SEVESEO
INDUSTRIAL DISASTER MANAGEMENT FROM SPACE

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Keywords

Remote Sensing, Pollutant Dispersion Modelling, Industrial Emergency Management

Abstract

The ESA-funded SEVESEO project aims at developing a decision-making tool that integrates environmental parameters derived from satellite imagery with pollutant transport models in order to support the risk management at Seveso-II industries. The development of the SEVESEO Information System (IS) implies the integration of contaminant transport models that aim at determining the environmental impact of a Seveso type accident, by modeling transport of pollutants around the site. A complete assessment of a simulation of an accident involving hazardous chemicals or an actual emergency response to an accident requires a system that rapidly and accurately models the source term and the subsequent transport of the chemical of concern trough different media. This information enables operators to define risk zones and perimeters. By integrating this information with local geographic information a valuable GIS tool will be provided. This GIS tool will be able to support decision making during technological accidents and to access the impact of the accident on the local environment.

Introduction

In 1976, an important industrial accident happened at a chemical plant in Seveso, Italy, manufacturing pesticides and herbicides. A dense vapor cloud containing tetrachlorodibenzo-paradioxin (TCDD) was released from a reactor. Commonly known as dioxin, this was a poisonous and carcinogenic by-product of an uncontrolled exothermic reaction. Although no immediate fatalities were reported, large quantities of the substance, lethal to man even in micrograms doses, were dispersed in the environment which resulted in an immediate contamination of some ten square miles of land and vegetation. More than 600 people had to be evacuated from their homes and as many as 2.000 were treated for dioxin poisoning. More recently, disastrous industrial accidents took place in Toulouse, Baia Mare and Enschede with many deadly casualties involved.

In Europe, the Seveso accident lead to the adoption of legislation aimed at the prevention and control of such accidents. In 1982, the first EU Directive 82/501/EEC – so-called Seveso Directive – was adopted. On 9 December 1996, the Seveso Directive was replaced by Council

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Directive 96/82/EC, so-called Seveso-II Directive. This directive was extended by the Directive 2003/105/EC. The aim of the Seveso-II Directive is two-fold. Firstly, the Directive aims at the prevention of major-accident hazards involving dangerous substances. Secondly, as accidents do continue to occur, the Directive aims at the limitation of the consequences of such accidents not only for man (safety and health aspects) but also for the environment (environmental aspect). All operators of establishments coming under the scope of the Directive need to send a notification to the competent authority and to establish a Major-Accident Prevention Policy. In addition, operators of upper tier establishments (i.e. having quantities of dangerous substances above the upper threshold contained in the Directive) need to establish a Safety Report, a Safety Management System and an Emergency Plan. Internal Emergency Plans for response measures to be taken inside establishments have to be supplied to the local authorities to enable them to draw up External Emergency Plans. Emergency Plans have to be reviewed, revised and updated, where necessary. Important new elements require operators to consult with their personnel on Internal Emergency Plans and on the local authorities to consult with the public on External Emergency Plans. The Seveso II Directive contains an obligation to regularly test in practice the Internal and External Emergency Plans.

Although it would be unrealistic to expect that men can fully control the industrial and technological risks with which they or their companies are faced, an appropriate management of the risk can be a decisive factor in leaving the least possible room to hazard. Public authorities and private industrial executives, faced with an industrial or a technological risk, are required to have a firm control of all the parameters involved. In that perspective, decision-making instruments are essential tools to help all stakeholders concerned by an industrial accident with the means to make the right decisions likely to anticipate catastrophic events and to plan the best actions to mitigate their impact. The prevention actions must be organized for short and long term risk since an appropriate prevention policy should assess the primary but also the secondary effects of an industrial exploitation / incident involving hazardous products. Past events have shown that environmental or health complications can persist far beyond the date of a technological accident or of the industrial exploitation. The management of these secondary effects generally mobilizes considerable resources.

Hence the need for decision-making tools for the analysis of these short and long term risks that can affect the local population, their property and the surrounding environment. These analysis are to be assessed before, during and after the accident. It is essential to be aware of the environment in which the highest risks are to be expected. Such awareness is derived from the type of SEVESO product concerned, and from an assessment of specialized industries producing those materials, processing them, handling them and transporting them. The different types of incidents and scenarios that might occur should also be taken into account.

In the SEVESEO project, a user tailored information system will be developed that allows an easy manipulation of pre-calculated dispersion scenario's. This includes the search, modification and extraction of the needed information as well as the manipulation of dispersion models that are connected to the SEVESEO IS. Different environmental compartments are considered, including air, soil, surface waters. A specificity of the system is the integrated use of satellite remote sensing for site specification during the preventive phase as well for visual aid during the response phase.

