Available online at www.sciencedirect.com
ScienceDirect
Journal of Hazardous Materials 145 (2007) 241–249
Journal of Hazardous Materials
www.elsevier.com/locate/jhazmat

Risk-maps informing land-use planning processes
A survey on the Netherlands and the United Kingdom recent developments

Claudia Basta [a,*], Jeroen M.M. Neuvel [b], Sisi Zlatanova [c], Ben Ale [d]

[a] *DIRC Sustainable Urban Areas, Section of Material Science and Sustainable Construction, Delft University of Technology, Stevinweg 1, 2600 GA, Delft, The Netherlands*
[b] *Land Use Planning, Wageningen University, Droevendaalsesteeg 3, Postbus 47, 6700 AA Wageningen, The Netherlands*
[c] *Section GISt, OTB Research Institute for Housing, Urban and Mobility Studies, Delft University of Technology, Jaffalaan 9, P.O. Box 5030, 2600 GA, Delft, The Netherlands*
[d] *Safety Science Group, TBM Faculty, Delft University of Technology, Jaffalaan 5, 2600 GA, Delft, The Netherlands*

Received 6 April 2006; received in revised form 8 November 2006; accepted 12 November 2006
Available online 19 November 2006

Abstract

The definition of safety distances as required by Art 12 of the Seveso II Directive on dangerous substances (96/82/EC) is necessary to minimize the consequences of potential major accidents. As they affect the land-use destinations of involved areas, safety distances can be considered as risk tolerability criteria with a territorial reflection. Recent studies explored the suitability of using Geographical Information System technologies to support their elaboration and visual rendering. In particular, the elaboration of GIS "risk-maps" has been recognized as functional to two objectives: connecting spatial planners and safety experts during decision making processes and communicating risk to non-experts audiences. In order to elaborate on these findings and to verify their reflection on European practices, the article presents the result of a comparative study between the United Kingdom and the Netherlands recent developments. Their land-use planning practices for areas falling under Seveso II requirements are explored. The role of GIS risk-maps within decisional processes is analyzed and the reflection on the transparency and accessibility of risk-information is commented. Recommendations for further developments are given.

Keywords: Land-use planning; Geographic information systems; Seveso II; Risk-maps

1. Introduction

The article is part of a broader comparative study on Member States practices in the field of land-use planning (in the following: LUP) in areas at risk [1,2] and presents recent findings of current research addressing the development of GIS-based tools for risk prevention and emergency response [3,4]. The framework of the study is Art 12 of the Directive Seveso II on dangerous substances (96/82/EC) [5], with a focus on Art 12 "Control of Urbanization" and its implementation in selected European practices. Aim of the article is investigating how LUP decision making processes are supported and informed by "risk-maps" in two selected Member States: the Netherlands and the United Kingdom. These two countries are selected on the base of their comparable methodological approach to LUP for at-risk areas, to which relevant differences between the decisional processes involving the risk-information system are associated.

As well known, Article 12 of Directive Seveso II requires Member States to consider, within their land-use planning policies, the need of defining opportune safety distances between dangerous establishments and urban, natural and infrastructural developments. "Dangerous" refers to the presence of substances which explosion, fire or release could lead to major accidents involving the external areas of establishments. In this respect, safety distances are risk acceptability criteria with a territorial reflection, as they affect the land-use destinations of the surroundings of Seveso sites.

In the last decade, different methods and tolerability thresholds fulfilling the Seveso II requirements were developed in European countries. Analyzed Member State's practices reflect the specific geographical, regulatory and societal background

* Corresponding author. Tel.: +31 15 2695438; fax: +31 15 2624341.
E-mail addresses: c.basta@citg.tudelft.nl (C. Basta), jeroen.neuvel@wur.nl (J.M.M. Neuvel), s.zlatanova@otb.tudelft.nl (S. Zlatanova).

0304-3894/$ – see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.jhazmat.2006.11.032

of the country [1]. The resulting heterogeneity of approaches and regulations may be interpreted, in general terms, as the result of the ‘discretionary freedom’ [6] Member States have in implementing European legislation. In the specific domain of the Seveso II, this discretionary freedom is coupled with qualitative and quantitative variables affecting the development of different regulations and methods. In the analyzed case, a different legal background (common law versus civil law) [7], a different population density (resulting in a different land scarcity) and a different configuration of the institutional lay-out are the most relevant ones.

From the European regulatory perspective, in order to achieve a harmonized implementation of Art 12, the heterogeneity of methods and practices which were developed or were under development in the “Europe of 25” had to converge to an agreement about the general principles informing a “safe” land-use planning practice. This objective is stated in the first amendment of the Seveso II Directive (2003/105/EC) [8]. The amendment requires to the Commission the elaboration of guidelines defining a d-base to be used as a common reference for assessing the compatibility between Seveso sites and surrounding areas. This requirement gave new inputs to previous comparative studies investigating the possibility of deriving a general ‘good-practice’ from national experiences [9,10]. A relevant part addressed the analysis of the decision-making processes supporting the definition, the enforcement and the communication of risk-reduction measures [11]. The issue of the different professional cultures, subjective perceptions and decisional approaches the great variety of actors have in ‘coping with risk’ are generally outlined [12,13]. Facilitating their dialogue and developing a shared understanding of risks is seen as crucial for a proper definition and enforcement of risk reduction strategies [14]. In this respect, an appropriate (national) risk-information system plays a central role.

As outlined in a previous study, “risk-maps” are a valuable tool for the visualization and exchange of risk-information in an easy-reading language. When responding to an-ambiguous requirements, risk-maps can improve the understanding of the geographical dimension of major accidents [15]. Despite this, the digital representation of risk-information and the creation of national d-bases accessible by different users are very recent in European practices. The Netherlands and the United Kingdom offered the opportunity to investigate on the most recent developments in this field. Both countries have well-established risk regulations, a comparable experience in term of risk prevention policy-formulation and a similar methodological approach to LUP for areas at-risk. On the other hand, coherently with their different regulatory backgrounds, they developed different spatial planning systems, risk tolerability criteria and risk-informative systems. Risk-maps find a different use during planning processes, and a different consultation procedure for accessing risk-maps by the side public offers the opportunity to reflect on the problematic interface between safety and security.

