ARAMIS Project: Achievement of the Integrated Methodology and Discussion about Its Usability from the Case Studies Carried Out on Real Test Seveso II Sites

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1 Introduction

Some recent technological accidents like Enschede (2000), Toulouse (2001) or Lagos (2002) have led the public to wonder or even mistrust both the industry and the regulatory authorities in their risk-informed decisions. The communities want now to be informed and require more transparent decision-making processes. Risk-based decisions of course require some reliable scientific input from risk analyses. But from one risk analyst to the next, noteworthy variation exists in the results, which would affect any relevant and local decision (ASSURANCE project, 2002). That is why emerges today the need for a methodology giving consistent rules to select accident scenarios and taking into account safety management effectiveness for risk control demonstration. In the context of Seveso II directive, there is also an underlying need for a method that could reach a consensus amongst risk experts throughout Europe.

ARAMIS overall objective is to build up a new Accidental Risk Assessment Methodology for Industries that combines the strengths of both deterministic and risk-based approaches. Co- funded under the 5th EC Framework Programme, this three-year project started in January 2002. A mid-term workshop was already organised in June 2003 in Maastricht and aimed at disseminating first results and collecting comments from the audience. One year later, the basic methodology is achieved and aims at becoming a supportive tool to speed up the harmonised implementation of SEVESO II Directive in Europe. This paper intends to summarise the major features of the methodology and to show how the needs of ARAMIS potential users were addressed. In a second part, the objectives of the case studies that are presently under progress will be discussed.

Five main tests will be carried out on industrial plants, in countries with a consequence-based approach (France and Denmark) and a risk-based approach (Netherlands). The full test of the method in two future EU countries (Slovenia and Czech Republic) should also contribute to the dissemination process towards these countries, whose issues in terms of risk management can be slightly different from those of western-European countries.

2 Needs of potential ARAMIS users

The potential end users of ARAMIS are numerous but the most concerned are the industrialists, the competent authorities and the local authorities. If all of them have an interest in the same risk management process, their needs are slightly different. Industrialists need a method to identify, assess and reduce the risk. This method has to be accepted by the competent authorities. This method also has to bring useful information about the ways to reduce the risk and **toman** age it daily. The competent authorities need to be able to assess the safety level of the plant, particularly through the safety report. They need to know why scenarios have been kept for modelling of consequences. Both need to assess the influence of the management on the safety level. The industrialist to be able to improve its management to reduce the risk and the competent authority to assess a true risk level which takes into account this major influencing factor. About 80% of the major accidents have causes related with human and organisational factor, which is a sufficient reason to take these aspects specifically into account.

The local authorities are interested in land use planning issues. They need to have a clear report about the risks or hazards their population actually faces. They also want to get information that can be used as a decision-aiding tool to define priorities or choose among alternatives. Basically, their capacity is about reducing vulnerability either by limiting the number of targets exposed to the risk or by introducing obstacles between the source and these targets. They also need to trust the industrialists and competent authorities when they propose risk or consequence-based contours from scenarios.

The aim of **ARAMIS** was to answer all these needs. It was also to make the convergence between the deterministic approach and the probabilistic approach and to resolve some difficulties inherent to each of them. These limitations have been discussed by Christian **Kirchsteiger [Kirchsteiger 99].** As far as the deterministic approach is concerned, the limit deals with the difficulty to justify the choices of the reference scenarios used for land-use planning decisions. Most of the time the selection is not about worst-case scenarios but an implicit choice is made to eliminate those which seem too improbable. For the probabilistic approach, the difficulty resides both in producing the probability data and in interpreting the results to take appropriate decisions. ARAMIS does not completely solve these difficulties but furnishes the tools and the structure to improve decision-making. It also provides a framework for the definition of further research programs as discussed in the last paragraph.

3 Main features of the ARAMIS methodology

ARAMIS is divided into four major steps (figure 1).