In this paper, the proejct will be briefly described and some considerations about remote sensing, dispersion modelling and information technology will be given.

Theory and Method

Within the SEVESEO project funded by ESA, focus will be on the development of a decision-making tool that integrates environmental parameters, pollutant dispersion modelling and safety strategies in the context of the industrial exploitation of SEVESO II companies and in the occurrence of technological accidents. The SEVESEO decision-making tool - also called SEVESEO information system (SEVESEO IS) shall base the observations and interpretations of the environmental parameters principally on satellite imageries.

The SEVESEO consortium consists of 6 partners from 4 different European countries:

1. Agence Prévention & Sécurité (APS), Belgium
2. Department "Industrial & External Safety", TNO, Netherlands
3. Departement "Direction des Risques Accidentels", INERIS, France
4. PRO DV, Germany
5. Créaction, Belgium

The project also includes five public organizations that participate to the SEVESEO project as end-users. These core user organizations represent 5 countries of the European Union: Belgium, the Netherlands, France, Luxembourg and Germany:

1. Belgium: Centre de Crise du Gouvernement Belge
2. Netherlands: Province of Zeeland
3. France: Chambre de commerce et d'Industrie des Ardennes
4. Luxembourg: Direction de la Protection Civile
5. Germany: Euro Info Centre, Trier

The main role of the user organizations consists of:

- Communication of the minimal requirements regarding the specifications of the SEVESEO IS with respect to the role of the organization in the regulatory framework of the SEVESEO Directive and the national and regional safety legislations;
- Access to input data that is available at the user organization for the execution of the service cases;
- Support to the consortium in the quality assessment of the SEVESEO IS and output products;
- Promoting the results of the projects in their community and in particular within the local organizations that fall under their responsibility.

A particular point of the SEVESEO project is the integrated use of remotely sensed information, modelling tools and advanced IT technology.

- Remotely sensing information has the possibility to offer a global view of the site environment and depending on the platform used (airborne, satellite or UAV), remote sensing can provide frequently updated information. Remote sensing can be used to obtain visual information, surface characteristics (land cover/use, state and abundance of vegetation, topography) as well as atmospheric composition. The phase of a disaster in which the use of remote sensing proves to be the most interesting depends on the platform:

- Airborne (airplane or helicopter) remote sensing can result in very high resolution imagery because of the low altitude compared to satellite imagery and depending on the autonomy also high temporal information for a certain time period (few hours) can be delivered.

- Satellite-based imagery has other advantages. The ground resolution is less compared to airborne sensors but on the other hand, once the sensor is operational in space, it allows to have long term regularly updated information. Minor points are the unavailability of visual information during cloudy conditions. It remains a challenge to further upgraded sensors with increased horizontal and temporal resolution.

- UAV (Unmanned Airborne Vehicle) technology is under development (see for example, **http://www.pegasus4europe.com**) but has the potential to combine the strong points of both airborne and satellite remote sensing). UAV's can fly at low altitude and in case of long endurance versions, continuous monitoring can be performed.

- Numerically modelling the fate of pollutants in the environment has evolved rapidly parallel with computer technology. Nowadays powerful modelling tools exists and are further being developed. With respect to industrial disasters there exist models for:

- Modelling of the source term, i.e. the calculation of the amount and the characteristics of the accidentally released material from a container, tank, pipeline, etc. There are many possible release ways: explosion, continuous outflow, gas release, BLEVE (boiling liquid expanding vapor explosion), ...

- Modelling of the dispersion of gaseous, liquid or solid toxic pollutant in the various compartments of the environment (atmosphere, soil, ground and surface water, biosphere, humans and animals). Depending on the required accuracy and the availability of input data, different models can be used. The range of models starts with simple analytical rapid models and goes until complex 3-dimensional grid models that require a lot of input data and are highly computationally expensive.