In order to present its findings, the article starts with a summary of the main differences and similarities between the two national practices. A more extensive description of the Dutch and the United Kingdom land-use planning regulations for areas at-risk follows. Decisional processes are described together with GIS-based risk-informative systems and maps. With the support of direct interviews to Safety and Planning Authorities of both countries and in-depth literature analysis, a concluding section reflects on possible further developments in the use of risk-maps as decision-support for risk prevention purposes.

2. Risk-maps informing planning processes: a comparison between the two examined countries’ practices

The comparison between the United Kingdom and the Netherlands focused on two distinct aspects. Firstly, the regulatory aspects related to the implementation of Art 12 were examined and compared; secondarily, the risk-informative aspects related to the creation of geo-data infrastructures and the development of risk-maps were analyzed and discussed.

The most remarkable similarity in the two regulatory contexts is the common adoption of a quantitative approach to risk assessment. In the context of the Seveso II, this approach involves the estimation of the probability of occurrence of major accidents. Consequently, the likelihood of accidents is a variable of the following LUP evaluation. In this respect, the two approaches are to be considered similar. Nevertheless, relevant differences related to the risk assessment approach (a and b) and to the decision-making process (c) were outlined:

a. The status of the risk acceptability criteria: a strictly quantitative risk assessment (QRA) is required in the Netherlands, where legally binding end-points are defined by law. A judgmental approach, using also consequence-oriented assessments, is instead used in the UK, where the As Low As Reasonably Possible (ALARP) principle applies.
b. A different definition of societal risk: strongly quantitative but difficultly estimable in the Netherlands, it is based on the integration of the individual risk (IR) estimation with population data in the UK.
c. A different configuration of decisional-processes, deriving from a different lay-out of the institutional system: strongly centralized and focused on a unique Safety Authority in the UK, it is a multi-level system involving different institutional competences in the Netherlands.

Concerning the deriving risk-informative systems and the elaboration of risk-maps, differences are:

d. In the Netherlands, shared information platform are used as reference for elaborating risk-maps and delivering risk data. The authority responsible for granting the license to plants’ operators (which differs according to the classification of the plant within given dangerous categories) is also responsible for the regular update of the data. In the UK instead, the national Safety Authority Health and Safety Executive (HSE) owns the data, and it is entirely responsible for their regular update.
e. In the Netherlands, the information reported on risk-maps is extended to different kind of risks with a geographical relevance. The specific nature of the substances treated/stored

within establishments and, until recently, iso-risk contours were available to general end-users. In the United Kingdom instead, risk-maps report only iso-risk contours with the level of risk/harm: no information is given regarding the dangerous substances.

f. In the Netherlands, risk-maps are used to inform the planning process as well as non-institutional users (i.e. involved stakeholders or general public). In the UK, risk-maps instead are directly delivered to the Planning Agencies by the Safety Authorities, without any direct communication of their content to the population.

In the following sections, details of each country's practice are given.

3. Land-use planning and major accidents risk in the Netherlands

3.1. Risk assessment method and risk tolerability definition

The Seveso II Directive is implemented in the Dutch legislation by the Dutch Major Hazards Decree (BRZO) and the Dutch Public Safety Decree (BEVI). The BRZO focuses on the management of hazardous installations. The BEVI instead regards the regulation of land-uses around hazardous installations, i.e. the external safety regulation. Spatial decisions related to the adaptations, elaborations, modifications, dispensations and revisions of land-use allocation plans within the sphere of influence of a hazardous establishment fall under the BEVI. The Dutch external safety's methodological approach is extensively described in literature [16,17]. Relevant aspects of the current risk prevention policy which have a direct reflection on the elaboration of geographical risk-information are:

a. The adopted quantitative approach to risk assessment, resulting from the estimation of both magnitude and expected frequency of accidental events.
b. The definition of individual risk as the chance, for an individual permanently located in the vicinity of a dangerous site, to die as a direct consequence of an accident involving Seveso II substances. Legally binding endpoints apply.
c. The classification of vulnerable objects into two classes. The first groups accounts hospitals, schools, and residential areas; for these objects, a risk tolerability threshold of 10^{-6} event/year applies. The second group accounts less vulnerable objects as industrial zones, office buildings or recreational facilities For these facilities, a tolerability threshold of 10^{-5} event/year applies.
d. The definition of societal risk (SR) as the chance, for a number of people >*N*, to die as a direct consequence of their presence in the vicinity of a dangerous facility in which an accident occurs; non-binding tolerability endpoints apply. The acceptability criteria for an accident are 100 times stricter for every expected tenfold in number of victim (i.e. the acceptability of a disaster with 10 lethal victims is set on 10^{-5} event/year, for a disaster with 100 lethal victims 10^{-7} event/year, etc.).

The legislation was recently updated. The configuration of the Dutch territory has to fulfil the endpoint reported in point c by the end of 2010.

3.2. Risk and LUP: the Dutch decision-making process

While the Dutch external safety methodological approach is extensively described in literature, its connection with the Dutch territorial management practice called for a direct survey. In the Netherlands, the spatial planning system involves three levels: the national, the provincial and the municipal levels. As in the majority of European planning systems, the government establishes principles for spatial planning, defines building regulations and set-up long-term objectives for relevant urban and environmental issues [18]. All three tiers of government have independent planning powers, although the consistency requirement stated in the Dutch Spatial Planning Act has to be respected. The interaction between the tiers of government is characterized by consensus building and mutual adjustment. Hierarchical relations are rarely activated [19].