1. **Definition** of the reference scenarios
   - identification of the major accident hazards **(MAH)**
   - definition of safety systems
   - definition of the reference accident scenarios (RAS)
2. Assessment of the management efficiency
3. Risk severity mapping from the set of Reference Accident Scenarios
4. Vulnerability mapping representing the sensitivity of one plant's surrounding environment

A last step involves the crossing of this information for decision making

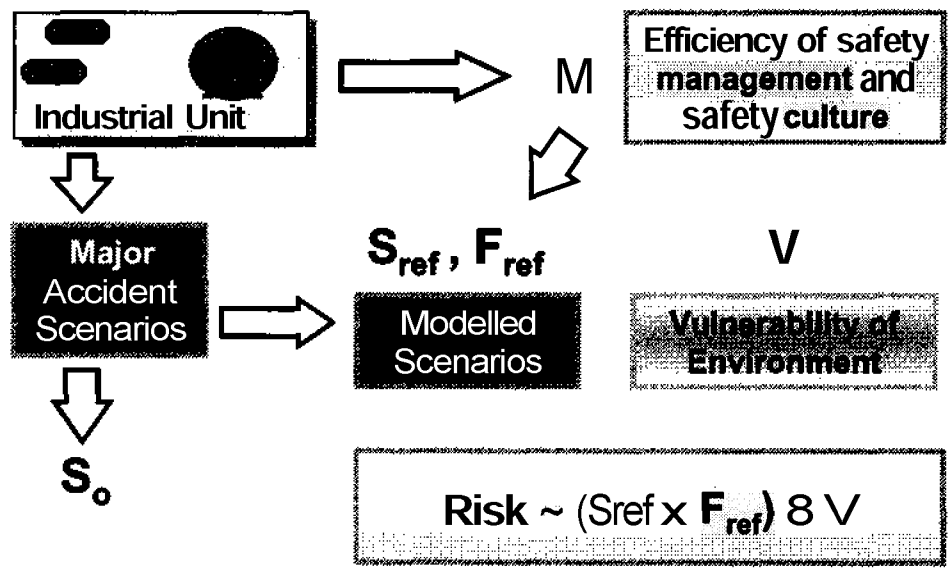


Figure 1: Summary diagram of the ARAMIS methodology

3.1 Identification of the major accident hazards (MAH)

MIMAH [Delvosalle 04] is the method for the identification of major accident hazards. It is based mainly on the use of bow-tie diagrams (figure 2), composed of a fault tree and an event tree. The major input of ARAMIS was to define a precise bow tie structure and to define precisely and exhaustively the list of equipment, potential critical events and their consequences. The critical events were defined to be either losses of containment for fluids or losses of physical integrity for solids. The complete list contains twelve critical events including breach, collapse, explosion, etc.

From a description of the plant including the chemical substances used, produced or stored, it is possible from **MIMAH** to list of all the critical events susceptible to occur in the plant. Then, for each of these critical events, MIMAH allows to identify all their consequences in terms of secondary events and dangerous phenomena.

Then, MIMAH provides the user with a set of generic fault trees, which are based on the most frequently observed causes. From these generic fault trees, the user will build specific fault trees that take into account the specificity of his plant: types of process used, presence of equipment, etc. The specific fault trees are obtained mainly by the suppression of causes and consequences which are not relevant to the context without any consideration on probability at this stage. It is important to notice that both the fault and event trees are considered without safety barriers, which will be defined in the next step of the method. This has the advantage to make an explicit distinction between hazard and risk. This first step allows the identification of hazards. The next one aims at identifying the risks which result from the hazard scenarios and the failure of safety barriers.

3.2 An alternative to classical probabilistic approaches

Standard risk analysis methods propose to assess the probability of major accident and to decide from this evaluation whether the risk is acceptable or not. But, during the **ARAMIS** project, this calculation of the probability was shown not to be an easy task. An inventory of the probabilistic data sources was carried out. It turned out that many of the available data are not adapted for use with the tools developed in the first steps of the methodology. Others were obtained by statistical methods in limited geographical areas like the Netherlands and are therefore not extendable to the whole Europe. Only very generic frequency ranges could be obtained for the critical events' causes, which hindered the possibility to rely solely on the probability of events.

However, one main objective of ARAMIS was to valorise through contextual frequency data the efforts realised by the operators both in prevention and mitigation. Generic frequencies of critical events are not suitable for that purpose and contextual frequency data is hardly available onsite.

