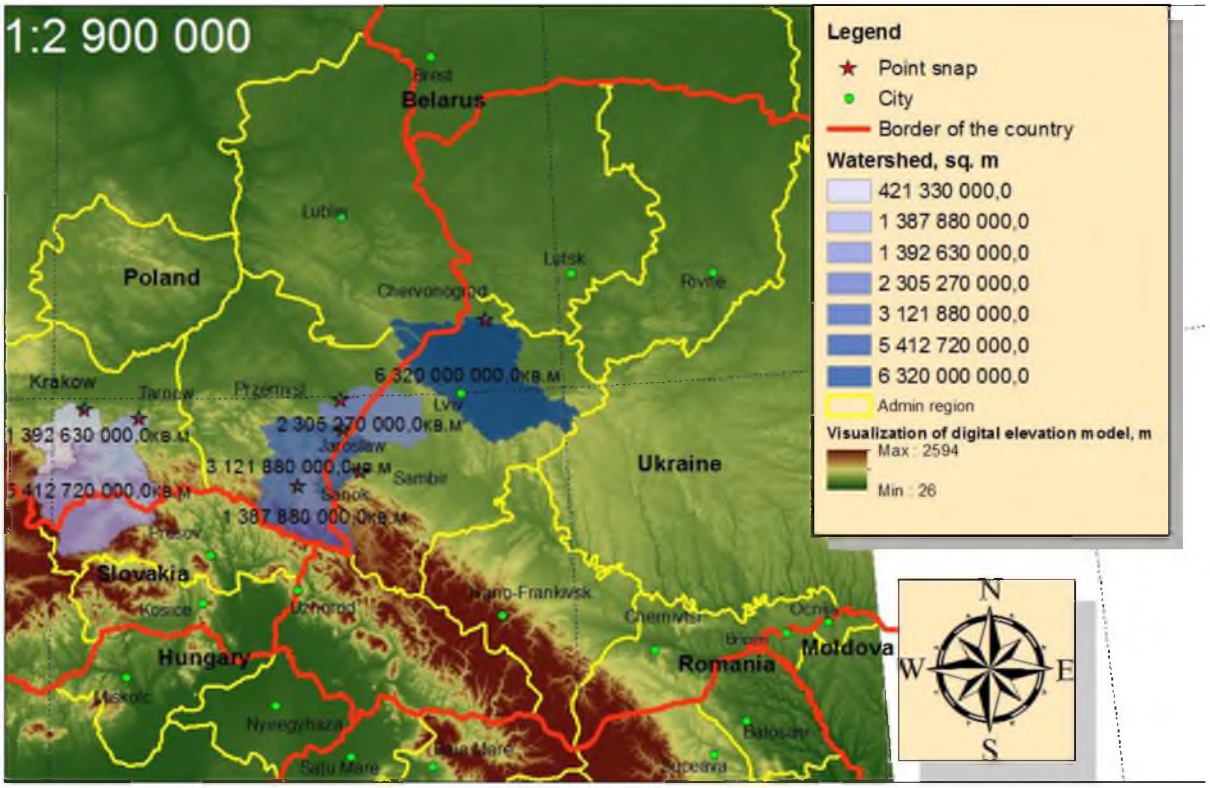

Fig.3. Established Poland and Ukraine watershed map border areas.

CONCLUSIONS

Project management study of water hazards emergencies of a large number of processes, the implementation of which depends on the success of the risk water management project were elaborated. One of the most important steps of the processes the watersheds modeling was carried out. For the method and algorithm of the explanations of the process, that is essential and crucial in the design study of the dangers of water emergencies was formulated. Also, when used in the watershed modeling, various types of data and images of different extensions, we conclude that files with extension of images types GRID are better suited for mapping watersheds, inspite they have several disadvantages.

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