This multi-level governance system is reflected in the supervision of hazardous installations by the side of different authorities. The Ministry of Housing, Spatial Planning and the Environment (VROM) is competent for facilities of national interest, such as nuclear power plants (NPP) and nuclear waste disposal. Dangerous establishments falling under the Seveso II requirements are classified in accordance to threshold values considering the quantity of stored/treated dangerous substances. According to their classification, top-tier Seveso plants fall under the provincial competence and, in case of lower-tier plants and small LPG storages, under the municipal competence. Operators whose facility falls under the Seveso Directive are responsible of the elaboration of a quantitative risk assessment (QRA). The supervising authority checks the validity of the analysis, and it is responsible for acquiring and updating all the information which are necessary to assess the compliance of the installation with the operational, spatial and environmental legal requirements.

The described organization in the acquisition and validation of risk-related information responds to a multi-level system, which reflects the institutional decentralization of the country. Because of this decentralization, until recent developments in the risk-information system, geographical and industrial data of plants were spread out over numerous authorities. As a reaction to the *Commissie Onderzoek Vuurwerkramp's* report [20], appointed after the accident of Enschede occurred in 2000, a national scale overview of the risk posed by Seveso establishments had to be created. Furthermore, the Seveso II Directive obligation of reporting major accident events to the European Commission Major Accidents Reporting System (MARS) [21] posed the problem of centralizing the information relative to accidents. Finally, the need of informing the public had to find a translation into a systematic elaboration and delivery of geographical risk-information. The most relevant initiatives in this respect were the development of the Installations Handling Dangerous Substances Database, managed by the Netherlands National Institute for Public Health and the

Environment (RIVM), and the development of GIS-based risk-maps (‘*risicokaart*’), which realization falls under the provincial responsibility. They are both described in the following section.

3.3. Elaboration and representation of major accident risk information

With the development of the Installations Handling Dangerous Substances Database the authority responsible for granting the environmental license to the operator of a given hazardous installations is obliged to forward all relevant information to the database. The authority responsible for granting the license is the owner of the data and it is responsible for their validity. Next to the development of the national database, the issue of delivering risk-information to different authorities and citizens in an easy-reading was addressed. As well known, the individual risk estimation is visualized as a set of concentric areas, representing different effect levels, which origin stands at the emission point of the accident. Effects are experimentally deducted. For each scenario, the probability of its likelihood is calculated; a representative scenario is therefore selected for formulating the planning advice [16,17]. The vulnerability of the involved urban and environmental elements is classified accordingly to vulnerable categories (high, medium, low). Standing to this approach, the visualization of the risk connected to an accident results from the overlap between the selected accidental event, its iso-risk contours and the specific territorial context. Digital risk-maps reporting this overlap are therefore an obvious, although recent, operational development.

For this purpose, risk-maps are developing under the provincial responsibility. The national Installations Handling Dangerous Substances Database is used as informative source together with the ISOR database. ISOR is the result of the cooperation between the 12 Dutch provinces, in which additional risk information such as flood risks and vulnerable objects are collected. Data in this database is owned by municipalities. Thanks to these developments, previously spread out risk information are converging towards national, multi-accessible d-bases.

Provincial risk-maps are realized on a GIS platform. The variety and quantity of reported information is notable and comprise the localization of plants, the amount and nature of substances stored/treated, iso-risk contours and the emergency planning in the area. A recent model plotting societal risks on digital maps was developed by the Dutch Applied Research Institute TNO [22]. A foreseeable evolution of risk-maps is therefore the incorporation of the societal risk contours. At present, individual risk contours are suitable to inform the development of spatial plans, building development plans and single planning permission. Furthermore, a version of risk-maps is used to inform the public and it is available via the Internet. This is discussed in the next section.

3.4. Accessing risk-maps: status of the information

In the Netherlands, besides to inform competent authorities, risk-maps have been developed as a tool to inform the public about the risk in their living environment. In accordance with the obligation of informing the citizens about the risk of major accidents stated in the Seveso Directive [5], risk-maps are accessible via the Internet. The amount of reported information is notable. Citizens can access information about the location of hazardous installations, the hazardous substances that are used or produced, risks related to transport and the vulnerable objects in the area. The understanding of this information is supported by a detailed legend. Other kind of risks like panic in crowd and main aircraft routes are illustrated. Risk-maps do not allow any elaboration of the information and serve only for illustrative purposes; nevertheless, users can select different layers with the information of interest and visualizing more or less accurate data. Examples can be found on http://www.risicokaart.nl (last visited: September 2006). The Province of Limburg risk-map is reported in Figs. 1 and 2.

Until the end of 2005, iso-risk contours were also reported in the provincial web-site and had a prominent communicative relevance. Strong of its information accessibility tradition, the underlying intention of the Dutch government was delivering easy-reading geographical information to the public and complying, in so doing, with the Seveso II requirements [23]. Interestingly, although the accessibility of risk-information was responding to a requisite of transparency, a conflict with the increased European security requirements followed. The European communication of 2004 regarding the protection of critical infrastructures in the fight against terrorism underlined how all those “(. . .) physical and information technology facilities, networks, services and assets which, if disrupted or destroyed, would have a serious impact on the health, safety, security or economic well-being of citizens or the effective functioning of governments in the Member States (. . .)” should be carefully monitored and protected [24]. The European Communication stressed the need of enhancing the elaboration and the exchange of information relative to critical infrastructures threats among public and private actors. Above all, it stressed the need of increasing the discretion in their dissemination. Being Seveso chemical plants responding to the definition of physical critical infrastructure, a conflict between the accessibility of risk-information and the security of the population had to be considered.

