
DECISION-MAKING SYSTEM FOR REGISTRATION AND PRIORITISATION OF POTENTIALLY POLLUTED SITES ADAPTABLE FOR MANAGEMENT OF WAR DAMAGE RISKS

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ABSTRACT

We would like to present a decision-support system developed for identification and storing data concerning with potentially polluted sites and their prioritising. This system could also be adapted for reviewing and evaluation of the war damages. The operation of the system comprises of three procedures: data collection, data handling and the prioritisation of the sites. The relevant data could be collected from different sources, represented mainly by administrative institutions, by sending questionnaires to site owners/operators and by site visits. The collected data should be handled by appropriate database. For this purpose the Contaminated Land Module of the GeoEnviron database application was developed. This application is also designed for providing the preliminary risk assessment scores, which results are used for the site prioritisation. As an example implementation of this system, we shortly present our experiences from testing the system in Slovakia.

Key words: war damaged risk, decision-support system, polluted sites

INTRODUCTION

This system was originally introduced in different countries to create a decision-making tool for state environmental administration on different levels. The concept is based on the Danish system on administration of contaminated sites and supplemented with an advanced database application able to process entered data. Presently this system is tested under Slovak conditions through a Danish environmental support project funded by the Danish Environmental Protection Agency and conducted by our company.

The decision-support system consists of three phases [2]:

1. Data collecting
2. Data handling
3. Prioritisation

Every of these steps are described in detail below.

1. DATA COLLECTION

Collection of data is performed within a geographically defined area. This area could be an administrative area, e.g. a district, or an area with natural boundaries like a watershed.

The data collecting process could be a quite complicated process, depending on economical and natural conditions of the investigated region. At first it is needed to state, that the collected data should be suitable for the prioritisation. It means, that the most important data are [2]:

- site identification (name, ownership, address)
- exact location on map, or by geographical co-ordinates
- previous or ongoing activities on the sites and activity related data
- list of chemicals handled, stored or produced on the sites, their amount, way of storing and/or handling
- damages, spill (oil or other) and/or accidents
- dangerous materials, equipment, etc.
- blue print or sketch of the site, with the location of the tanks, warehouses, installations, equipments, etc.

For an application of the system in the country suffered by war damages the set of the required data should be extended by information regarding damages, like the character and extent of the damage, environmental consequences of that like leakage of oil or other chemicals, different emissions, occurrence of explosive materials, etc., eventually state of the reconstruction.

These data could be supplemented by additional data, e.g. any administrative information like environmental or other permits, accidents past of human activities, hydrogeological investigations, sampling, environmental indicators, photographic materials, etc.

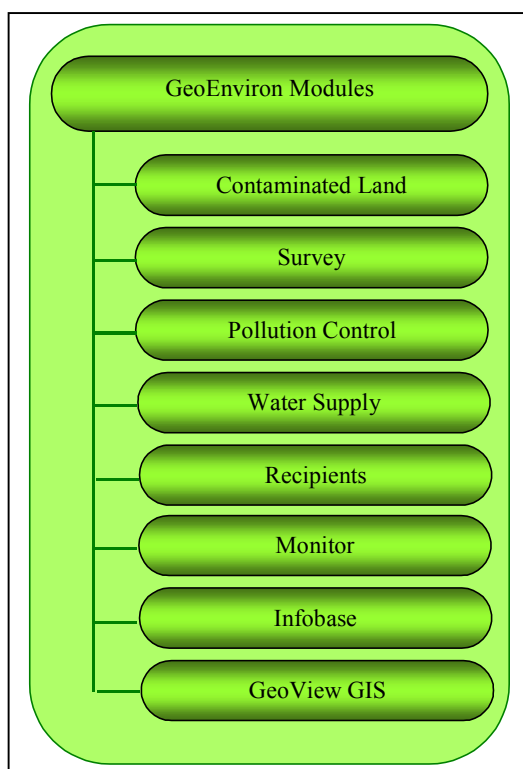
The data collection process could be subdivided within three steps. The task of the first step of the data collection process is identification of sources for information. These are mainly data administrated by state authorities responsible for environmental protection and/or water and waste management, fire departments, police, army authorities, local authorities, etc. Availability of data in these institutions depends on past and recent political, legal and administrative situation of the country. For example comparing two countries. On the one side Denmark, a well-consolidated country, and on the other side Slovakia, with several dramatic changes in policy, administration and legislation during the 20th century. These changes had a remarkable influence on establishing various state institutions, their roles and responsibilities. This situation resulted in the intermittent recording of data within the institutions implicating that data obtained from these sources are often obsolete or incomplete. Consequently, it is needed to start the second step of data collecting - sending the questionnaires to the site operators identified in the first step. The task of the third step is visiting the sites, after evaluation of the fulfilled questionnaires. The visits should obviously

be focused on sites, where submitted questionnaires had no feedback, or to sites with a higher level of danger. The site visits should be organized in co-operation with the institution that possessing the legal right to execute site inspections. In Slovakia these institutions are for example the Environmental departments of the district and regional offices and also the Slovak Environmental Inspectorate.

