GEOGRAPHIC INFORMATION SYSTEM FOR THE MANAGEMENT OF INDUSTRIAL RISKS AT THE SUBREGIONAL SCALE

G. DUSSERRE*, J.M. CITEAU, E. TOURAUD* et P. LE CLOIREC***

*Laboratoire du Génie de l'Environnement Industriel- Ecole des Mines d'Alès- 6, Avenue de Clavières- 30319 Alès

Tel: 33 66 78 53 68 - Fax 33 66 78 52 01

**B.R.L. Avenue Pierre Mendes France B.P. 4001 30001 Nîmes Tel 66.87.50.00

KEYWORDS

Risk analysis, Geographical Information System, subregional scale, simulation planning, prevention

ABSTRACT

Risk assessment and environmental issues are among the most important subjects of research today.

The dynamics between atmospheric and hydrologic systems imply that all datas in an environmental system can be spatially interrelated.

Thus, an information system can be used as a decision support tool in risk prevention and planning for industrial activities.

The innovative aspects of the proposed project can be summarized in two main approaches:

-Risk evaluation based on an intersystem analysis

-Integrated knowledge of an industrial risk at the subregional scale.

In an evaluation process, all sources, vectors and receptors are taken into account in order to achieve a description of territorial risk (infrastructural networks, transportation of hazardous materials etc...) factors influencing the general evaluation framework.

This validated integrated information system allows evaluations of the possible consequences of industrial disasters or spills regarding:

-new plants and installations, relocation of existing production activities

-infrastructural modifications

-general planning activities,

by using specific models.

The system which can be developed from this project would supply information services at several levels:

-to authorities charged with the control and the management of industrial risk

-to managers of hazardous industries

-the information to the population.

This work takes place in a European Contract (DG XII,n°EV5V-CT920095) with M. G.Giannandrea as scientific coordinator from the Consorzio Venezia Disinquinamento.

INTRODUCTION

The objective of this project is to manage industrial risks at the subregional level. The used tool will be a Geographical Information System (G.I.S.).

Its definition is still a subject of debate (Kineman *et al* 1991) (Klark D.M. , Ruttenberg S. 1992) .

GIS can be described as a combination of several functionalities such as remote sensing,

computer cartography, database management and computer aided design (Maguire D.J. et al 1991).
The innovative aspects of this project can be detailed in two points:

-Integrated knowledge of an industrial risk at the subregional level.

-Risk evaluation based on an intersystem analysis using models.

GIS databases contain information on location, spatial distribution and spatial relationships while environmental models work on a basic currency of mass and energy transfer.
In the last ten years, considerable progresses have been made in integrating spatial information systems and mathematical models of the environment (Karen K. Kemp 1993).
This project intends to define specific criteria in order to create an information system for risk assessment. It will be considered as a decision support tool in a prevention concept.

This workshop is divided into several parts:
-Law analysis of three European countries (France, Italy and Spain). This work is connected with the definition of real users of the proposed tool.
-Definition of the territorial database (definition of parameters for territorial systems and their relation to each other, in order to achieve a systemic knowledge of the territory as a guide to global risk evaluation)
-Elaboration of a database of hazardous industrial plants
(individualization of all information useful for a complete description of an industry as a risk source)
-Database of transportation of hazardous goods (for example, parameters defining the flow of hazardous substances)
-Modelization (description and validation of existing models for accident simulation and evaluation of consequences concerning risks in fixed plants and during transportation).

DESCRIPTION OF THE FRAMEWORK

-Definition of the territorial database (definition of parameters for territorial systems and their relation to each other, in order to achieve a systemic knowledge of the territory as a guide to global risk evaluation)

We detailed a comparison between French, Italian and Spain régulation on risk management in table 1.
For the French part, the territorial database will be the DB TOPO from the Institut Geographique National (I.G.N.) at the scale of 1/25000. Other informations are individualized and will be taken in account: sub-soil, meteorology, land cover, public dweelings etc...

For other European countries, it will depend on the availability degree and the developpment of local and cartographic information.