This discussion opens an interesting reflection about the so-called “citizens’ right to know” (Gouldson, 2005) [25]. Generally, the access to environmental information related to industrial performance enhances a more transparent participation of institutional, industrial and non-institutional parties into decision making processes. Notwithstanding, in the case of risk-information, the same information access may result in a security threat. Once published on the Internet in fact, risk-information is accessible by uncontrollable users. The possibility of quantifying the amounts of safety increase and security loss is an interesting, although irresolvable, topic, which led to a political debate within the Dutch government. The debate led to the cancellation of iso-risk contours from the risk-maps delivered on the internet, as proposed by the cabinet on September 9, 2005, on the base of the assumption that “[. . .] currently, security is more important than indefinite access to public government

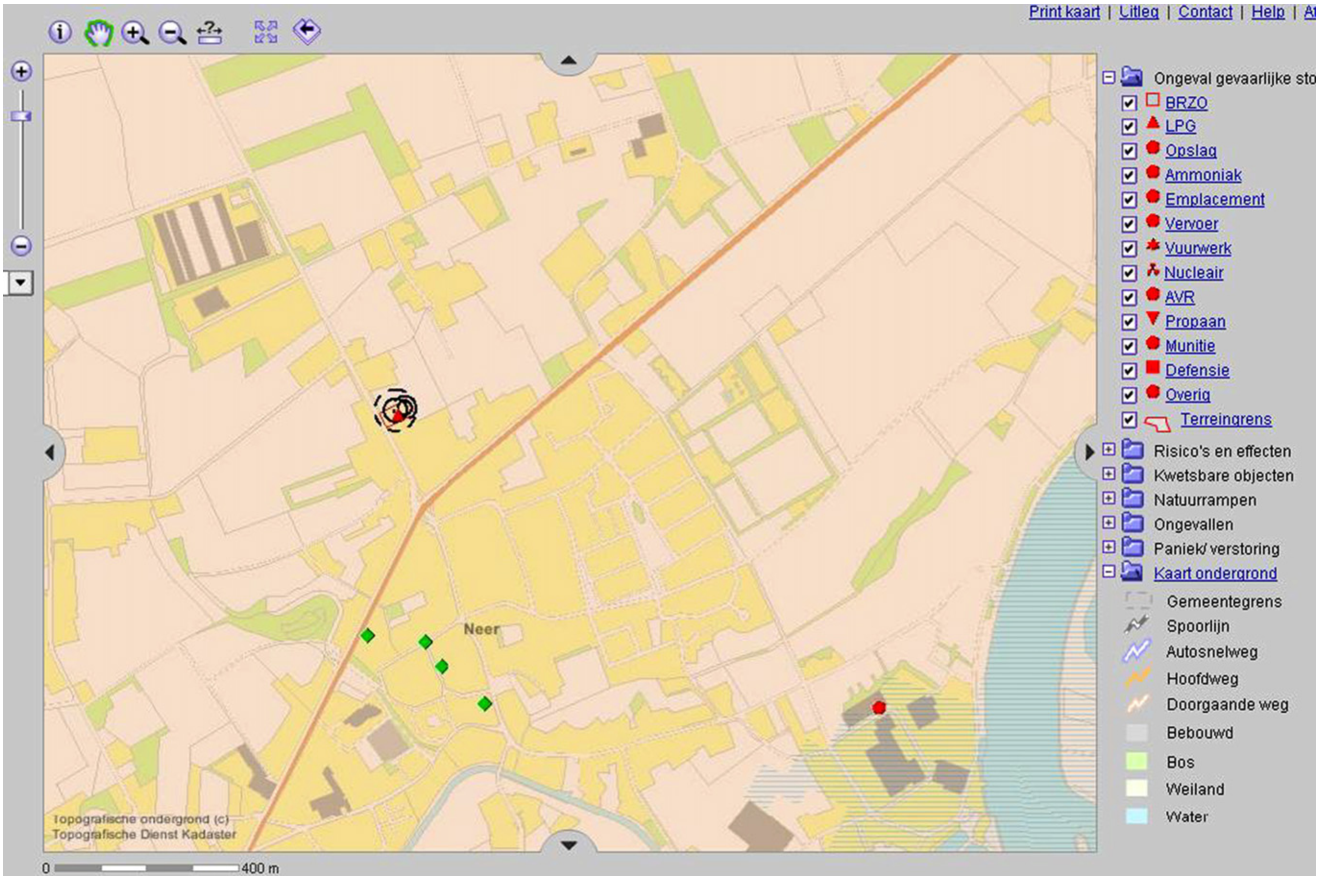

Fig. 1. Risk-map of the Province of Limburg: general overview of the area.

information [. . .]” [26]. Interestingly, initially Dutch provinces refused to deny the access to iso-risk contours via the Internet. Their motivation was based on the assumption that accessing risk-information played a role in the improvement of citizens’ coping-capacity, and that the adopted risk information policy was in line with the citizens ‘right to know’. Nevertheless, after January 1, 2006 iso-risk contours were cancelled from the web and currently the consultation of risk contours by the side of citizens is subject to a specific procedure.

This paper reports only general reflections about this controversial issue in the conclusions; further research on this delicate interface between safety and security will be the object of a following study.

4. Land-use planning and major accidents risk in the United Kingdom

4.1. Risk assessment method and risk tolerability definition

In the United Kingdom, the Seveso II Directive is implemented in several regulations. With respect to the licensing procedure and prescribed risk assessment methods, legal references are the Notification of Installation Handling Hazardous Substances Regulations (NIHHS) and/or the Control of Industrial Major Accidents Hazard Regulation (CIMAH) 1999. Land use planning in the surroundings of chemical sites is regulated by the Planning (Hazardous Substances) Act 1990 and the Planning (Hazardous Substances) Regulations 1992, as amended by The Planning (Control of Major-Accident Hazards) Regulations 1999.

The competent authority for safety-concerned issues is the Health and Safety Executive (HSE). HSE risk assessment method is extensively described in literature [27,28]. The Hazardous Installation Directorate (HID) of HSE has developed a judgmental approach to risk assessment. The proportionality principle and an approach to risk estimation that varies depending on the different types of accidental scenarios apply. Although probabilistic in principle, a consequence-oriented approach is usually used to assess accidental scenarios involving the release of flammable liquid to which the risk of fires or explosions is associated. When performing the planning advice, these scenarios are object of a consequence-oriented estimation. Notably, risk assessment is based on the maximum quantity of substance each establishment is allowed to store. This leads to a conservative and precautionary evaluation of safety distances. After the characterization of the accidental scenarios associated to a specific plant is concluded, the one more relevant to perform the LUP advice is selected. As the “risk profile” of a plant usually sees the predominance of a single scenario, LUP evaluations are based on it [29]. Concluding, the aspects of HSE risk regulation relevant to land use planning are:

