Journal of Hazardous Materials 163 (2009) 683–700

Contents lists available at ScienceDirect

Journal of Hazardous Materials

journal homepage: www.elsevier.com/locate/jhazmat

Introduction of threat analysis into the land-use planning process

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ARTICLE INFO

Article history:
Received 9 August 2007
Received in revised form 12 May 2008
Accepted 3 July 2008
Available online 15 July 2008

Keywords:
Risk
Land-use planning
Threat analysis

ABSTRACT

The subject of this paper is a method for introducing risk assessment into the land-use planning (LUP) process. Due to adaptations of the results of risk assessment, which are needed to make the risk assessment usable by land-use planners, we term the overall process threat analysis. The key features of the threat analysis can be summarised as follows. (i) It consists of three main steps. The first is determination of the threat intensity level of an accident, the second is analysis of the environmental vulnerability of the surroundings of an accident, and the third, integrating the previous two, is determination of a threat index in the accident impact zone. All three are presented in GIS based maps, since this is a common expression in LUP. (ii) It can and should be applied in the early stages of the LUP process. The methodology is illustrated by an example in the context of renewal of a land-use plan for the Municipality of Koper in Slovenia. The approach of threat analysis follows directions of the Article 12 of the Directive 96/82/EC of the European Commission (the Seveso II Directive).

1. Introduction

The most effective preventive approach for reducing the consequences of industrial accidents is provision of appropriate distances between hazardous installations and residential areas [1–4]. Proper distances should be assured by means of land-use planning (LUP): consideration of risk assessment results in land-use planning for the purpose of limiting the consequences of accidents is one of the requirements of the Seveso II Directive [5,6]. EU member states are searching for their own best ways of achieving compliance with this specific requirement [4,7–13], but the process seems to be slower than expected at the time of adopting the Directive.

In general there exist three approaches to risk-informed land-use planning: the approach of generic separation distances, a risk-based and a consequence-based approach [3].

The determination and use of "*generic*" separation distances is based on the type of activity rather than on a detailed analysis of the risks. These safety distances are usually derived from expert judgments and are mainly based on historical factors, experience, rough consequence calculations or information regarding the environmental impact of the plant. The approach of generic separation distances has been established and used in Germany and Sweden [2,3].

The risk-based approach focuses on the assessment of both consequences and expected occurrence frequency or probability of possible accident scenarios. The results are represented as individual risk and/or societal risk (expressed as individual risk contours and societal risk (F–N) curves) [3,14–16]. LUP criteria are based on specific acceptability criteria with respect to the calculated risk. In terms of LUP the results of risk analysis are used as a basis for risk reduction measures in terms of lowering both the probability and the magnitude of incidents, as well as a guideline for determining the acceptability of proposed development in the vicinity of hazardous sites. This approach is used in the United Kingdom and in the Netherlands [13,17–20].

The consequence-based approach focuses on the assessment of the consequences of a number of reference scenarios obtained from a quantitative risk assessment (QRA) study. Damage threshold values for accident physical effects (overpressure, thermal radiation, toxic concentration) are determined with respect to undesired consequences (fatalities, irreversible effects, reversible effects, etc.) [3]. The method has generally been used in Finland, Luxembourg, Spain, Belgium and Austria [2,10,13,21,22]. France has also been included as a typical example of the consequence-based approach until recently [2,3]. After the Toulouse accident and the French Law for Land-Use Planning of 2003, the approach has changed into a hybrid one, requiring the operator and the authorities to take the likelihood of accident scenarios into account [23,24]. Besides introducing a probabilistic approach into the risk assessment process, the novelty/new feature is consideration of probabilities in the framework of strategies for communication with local communities, with the aim of

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doi:10.1016/j.jhazmat.2008.07.040

achieving consent for existing situations or development proposals.

A hybrid approach combining risk and consequence based approach has also been devised and used in Italy [13]. The method requires the identification of four damage zones. Threshold values for each of the three accidental cases (toxic concentrations, fire and explosion) are supported by legislation. The vulnerability of surrounding land uses is also taken into consideration [25,26]. The frequency values calculated for each scenario are considered as worsening factors for LUP restrictions and are not used to express the individual and societal risk.

EU member states expected a resolution of the land-use planning issues by providing common guidelines for land-use planning, as required by the Seveso II Directive; these were prepared by the Institute for systems informatics and safety and the Major Accident Hazard Bureau (MAHB) of the EU Joint Research Centre in Ispra, respectively [27,28]. The guidelines are aimed at assisting the interpretation of the requirements of the Article 12 of the Seveso II Directive as a help in achieving compliance. An additional aim is to provide collaboration between land-use planners and risk assessment experts [28]. However, since no specific or detailed support is provided in these guidelines in terms of integrating risk assessment results into the land-use planning process, it remains to be seen what their practical utility and benefit will be, especially because member states will need to develop their own practice on this subject.