An alternative method was proposed, which focuses on generic values on safety systems and clear guidelines to lower the final frequency of identified scenarios. First, it aims at helping the user with the definition of the safety requirements applying to its plant. These requirements are defined according to the initial risk level without barriers. This means that an initial coarse calculation of the probability is made and that a consequence level is assigned to the major effects independently to any vulnerability of the surroundings. Then, the method helps the user to define the safety barriers [Debray 04] by promoting the concept of safety function and by providing different possible strategies of barrier implementation for a given safety function.

The frequencies of resulting scenarios are then evaluated from the frequency of the initiating event the probabilities of failure of the different safety barriers implemented, according to principles derived from the **SIL** concept (Safety Integrity Level) available in IEC **61508-61511** standards. Among the scenarios, which result from the application of the safety barriers, only the phenomena that range from 10^{-6}**/year** to 10^{-8}**/year** (figure 2) are kept for further calculation of risk severity. These are called the Reference Accident Scenarios (RAS).

3.3 Defining the safety requirements

As it can be understood from the previous paragraph, the definition of the safety requirements is a keystone of the ARAMIS methodology. The proposed method is inspired by the IEC 61508 standard. The idea is to guide the user in the identification of the risk reduction goal that should be associated with different scenarios (table 2). This approach has a triple interest. It helps the user improving its management of risks by defining clear targets. It helps the competent authorities checking the risk reduction for the same reasons. It provides an evaluation of the residual risks. The way it was built also reduces the stress put on the quality of probability values.

To define the safety requirements, four consequence classes were defined and associated to the major effects independently from the intensity of the considered phenomenon. For example, a fireball will

always be assigned a consequence class C4 (irreversible injuries or death outside the site) whereas a jetfire could only be considered as C2 (Injuries leading to hospitalisation). The consequence classes also reflect the possibility of domino effects. In this case, the consequence class attributed to a given phenomenon is increased potentially generated by escalation.

The risk graph (IEC 61508) in figure 2 sets then the levels of confidence in the barriers which should be applied to reach the safety objective, i.e. the risk reduction goal defined in the matrix, namely to make the risk residual or even negligible. This risk graph takes also into account an exposure frequency parameter - (T_1 if the targets are exposed less than 10% of the time T_2 otherwise) and a parameter linked to the capacity to avoid the consequences (kinetics is long enough and emergency measures are robust enough). The frequency classes are linked to the initiating event of the scenario and ranges from P_A ($F<10^{-4}$/year) to P_D ($F>10^{-2}$/year).

Once this work carried out in risk analysis, the resulting dangerous phenomena can then be ranked according to their classes of probability and consequences.