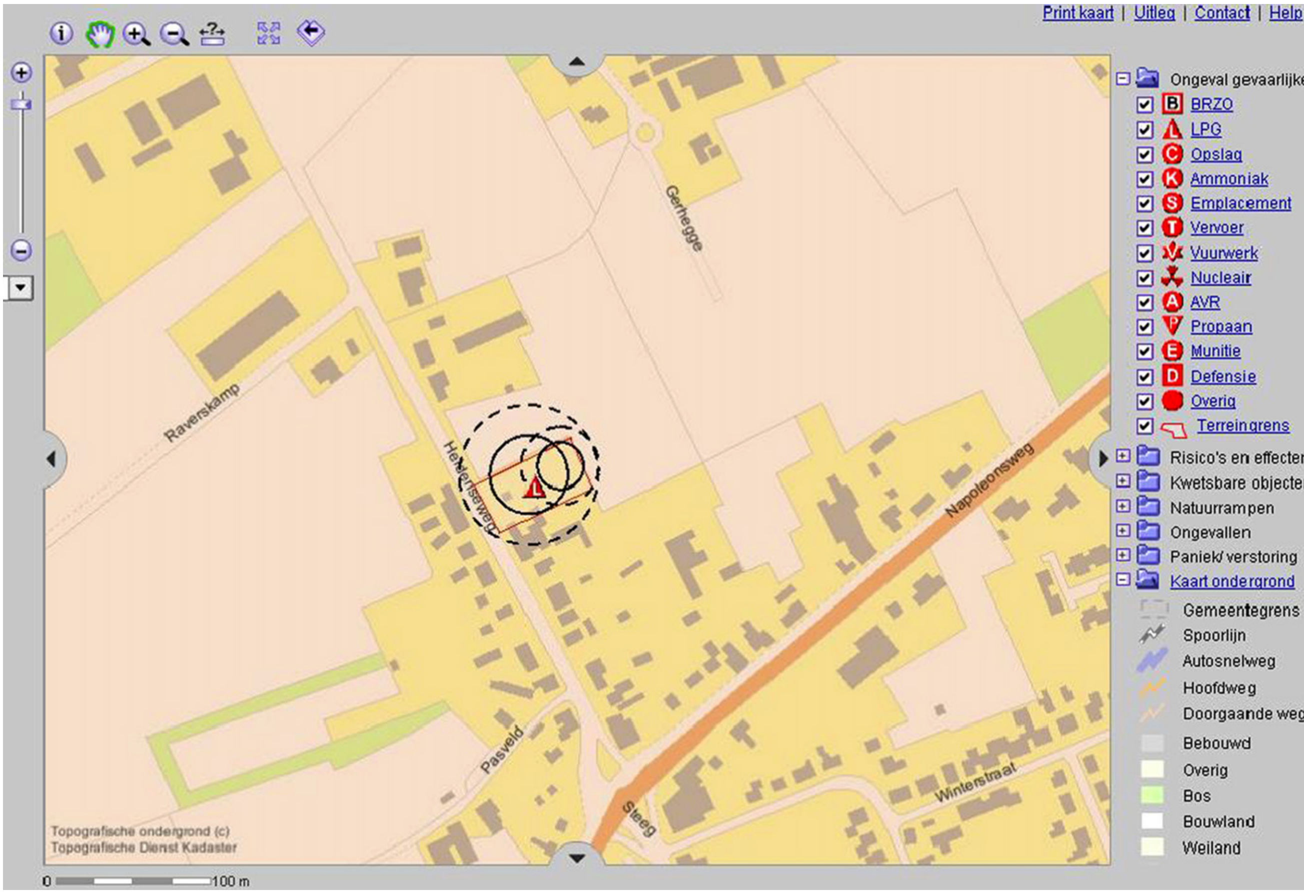

Fig. 2. Risk-map of the Province of Limburg: the plant.

1. the ALARP/ALARA principle, which origin can be retraced in the common-law orientation of the UK legal system [7];
2. the quantitative approach to risk assessment, using both the risk-oriented (in case of toxic release) and the consequence-oriented (in case of thermal radiation and explosions) methods for the definition of "consultation-distances" around plants;
3. the definition of individual risk (IR), in the first case, as the probability to receive at least a dangerous dose (DD) and, in the second approach, to receive a prescribed thermal dose unit (without any probabilistic judgment) account is taken of those local circumstances (such as the prevailing wind direction) that are relevant to estimating the area the hazard will affect;
4. the definition of societal risk as the integration of the IR judgment with population data;
5. the definition of four sensitivity levels for territorial and human targets, supporting the classification of a given area in terms of its specific vulnerability.

The HSE is responsible for the definition of each dangerous installation, of the so-called "consulting-distance", reporting the three inner, middle and outer iso-risk contours. Within this area, the consultation of the agency for planning purposes is mandatory.

4.2. Risk and LUP: the UK decision-making process

Differently than the Netherlands, the UK relies on a strongly centralized Safety Authority, which is the Health and Safety Executive and, in Northern Ireland, the Health and Safety Executive of Northern Ireland. The Hazardous Installation Directorate (HID) of HSE is competent for all hazardous installations in the country and it is involved in planning processes regarding chemical installations, pipelines and explosive facilities. The role of HSE is two-fold: on the one hand, it advices Local Planning Agencies (LPAs) on the Hazardous Substances Consent (i.e. installation and/or modification of Seveso II plants), while on the other hand it gives advice on the compatibility of proposed territorial developments within pre-existing dangerous areas. This second advice is carried out by personnel of the local offices of the HID Directorate and it is supported by a codified system known as Planning Advice for Developments near Hazardous Installations (PADHI), a software that came into force in 2002 in order to facilitate and speed the advising process. PADHI leads to the outputs "ADVICE AGAINST" or "DON'T ADVICE AGAINST" on the base of both risk analysis data (scenarios, risk contours and/or effects areas) and territorial data (type of targets, proposed developments' sensitivity level, population data) [30].