-Elaboration of a database of hazardous industrial plants and transportation (individualization of all information useful for a complete description of an industry as a risk source , and parameters defining the flow of hazardous substances)

This database aims to define industrial plants in the studied region .
In each country, the information must be extracted from safety reports because they contain enough technical information to guarantee the exhaustive check of safety problem.
The suggested methodology can be understood as a utility to the end user to implement the information of the hazardous plants in the database on the bases of safety reports.
This database definition is made up from geographical objects and organized by themes and objects.
Themes are:
-Safety report classification
-Industrial area or pole information
-Plant information
-Raw materials, products, subproducts
-Storage plants
This theme aims to collect information about the storage conditions in terms of the following aspects:

*Quantity
*Tank characteristics and geometry
*Storage conditions
*Storage safety tools
*Features of the containment basins

-Pipelines
The present theme identifies features of the eventual pipeline network (Nature function and quantity of the transported substances, pumping conditions, pipeline, interruption points
-Carriage by tanker truck
The objective of this theme is to identify the flow-rate of dangerous substances inside and outside the considered plant.
-Main accident scenarios
The objective of safety reports in the French case is to evaluate the adequation of the risk of major accidents and the proposed preventive measures. Informations will be collected about accident scenarios retained.
-Intervention
The aim of this theme is to define the availbility of intervention tools and means in case of accident

*Emergency alarms
*Prevention systems
*First intervention equipments
*Fire fighting systems
*Gas detection systems
*Organization of the emergency plan
*Mutual aid assistance

-Database of hazardous goods tranportation (for example, parameters defining the flow of hazardous substances

Transport of dangerous goods is directly in relation to the protection of human health, environmmental protection and traffic safety (Luketic 1994) (Vallet B., Giger F. 1991).
The main aim of this part was to draw up the specifications for a database dealing specifically with the transportation of hazardous goods, identifying the actual flow of substances considered as hazardous materials and defining movement relations with other databases.
A geographical approach is essential. The effects of an accidental spillage of a substance is directly related to the topological, hydrological and geological configuration of the zone in question. In this respect, the drainage basin is the most pertinent scale for analysis.
A comparison of the routes used for transportation of hazardous materials with the biophysical environment reveals sensitive areas, especially because of various environmental features which are more or less resistant to the various forms of attack of a dangerous chemical substance.
This work began with a first part dealing with a general study of national and international regulations dealing with of the transportation of hazardous materials.
The second part was to identify existing databases concerning regulations for the transportation of hazardous materials:
It would appear to be very difficult to find one database that contains all the specific regulations for all of the countries involved in the study.
Several databases were studied with the following criteria:
-General features and purposes
-Accesibility
-Structure
-Information on product regulation
-Information on product toxicity and ecotoxicity
The present conclusions concentrates more particularly on the following databases :
-SECURICI
-INFOTANK
-CC-INFO
-ECDIN
-SAFETY
-ECODATA

The third part aims to identify the main administrative partners involved in the transportation of hazardous materials in each specific the region. The study consisted in identifying fields of competence, researching datas concerning the flow of hazardous substances and availability of these datas :
-Firemen (in the subregional scale, for French, one find the CODIS: Centre Operationnel de Défense contre les Incendies et de Secours)
-Administrative inspectors of the Industry, Research and Environment (Authority: Direction Regional de l'Industrie, Recherche et de l'Environnement DRIRE)
-Police force (Gendarmerie)
-Regional public works authority (Direction Regionale de l'Equipement)
-Harbour authority
-Railway autority
-Environment Ministry

-Transport Ministry
The increasing traffic carrying dangerous substances has led industrialists and administrative concerns to require more and more detail on the exact nature of both the substances carried and the flow of traffic for more efficient monitoring of the transport of hazardous materials.
In fact, it appears as impossible to find a structured database with georefenced coordinate concerning the flow of hazardous substances. A few databases design to respond to specific requirements or involving only one form of transport do exist, but their information would be difficultly connected with the G.I.S. project.
In order to obtain precisions concerning several points, or nodes, of the network involving the flow of hazardous goods, we propose to undertake count campaigns in the region of study.