2. DATA HANDLING

Collected data should be stored and processed by a proper data handling application. For this purpose a database application GeoEnviron was developed through an international project headed by the Danish company Geokon [3]. This application was introduced so far in 14 countries, for example in Denmark, United Kingdom, Spain, Singapore, Lithuania, Slovakia, etc.

GeoEnviron is an object oriented client/server system covering a wide range of environmental subjects (see picture 1.) such as contaminated land, integrated pollution prevention control (IPPC) of running industries, waste management, water catchment and supply, recipients (status of surface waters), monitoring of point and non-point objects including alarm response facilities for early-warning system. For storing and handling data concerning potentially polluted sites serves the GeoEnviron Contaminated Land module. This module could be adapted also for registration and prioritisation of war damages.



Picture 1. The available GeoEnviron modules

The term "site" could mean any site of running or past human activities connected with producing, storing or handling any dangerous chemicals, like factories, gas stations, warehouses, garrisons, landfills, etc.

The integrated GeoEnviron InfoBase module contains detailed description of more than 900 chemical substances relevant to environmental issues, a frame for the description of industries and their potential contaminants, description of remediation techniques, and literature sources. A CD-ROM port is established for direct connection to external information databases such as chemical inventories, environmental acts and regulations, geographical maps etc. Most useful is also an Internet port giving the user direct access to all available environmental information on the net. GeoEnviron is integrated with common GIS applications such as MapInfo and ArcView for handling of scanned or other digitised maps. Digital photo documentation is a standard facility of the system along with image handling, GPS positioning, direct connection to Word, Excel and other Office applications. The application also enables to control and manage access to single data in the database, what is a useful feature for example for the military sites, or any other "sensitive" information.

Entering data into the database is a very simple process, thanks to the user-friendly interface designed as obvious formulars organised in tabfolders (see picture 2).

The screenshot shows a software interface for entering data about an industrial site. The form is divided into several sections:

- Site identification:** Fields for name, address, location (country, region, district, municipality), and contact information.
- Activity related data:** Fields for activity type, priority, and classification.
- Plant related data:** Fields for plant type and a table of potential contaminants.

Contaminant	Concentration	Date	Unit	Location	Count	Other
H400(10%)	5x100	1988	nezn.	1	800	
H400(30%)	5x100	1988	nezn.	1		
Osun	1x100	1988	nezn.	1		

Picture 2 Example of the site related data organised in the Contaminated Land Module

3. THE PRIORITISATION PROCESS

The GeoEnviron Contaminated Land module includes a feature for the prioritisation of the sites with respect to level of contamination based on a ranking system. The basic idea of the prioritisation of normal contaminated sites is described in the paper published by the Danish Environmental Protection Agency (DEPA) "System for the Prioritisation of Point

Sources, DEPA, 1995" [1]. The ranking system developed for point source contaminations is implemented as a processing module of the GeoEnviron application. The ranking is based on the investigations and information (so-called the "preliminary risk assessment"), which are the basis for registration of potentially contaminated sites according to the Danish Soil Contamination Act. The purpose of this ranking system is:

- To set up a clear and simple system for prioritisation
- To use existing data for assessments and calculations
- The ranking shall be based on standard assessments and calculations of pollutant dispersal
- The scoring system shall be reproducible irrespective of the person who is working with the system.
- The scoring system shall be usable at all administration levels, e.g. national, regional and local.
- The time used to rank a single site shall be minimal.

The ranking concept is divided into three well-defined sections:

- Groundwater, i.e. the threats to groundwater contamination
- Land use, focused on the conflicts of using potentially contaminated land for sensitive purposes
- Surface waters, as risks of direct or indirect pollution

The groundwater assessment includes knowledge of:

- Regional planning of groundwater abstraction, like groundwater protection zones, potential for groundwater abstraction, hydrogeological units, etc., expressed as groundwater classes
- Groundwater vulnerability, i.e. important properties of the topsoil and the unsaturated zone (thickness, character), the groundwater level and its regime
- Mobility, toxicity and degradation of contaminants.