Notably, the HID has no enforcement power: it is entirely under the responsibility of Planning Agencies, which are competent for local land-use plans as well as for granting the license to plants' operators, whether to implement the advice stemming from the PADHI procedure. This advisory role of HSE with respect to planning authorities reflects the nature of UK Health and Safety system, based on a great autonomy of local authorities on the one hand, and on an efficient cooperation among different governmental agencies on the other hand. Standing to this configuration of the decisional process in fact, the two phases of risk assessment and risk reduction are clearly distinguished: LUP decisions may, theoretically, exceed the safety advice both towards a major than a minor safety level. Practically, HSE advices are followed in the large majority of cases and are implemented by LPAs in the almost totality of land-use plans.

The HSE advice is delivered to LPAs in form of risk-map, where the three inner, middle and outer iso-risk or iso-harm areas are represented on the relative cartographic base. As in the Netherlands, both the individual and the societal risk are LUP criteria. Differently, the societal risk is not numerically assessed and compared with numerical risk criteria. The concept refers to general high-density populated areas and/or specific vulnerable targets (hospitals, schools, elderly, children, etc.), which presence has to be considered in order to integrate the judgment resulting from the individual risk criteria. Hence, SR assessment is an integration of the individual risk estimation with population data. Interestingly, this approach to the definition of "societal risk" for modelling major accident scenarios involves a major attention for the vulnerability of the population of a given area. In UK, this resulted in the development of a national database mapping, using a GIS technology, the population distribution with a specific reference to different vulnerability levels. Its development was commissioned by the Methodology and Standards Development Unit (MSDU) of the HSE in 2002 [31]. Focusing on the distribution and characteristics of the population of given areas, it aimed at developing the potential for a GIS system to be used to provide data on the targets at risk from hazardous events. Owned and managed by HSE, no direct public access is allowed. Therefore, in comparison to the Netherlands, the UK risk assessment method, the adopted LUP criteria and the societal risk definition led to the development of a remarkably different risk-informative system, in which it is particularly evident a different risk-maps elaboration and accessibility. These aspects are discussed in the following section.

4.3. Informing LUP process: the role of GIS risk-maps

In the light of the essential role of HSE in the UK land-use planning processes, a review of its method was initiated in

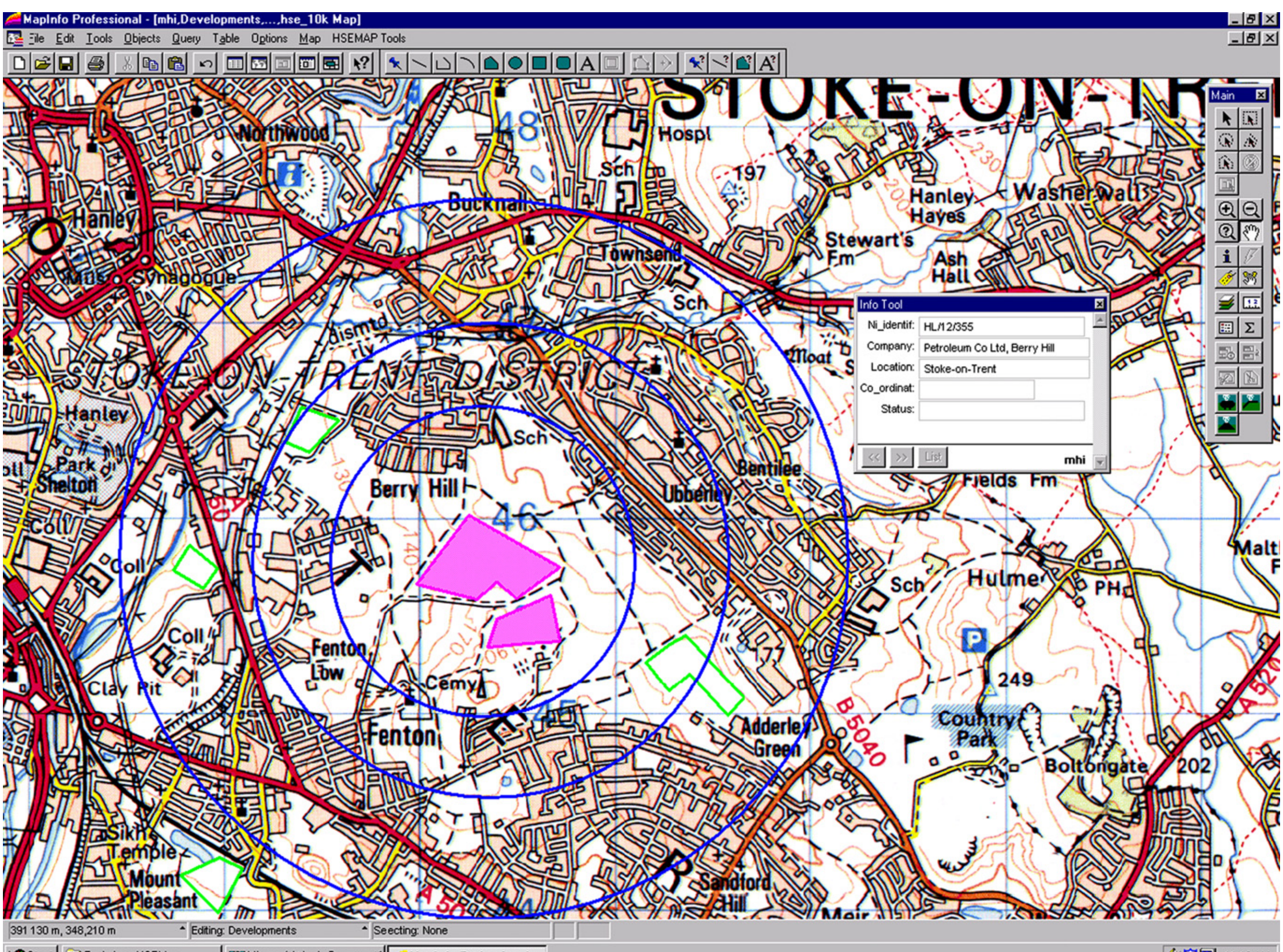

Fig. 3. Example of a hypothetical three-zone risk-map realized in ArcGIS format, representing the case of a toxic substance for which three effects areas with different frequencies values are estimated.