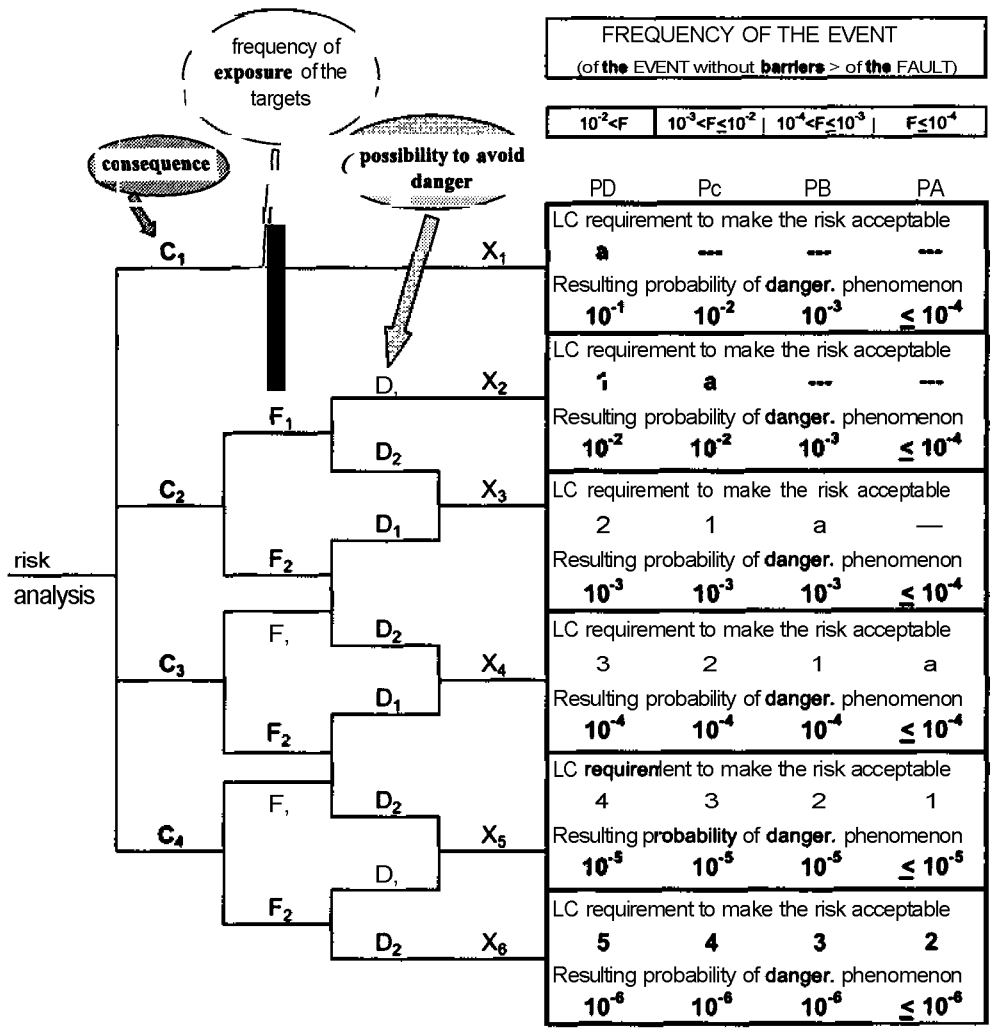


Figure 2 : Risk graph. It determines the required LCs (Levels of Confidence) to make risk acceptable as shown in figure 3

The Risk Matrix in figure 3 has been devised for this purpose. The middle zone highlights the scenarios that can be selected for quantitative modelling then risk severity mapping. The upper zone means that not enough barriers have been implemented and risk cannot be tolerated. The lower zone finally states that enough layers of protection are present in order not to select the scenario for e.g. land-use planning purpose but rather emergency planning. The limits were proposed within the project from our extended review but they should be discussed in principle in each country.

Level of Confidence in a barrier	*Risk Reduction Factor*	*Equivalent Probability of Failure on Demand (PFD)*	*Equivalent probability of failure per hour*
4	10 000	$\geq 10^{-5}$ to $<10^{-4}$	$\geq 10^{-9}$ to $<10^{-8}$
3	1 000	$\geq 10^{-4}$ to $<10^{-3}$	$\geq 10^{-8}$ to $<10^{-7}$
2	100	$\geq 10^{-3}$ to $<10^{-2}$	$\geq 10^{-7}$ to $<10^{-6}$
1	10	$\geq 10^{-2}$ to $<10^{-1}$	$\geq 10^{-6}$ to $<10^{-5}$

Table 2: Definition of the Levels of Confidence in the barriers

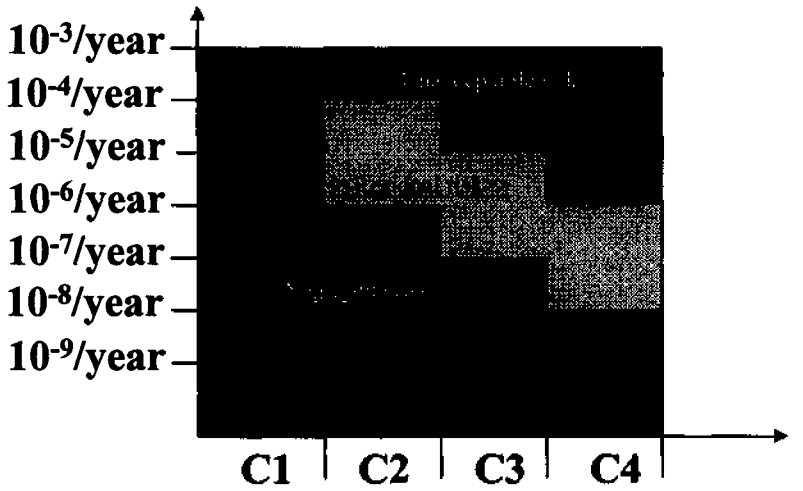


Figure 3: Risk matrix used for ranking the dangerous phenomena and selecting the Reference Accident scenarios for the risk severity mapping