-Modelization (description and validation of existing models for accident simulation and evaluation of consequences concerning risks in fixed plants and during transportation)

The objective of this part is to identify in the litterature models of consequences evaluation in order to integrate them in the system and providing reliable estimates of risks on a territorial basis.
Concerning the specific case of transportation of hazardous goods, the mathematical models "TRANSIT" and "COLLISION" developped by TRR will be included (Romano A. Renau J.M. 1985).
Concerning the risk due to the BLEVE, the model of LIHOU giving the diameter (average value) of the fireball will be taken in account (because of the consistency of its hypothesis) (Lihou D.A., Maund J.K. 1982)(Fulleringer D. 1991).

Concerning analysis calculation of uconfined vapor cloud explosions, the TNT equivalent model has been chosen.

For the specific problem of models for the calculation of neutral gas dispersion, the Pasquill-Gifford model will be included (Pasquill 1962)

Other specific models have been identified, analysed and chosen for calculating the dispersion of underwater release, dispersion of dense gases and poolfires(Casal J.*et al* 1994)

CONCLUSION

Due to the complexity of chemical plants, hazard analysis is commonly carried out using systemic manual methods like Hazard and Operability Studies (HAZOP) wich are, however very labour intensive and for complex plants very time consuming. An alternative approach for the systemic examination and the application of specific expert knowledge to hazard analysis in industrial plants can be achieved by using GIS tools (Göring M.H., Schrecker 1992).

This work is still in progress. Many parameters and much informations concerning regional studies have been collected. The future objective will be the implementation of dispersion models of hazardous substances in the defined G.I.S.
The final tool will provide the enduser with a complete and pragmatic management of the industrial risk at the subregional scale.

ACKNOWLEDGEMENTS

The authors thank Consorzio Venezia Disinquinamento, Bas Rhône Languedoc, Technologia Ricerca Rischi, Universitat Politecnica de Catalunya involved in the EEC research contract n° EV5V-CT92-0095

REFERENCES

Kineman j.j., et al.1991
"The IGBP multithematic databases plt project: status and plans"
Proceedings of the eleventh ESRI users Conference. Redlands.
Environmental Systems Research Institute, 103-109

Klark D.M. , Ruttenberg S. 1992
"The integration of multithematic global databases, GIS, and environmental modeling: A tool for the study of global change"
Codata bulletin, 24, 4, 15-22

Maguire D.J. et al 1991
"An overview and definition of GIS"
Maguire J, Goodchild M, Rhind D (eds.)
Geographic Information Systems, Overviews, Principles and applications. London,
Longman, 2, 9-20

Romano A. Renau J.M. 1985
"Analisi comparate dei rischi nel transporto ferrviario e stradale di sostanze tossiche"
Tecnical report
TRR, BERGAMO Italy

Pasquill 1962
"Atmospheric diffusion" - D. van Nostrand Company, LTD London

Göring M.H., Schrecker 1992
"An integrated expert system to support hazard analysis in process plant design"
European Symposium of Computer Aided Process Engineering , 2
S 430-S435,

Luketic 1994
"Transport of dangerous goods"
Nafta, 45, 1, 45-51,

Vallet B., Giger F. 1991
"Transport des matières dangereuses, vers une coordination des actions de prévention des risques"
Préventique,40, 3

Lihou D.A., Maund J.K. 1982
"Thermal radiation from fireballs"
I.Chem. E. Symposium Series N°71.
The Institute of Chemical Engieers, North Western Branch, 1982

Fulleringer D. 1991
"Synthèse des connaissances acquises sur le BLEVE et sur les moyens de le prevenir"
Rapport DAS N° 773
Révision N°2

Karen K. Kemp 1993
"Environmental modelling and GIS: Dealing with spatial continuity"
HydroGIS 93: Application of Geographic Information Systems in hydrology and water resources.Proceedings of the Vienna Conference, April , IAHS Publ 211

Casal J. *et al* 1994
"Modelling consequences of accidents"
Activities developed in task 7 (Vol 2).
Universitat Politecnica de Catalunya- SIGRI Project -Barcelona