1998 [32]. The review aimed at clarifying whether HSE role and methods were still valid, robust and in line with broader governmental policies for land development. Being the HSE advice still based on the document *Risk Criteria for Land Use Planning in the vicinity of Major Industrial Hazards* of 1989 [28], verifying eventual bottlenecks in the system was advisable. One of the outcomes of the review was the proposal of developing a modified version of PADHI enabling LPAs to carry out risk-related LUP assessments independently. The project has been carried out by the Geographical Information Systems (GIS) team of the Risk Assessment Section of HSL [33]. Within the project, a scoping study involving volunteer LPAs and addressed to explore the format of the HSE advice that could have replaced the ordinary paper format was carried out and published in 2005. Results outlined that a GIS format for risk-maps (called, in the document, "3 zone map") was preferred by LPAs, as they would have had the opportunity of updating their existing database with compatible format data.

The need of facilitating the consultation procedure via GIS-based advices stemmed from the relative frequent update of HSE risk-maps. Each time HSE assessment involves some changes in the risk contours or new developments in the vicinity of installations are promoted, new risk-maps are to be forwarded to LPAs. Hence, evolving to a GIS format represented a natural step of the advice procedure. Other findings of the scoping study were the preference, by the side of LPAs, of the representation of the three-zones in three different GIS layers instead on one layer with three different zones, in order to allow the switch off of different harm/risk areas when desired. Notably, with the came into force of the National Population Database in 2005, an overlap between the three-zones risk-maps and the geographical sensitivity population data is been made possible, enhancing the visualization of all the information relevant to define appropriate land-uses.

4.4. Status and accessibility of risk-information

Differently than in other European countries, the increased security needs deriving from (the threat of) terrorist attacks found in the United Kingdom a prompt translation in limited accessibility to risk-related information. Concerning the specific case of risk-maps, a first remarkable point is that they do not contain neither any reference regarding the substance treated/stored within the plant nor a pinpoint regarding the areas of plants where substances are stored. Maps as the one showed in Fig. 3 report only the three-zones of iso-risk or hazard and the name and address of the hazardous site (Fig. 3). Risk-maps are not directly accessible via the Internet although they can be consulted by the citizens upon request. This can be obtained applying both to the HSE and LPAs. In this second case, a procedure concerning the motivations for which subjects want to access risk-maps may be in place. As a result of the IFRLUP project, during the course of 2006 HSE's risk-maps will be stored on a secure electronic server, accessible by LPAs by setting up a user profile. Citizens will not be granted access to this "map library" but they will still be able to access them via specific request.

5. Conclusions and discussion

In both the examined countries, the potential of geographically based risk-informative systems to represent major risks at national scale is evident. Furthermore, the suitability of shared d-base to connect different institutional actors during decision making processes is of outstanding evidence. In both countries, risk-maps are becoming more central to local risk-prevention practices and GIS databases storing the enormous amount of data regarding the national risk situation came recently into force. Although differences in the two risk regulations led to the development of different forms of cooperation among the several competent authorities, a good connection between the operational competences of Safety and Planning Authorities seems to be achieved.

A notable difference between the two examined countries regards the possibility of accessing risk-maps by the side of the public. In the Netherlands, a notable amount of risk information is available for the public via the Internet. In the UK, although the transparency of decisional processes is guaranteed by the public status of the information, risk-maps can be gathered by the public after a specific request.

This remarkable difference cannot be explained in a univocal way. A first explanation might be a different interpretation of the threat represented by the availability of information regarding the existence and localization of chemical sites in the national territories. Evidently, a different estimation of deriving risks and a different priority assigned to the accessibility of information ground the choice of limiting or allowing the access to risk-maps by the side of public. In this perspective, a different interpretation of the precautionary principle (PP) can be brought into the discussion. As well known, there is no univocal interpretation of the PP and the debate about its feasible use within the risk prevention domain is still lively. In the Dutch case, where the delivery of risk information might lead to an uncontrollable (and not estimable) decrease of security, a more precautionary approach seems to be in conflict with the transparency informing the planning policy. In the UK instead, a major concern regards the confidentiality of industrial information and the protection of the population from the threat of terrorism; consequently, a precautionary approach applies. Both choices have a consequence in the balance between security and transparency. In the Dutch case, the balance hangs for transparency, with a governmental exposure in terms of responsibility for the exposed citizens. In the United Kingdom instead, the 'right to know' of citizens is not interpreted as a passive delivery of risk-information, as the balance hangs for security. Which role, then, for the precautionary principle as a needle of the balance? This question opens to interesting research developments. Generally, the authors believe that the two national orientations are responding to historical heritages and cultural backgrounds.

In the UK, terrorism has been a serious threat during the past three decades, until the recent terrorist attack of Al Qa'ida in 2005. Combined with the traditional confidential attitude of the UK culture, it is not surprising that information which is potentially subject to misuse is carefully protected. Differently, in the recent Dutch history terrorist attacks have been of scarce impact. The risk-regulation policy development shows that the attention given to inform the public lies in the long history of accidental events occurred within densely urbanized areas. In a country with a population density of 450 inhabitants/km^2 [7], which is affected by the prior and constant risk of flood, the full awareness concerning major risks is a key factor of prevention. This explains, at least in part, the tendency of facilitating the access to risk information. In this respect, the choice of binding part of it seems reasonable, as it balances safety and security needs without altering the Dutch political tradition.

In conclusion, the creation of national risk-informative systems on a geographical information platform to enhance the cooperation between authorities and stakeholders seems to be the advisable frontier of European risk prevention practices. Nevertheless, the investigation confirmed that different developments and applications of these instruments are grounded, again, on the political, cultural and historical contexts in which they are created.

