Chapter XII

GIS Application for Detection of Ecological Risk Zones

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INTRODUCTION

Many emergency safety problems are connected to detection of risk zones. It is not enough only to display on a map sources of risk and protected objects. The correct prediction of dangerous directions and areas is necessary. However, the traditional mathematical methods do not always suit this purpose. Geographic Information Systems (GIS) are the most appropriate tool to solve these problems. The main aims of the chapter are to solve three typical problems from practice of work civil defense and emergency rescue service and to generalize the used approach as a new kind of modeling—the mathematical-cartographic modeling.

BACKGROUND

It is necessary to solve the following three problems of risk zones detecting and emergency response planning:

1. at selection of a landfill site;
2. at discovery of a bacteriological danger source;
3. at extreme raising of water level in a water body.

There are many works where risk zones detection problems are reduced to mapping of danger sources and protected objects (Lang, 1998; Morozov and Koshkin, 1999). But for the solution of problems, such as problem no. 1, use of digital elevation models is possible. In the case can be useful hydrology extension for ArcView Spatial Analyst (Kopp, 1998).

There are many mathematical models to calculate pollutant concentrations in water and air under emergency emissions. It is impossible under bacteriological danger. In this case an epidemiologist nominate a zone of risk on the base of professional experience. The response to such an emergency is connected to evacuation and quarantine of the people and solving some tasks of routing. The Network Analyst of ArcView GIS can be a useful module in this case.

A number of hydrological and hydraulic models are known. The models allow for calculating water levels in water bodies, but they do not have the capability to determine the borders of flooding territory. To calculate flooding zones the up-to-date science has no mathematical methods at all. It is solvable only by modeling, either physical (as it was done earlier) or on computer, with the help of modern GIS. It is possible to solve problem no. 3 by using digital elevation model and ArcView Spatial Analyst (Kopp, 1998).

So, ArcView GIS with Spatial Analyst and Network Analyst modules are perspective tools for solving of the problems 1-3.

PROBLEMS

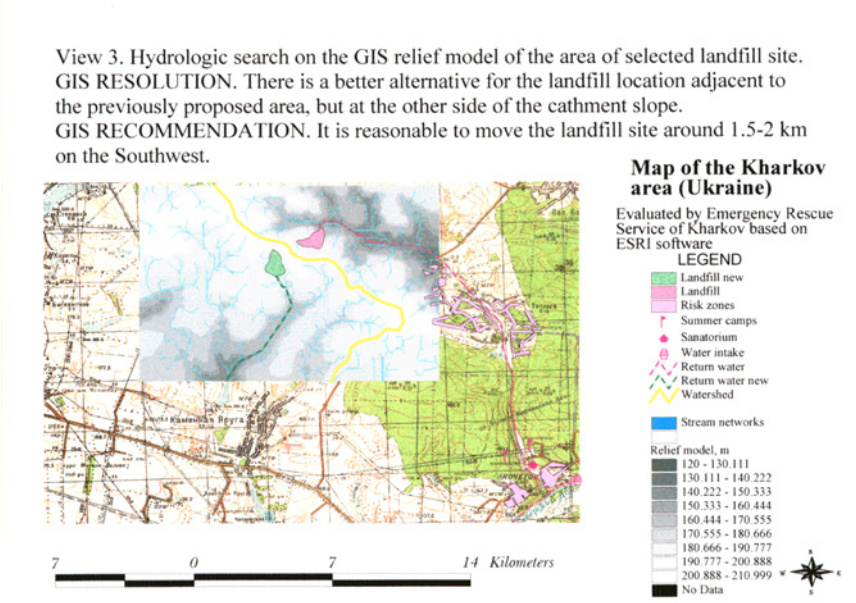
Ecological Evaluation of Landfill Site

The problem consists in the evaluation of suitability of selected landfill sites for the city of Kharkov with a population of approximately two million people. The landfill will be a large capacity long-range (rated for 50 years) construction, with utilization of gases, collection of leachate and return water, their treatment and discharge to the land relief. The Kharkov administration has approved the design site of the landfill in a scarcely populated region, 30 km from the city.

The problem was solved with the help of ArcView GIS with Spatial Analyst module. Watersheds were determined with the help of functions FLOW DIRECTION, SINK, and FILL. Direction of leachate and return water flow were determined with the help of FLOW LENGTH function. The surface hydrologic analysis was performed in GRID, constructed with the help of elevations on a topographic map 1:100 000 of the surveyed territory.

The results obtained elucidated the shortcomings of the selected site. The risk zone includes the area of Chuguevo-Babchanska Dacha forest, three villages, two

Figure 1. Direction of leachate and return water flow for two landfill sites: selected by the administration and recommended with the help GIS.



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