The approaches discussed above are either procedures involving evaluation of the conformity assessment of existing urbanisation with selected risk criteria (ex-post evaluation), or are applied during the licensing process for new developments (ex-ante evaluation). In both cases a land-use plan is already available, so risk assessment is not involved in the plan preparation process; it is, rather, a basis for compliance assessment with the plan. The LUP issues in this regard are presented schematically in Fig. 1. The figure also shows the ultimate aim of the threat analysis for solving the risk related LUP issues.

Part (a) of Fig. 1 illustrates current situations: 10 or 20 years after the plan approval, and due to urbanisation development in the surroundings of the industrial zone where a Seveso II plant is situated, the situation is no longer satisfactory or acceptable (high risk) as it was at the time of plan adoption (at $t = 0$). Possible LUP safety (risk) improvement measures are: relocation or shut down of the Seveso II plant; movement of the population from the residential objects in proximity to the plant if the risk situation is extreme; implementation of additional preventive measures at the plant (e.g. safety improvement by installing additional safety device) as well as more effective protective measures in the surroundings (e.g. additional technical barriers against direct exposure of the population or improvement of the external emergency plan by assuring

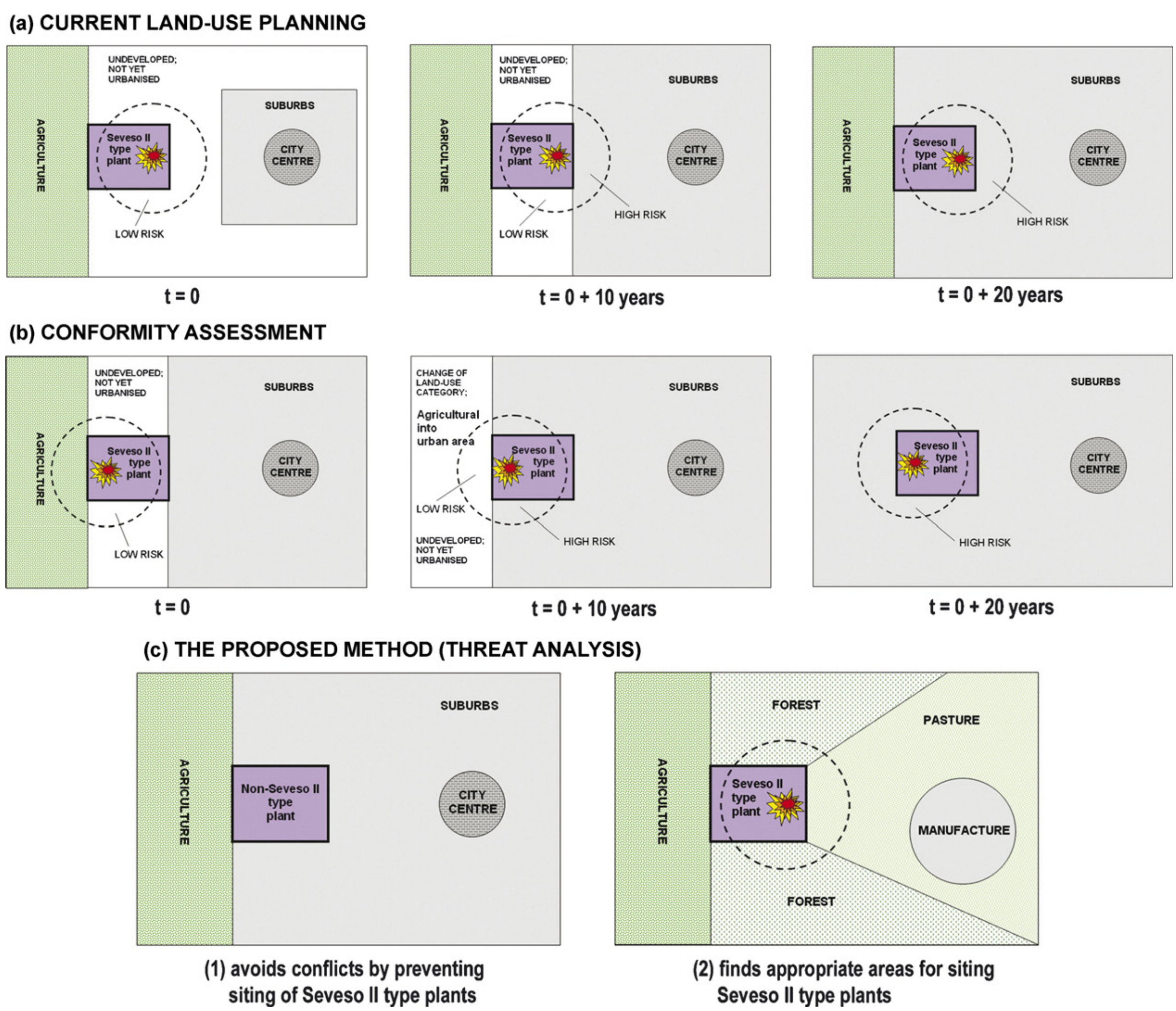

Fig. 1. Illustration of risk related LUP issues.