The land use assessment includes knowledge of:

- Vulnerability of the site, i.e. the risk of the site use in relationship toward the human beings potentially present on the site
- The exposure of contamination to humans
- The hazards presented by the contaminants, in terms of toxicity
- Site specific conditions, as the location of the contaminants
- The explosion risk of landfill gas

The surface water assessment includes knowledge of:

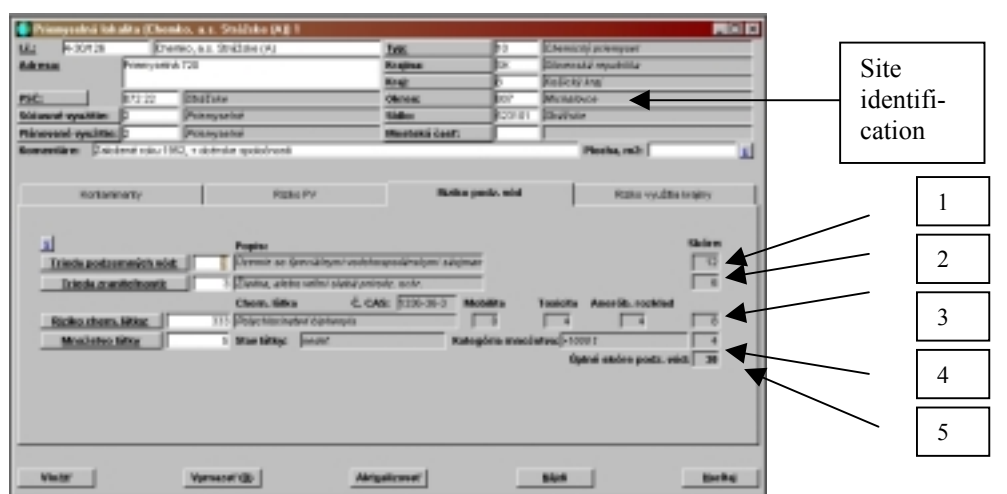
- Actual impact on water quality
- Distance to the surface waters
- The mobility, toxicity and degradation of the contaminants
- The planning status of the surface waters, i.e. the possible or present use of the specific water body as a water supply, the water quality important for fish life conditions, etc.

Every of these parameters listed above are valued by a score. The sum of these scores gives a risk score of a section (groundwater, surface water and land use) for a particular site. The

rank of the scores of the sites within a particular administrative/geographical area makes a basis for the prioritisation and decision for actions.

The prioritisation system could be adapted for the local conditions and specific environmental risks, as happened in Slovakia, where it was needed to introduce some essential modifications. The significant modifications in the Slovak system were introducing the scoring of the amount of chemicals on the site, the technology of wastewater treatment and the landfill operation status and protection [2], [3].

The scoring of the sites is performed within a sub applications by the tabfolders designed for this purpose. Picture 3 is presenting the 'groundwater assessment' tabfolder (Slovak version).



Picture 3 The groundwater assessment tabfolder. 1 - Groundwater class, 2 - Groundwater vulnerability, 3 - Pollutant related scores (mobility, toxicity, anaerobe degradation, 4 - Pollutant amount categories, 5 - Final score of the groundwater risk

For the ranking purposes it is essential to gain information from maps of groundwater vulnerability, groundwater classes and planning status of the surface waters. The way of constructing these maps and defining the classes depends on the specific geological/geographical/hydrological situation and the state of the water management. The complicated geological and geographical situation in Slovakia caused a need to develop a different methodology of the map construction as it was applied e.g. in Denmark. However, some similarities in geology in Slovakia and Yugoslavia allow applying the same methodology of map construction, more or less modified, in those two countries.

4. IMPLEMENTATION OF THE DECISION - SUPPORT SYSTEM

The implementation of the presented decision-support system in the particular country or any administration area is a complicated process and requires an approach of detailed planning.

The implementation process is running in several phases:

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- Planning - during the planning process it is needed to solve several technical, political and administrative problems and to define tasks and responsibilities on the different levels of the state administration.
 - Installation of the GeoEnviron database application - are several possibilities exists to locate the database and solve the user's access to it:
 - o "local" database, it means that the database is installed on the user's PC
 - o access to the server database through LAN/WAN network
 - o access to the server database through ISDN dial-up connection
 - The staff training - it is an essential task for the implementation. For the effective operation of the system the fully understanding of all the phases of the data collection, data handling and prioritisation is needed emphasizing the interpretation of the risk scores.
 - Establishing the database and data collection and handling - the data collection and data handling could be running in parallel, executed by the state administration staff. It is needed the specialised staff for administrating the database and preparing maps needed for the preliminary risk assessment.
 - Prioritisation - the prioritisation is executed by the specialized staff, in co-operation with the state administration staff.
 - Updating data - this is the operational phase of the implementation. The responsibility for the updating data should be defined in the planning phase.

5. CONCLUSIONS

The successful implementation in different countries and testing the presented decision-support system proves, that it is a useful tool for decision-making of different kinds of permits and approvals, ordering remedial actions, monitoring and land use planning.

The system could under Yugoslavian conditions be extended by registration and scoring of the existing war damages and their appearing dangers. This approach could be a useful tool for evaluation of environmental or other risks of the war damages by environmental authorities, simultaneously dealing with other "normal" environmental risks, to be an integrated part of the general environmental management system.

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