For any risk path (i.e. scenario) composed of a minimal cutset in the fault tree and a branch of the event tree, a couple of exposition level $\mathbf{X_i}$ and event probability Pj can be calculated. For each of them, the risk graph proposes a value of confidence class to be reached by the entire set of barriers applied to the risk path. When several barriers are applied on a single risk path, the confidence class is the sum of the individual confidence classes of the barriers.

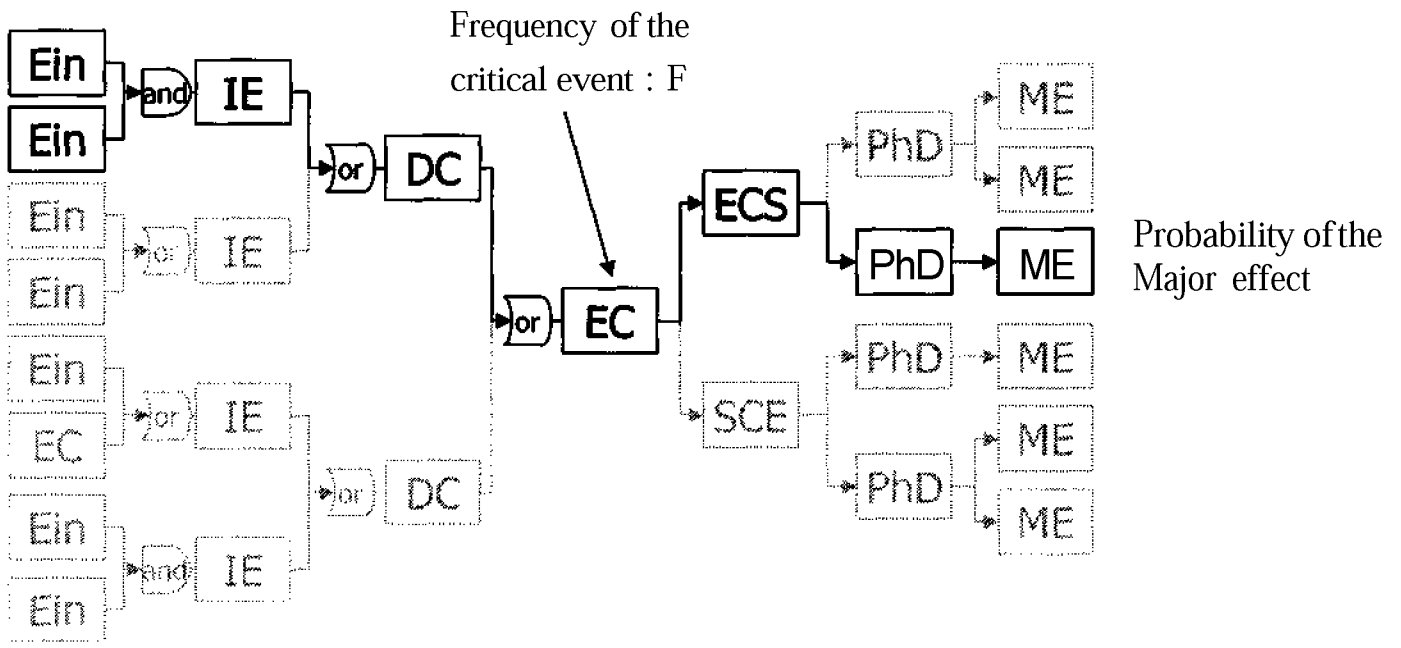


Figure 4: Risk path considered for use in the risk graph. Barriers can apply either on the left-hand side (prevention) or the right-hand side (mitigation) of the bow-tie

The bow-tie diagrams turn out to be a very **powerful** tool to communicate about risks, in particular towards non-technicians (managers, politicians, etc.). However building-up a bow-tie could become very rapidly quite time-consuming. That is why in the context of **ARAMIS,** we also searched for a method to select the most appropriate equipment and critical events within an entire plant to build up bow-ties upon. This is also part of the MIRAS methodology.