Acknowledgments

We are grateful to Helen Balmforth from the Health and Safety Laboratory of HSE (Buxton, UK) for the documents and the suggestions she furnished. We acknowledge the Dutch personnel of the Dutch Ministry of Environment (VROM) for their remarks and corrections.

References

[1] C. Basta, M. Struckl, M.D., Christou, B.J.M. Ale, Technological risk, land-use planning and good governance: towards common principles of good-practice in an enlarged Europe, Proceedings of the Annual Meeting of the Society for Risk Analysis Europe, in press.
[2] V. Cozzani, R. Bandini, C. Basta, M. Christou, Application of land-use planning criteria for the control of major accident hazards: a case-study, J. Hazard. Mater. 136 (2006) 170–180.
[3] J.M.M. Neuvel, E. Van Borkulo, S. Zlatanova, H.J. Scholten, G.J. Beugelink, A. Van den Brink, De geografische dimensies van risicomanagement, Definitiestudie, Wageningen University, Wageningen, 2006.
[4] P. van Oosterom, S. Zlatanova, M. Fendel (Eds.), Geo-Information for Disaster Management, Springer-Verlag, Berlin, 2005.
[5] Directive 96/82/CE on the control of major-accident hazards involving dangerous Substances, Off. J. Eur. Union L 010, 14.01.1997.
[6] W. Bakker, F. Van Waarden (Eds.), Ruimte rond regels Stijlen van regulering en beleidsuitvoering vergeleken, Uitgeverij Boom, Amsterdam, 1999.
[7] B.J.M. Ale, Tolerable or acceptable: a comparison of risk regulation in the United Kingdom and in the Netherlands, Risk Anal. 25 (2005) 231–241.
[8] Directive 2003/105/EC of the European Parliament and of the Council of 16 December 2003 amending Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances, Off. J. Eur. Union, 31.12.2003.
[9] M. Smeder, M.D. Christou, S. Besi, Land use planning in the context of major accident hazards, an analysis of procedures and criteria in selected EU Member States, Report EUR 16452 EN, Institute for Systems, Informatics and Safety, JRC ISPRA, 1996.
[10] M.D. Christou, A. Amendola, M. Smeder, The control of major accident hazards: the land-use planning issue, J. Hazard. Mater. 65 (1999) 151–178.
[11] A.V. Jones (Ed.), The Regulation of Major Hazards in France, Health and Safety Executive, Germany, Finland and the Netherlands, 1997.
[12] T. Horlick-Jones, Meaning and contextualization in risk assessment, Reliab. Eng. Syst. Saf. 59 (1998) 79–89.
[13] C. Vlek, A multi-stage, multi-level and multi-attribute perspective on risk assessment decision-making and risk control, Risk Decision Policy 1 (1996) 9–31.
[14] S. Contini, F. Bellezza, M.D. Christou, C. Kirchsteiger, The use of geographic information systems in major accident risk assessment and management, J. Hazard. Mater. 78 (2000) 223–245.
[15] J.E.T. Moen, B.J.M. Ale, Risk maps and communication, J. Hazard. Mater. 61 (1998) 271–278.
[16] P.H. Bottelberghs, Risk analysis and safety policy development in the Netherlands, J. Hazard. Mater. 71 (2000) 59–84.
[17] B.J.M. Ale, Risk assessment practices in the Netherlands, Saf. Sci. 40 (2002) 105–126.
[18] A. Van der Valk, The Dutch planning experience, Landsc. Urban Plan. 58 (2002) 201–210.
[19] A. Faludi, A. Van der Valk (Eds.), Rule and Order, Dutch Planning Doctrine in the 20th Century, GeoJournal Library, vol. 28, Kluwer Academic Publisher, Boston, 1994.
[20] Commissie Onderzoek Vuurwerkramp, De vuurwerkramp, Eindrapport, Phoenix en Den Oudsten, Rotterdam, 2001.
[21] Major Accident Reporting System (MARS), Joint Research Centre, Institute for the protection and the security of citizens, Ispra, http://mahbsrv.jrc.it/mars/Default.html (online), March 2006 (last visited).
[22] T. Wiersma, W. Roos, M. De Wit, Gebiedsgericht groepsrisico Groepsrisico op een kaart, TNO, Apeldoorn, 2005.
[23] V.R.O.M. Ministerie van, Handreiking ruimtelijke ordening en milieu voor ruimtelijke plannen, Ministerie van VROM, Den Haag, 2005.
[24] European Commission, COM (2004) 702 final, Critical Infrastructure Protection in the Fight Against Terrorism.
[25] A. Gouldson, Risk, regulation and the right to know: exploring the impacts of access to information on the governance of environmental risk, Sustainable Dev. 12 (2004) 136–149.
[26] Dutch Cabinet, Kabinet wil effectafstanden risicokaarten van Internet, Press Release Ministerraad, 9 September 2005, http://www.regering.nl/actueel/nieuwsarchief/2005/09September/09/0-42-1_42-70961.jsp (online), March 2006 (last visited).
[27] R.P. Pape, HSE assessment for consultation distances for major hazard installations, in: F.P. Lees, M.L. Ang (Eds.), Safety cases within the CIMAH Regulations, Butterworths, 1989.
[28] Health and Safety Executive, Risk Criteria for Land Use Planning in the Vicinity of Major Industrial Hazards, HMSO, UK, 1989.
[29] HSE, HSE Current Approach to Land Use Planning (LUP), 2004, http://www.hse.gov.uk/landuseplanning (online), March 2006 (last visited).
[30] HSE, PADHI—HSE's Land Use Planning Methodology, 2005, http://www.hse.gov.uk/landuseplanning/padhi.pdf (online), March 2006 (last visited).
[31] G. Smith, C. Arnot, J. Fairburn, G. Walker, A national population database for major accident hazard modelling, HSE Research Report 297, 2005.
[32] HSE, Implementation of the Fundamental Review of LUP, 2005, http://hse.gov.uk/landuseplanning (online), March 2006 (last visited).
[33] H. Balmforth, Scoping study for 3 zone map delivery to Local Planning Authorities, HSL Research Report RAS/05/01, 2005.