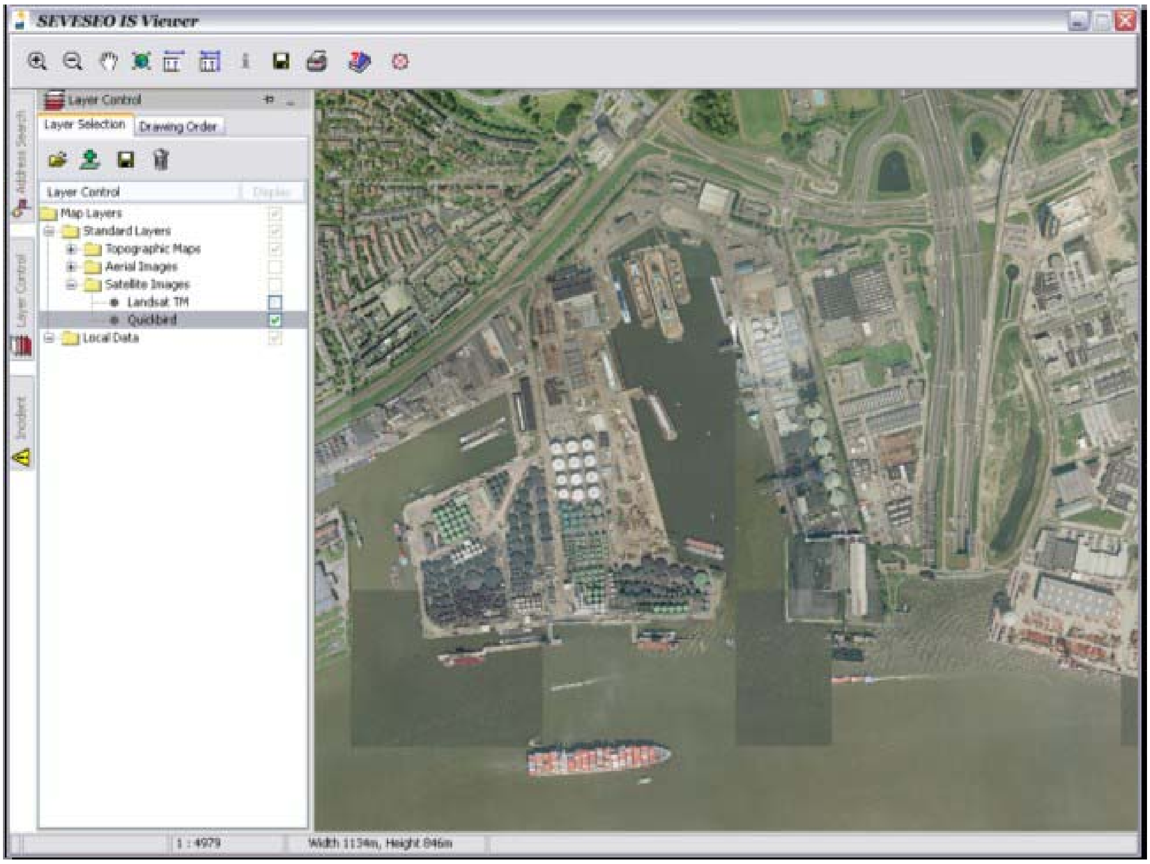
- Modelling of the impact on ecosystems and human beings individually and on larger groups of the population. .

- Information technology evolves rapidly. Since the existence of personal computers, anybody has access to computing power. The development of the internet further increases the use of computers and has accelerated the use of central databases and the rapid exchange of digital information all over the globe. Current IT technology provides innovative ways of delivering modelled and remotely sensed information to the field actors actively in disaster management. A point of attention is the operability of the service in case of internet shutdown.

Conclusion

The development of the SEVESEO Information System is on its way (Figure 1). Its development is based on many user interactions. The testing of the SEVESEO IS will be done on real cases situated in Belgium, Luxemburg, France and the Netherlands and the results will be confronted with the users in order to further refine the system. The use of remote sensing will in a first step be limited to the use of visual Quickbird satellite images for site viewing and classified SPOT images for land use/cover determination. The latter will also be used for the determination of the surface roughness parameter of any site. This parameter plays an important role in the atmospheric modelling of pollutants around the accident. For the atmospheric modelling, the TNO EFFECTS model will be linked by means of web service technology.

Figure 1: Screenshot of the SEVESEO IS for a test area in Holland (harbor of Rotterdam).



Acknowledgements

The authors want to acknowledge ESA for funding this project under the Data User Element programme (http://www.esa.int/DUE). More information about the project is available on www.seveseo.eu.

Author Biography

Dr. Filip Lefebre graduated as a physicist from the University of Ghent (1996). During his studies he has been abroad in France for 1 year at the University of Toulouse where he specialized in Atmospheric Sciences. From 1997 until 2001, he has been doing a PhD at the University catholique de Louvain-la-Neuve in atmospheric modelling on the determination of the Greenland surface mass balance. Since 2001, he is working at VITO, first as a researcher and presently as a project manager within the department "Integrated Environmental Studies". He has been working on the modelling of atmospheric air pollution at the local, urban and regional scale. He has been project leader for a number of national and international projects and is co-responsible for the research group "modelling of atmospheric processes" that has more than 30 years of experience in the modelling of air pollution. Since 2006, he is working on industrial disaster information systems in collaboration with the remote sensing department of VITO.