Allocating risk reduction objectives and evaluating explicitly the performance of each safety barriers is a very fruitful work to be performed in risk analysis, especially for the operators. It allows to discuss directly the safety strategies onsite through the architecture and implementation of barriers. The levels of frequency derived from the **SIL** principles also allow to use quantified data when these exist but also qualitative estimation from work group judgement when no data is available. This allows a maximum flexibility but requires anyway at some stage a consensus about the initiating event frequencies and barrier levels of confidence in order to ensure a minimum variability in the resulting evaluation of scenario frequencies.

3.4 Assessing the influence of management and safety culture

The management has a strong influence on the capacity to control the risk. Here again, the interest of **ARAMIS** is to provide tools to assess the safety management system (SMS) and the safety culture and to allow their taking into account by the competent authorities as well as to help the operators identify the opportunities for improving safety management. The approach in ARAMIS **[Duijm** 04] consists in devising a process-oriented audit protocol focusing on the activities relating to the life cycle of the safety barriers. This life cycle includes design, installation, use, maintenance and improvement activities. For each, ten important structural elements are evaluated as requirements for the SMS. The outcomes of the audit are then compared to the results of a safety climate questionnaire collected from employees in order to get a contextual level of confidence, in particular regarding behavioural barriers. The questionnaire is made up of eight cultural factors that characterise a company's safety culture.

- learning and willingness to report
- safety **prioritisation,** rules and compliance
- leadership involvement and commitment
- risk and human performance limitation perception
- felt responsibility
- trust and fairness
- work team atmosphere and support
- motivation, influence and involvement

From paragraph 3.3, each type of barrier is given a generic level of confidence indexed on its probability of failure on demand. These indicative values require then to be adjusted from the local context where they are implemented and maintained. For instance for a behavioural barrier, we would like to adjust the generic **confidence** in the barrier depending on whether the operator knows the stakes of his actions, or his decisions require complex diagnosis, conflict with production. The aim of the **project** was also to aggregate the results from the auditing and use of questionnaires into a final score for adjusting -possibly lowering- the generic values into contextual ones.

This link and the whole scoring process is obviously an ambitious goal and still needs to be worked out in the project. The case studies already help getting some benchmark between different types of management and will allow eventually to propose a set of "minimum requirements" for both the culture and management system in order to anchor a first scoring scale. This remains however an important area of research.

3.5 Risk severity assessment and mapping

Each reference accident scenario (RAS) is defined by an initiating event that leads to a critical event, which can potentially lead to different dangerous phenomena. For each phenomenon, a specific severity index has been defined [Planas **04].** The aim is to measure and compare the severity of any dangerous effect with a single scale ranging from 0 to 100. This should allow the comparison of risks of different nature. Depending on the phenomenon, different severity levels were associated to different amplitudes of the considered phenomenon.

Table 3 presents an example of severity values associated with intensities of dangerous phenomena. The user is free to use any model he considers relevant for modelling intensity along distance.

S_{DPI}	*Overpressure* ***(mbar)***	*Radiation* ***(W/m²)***
0	0	1
25	30	1800
50	50	3000
75	140	5000
100	250	8000

Table 3 : Severity levels associated with different intensities of effects

One major difference between ARAMIS and usual quantitative risk assessment is our purpose to study separately the vulnerability and the severity from the potential accident scenarios. In this respect, we could not use any Probit function to quantify the severity but had to define thresholds for each

phenomenon (table 3) in order to characterise intensity. Even though these thresholds can sometimes be derived from Probit functions (thermal load and toxic load), they above all require consensus first from the competent authorities of the Member States, which we do not have for the moment.

For each RAS, a risk severity map is then produced. Risk severity is defined for one scenario as the combination of the level of frequency with the intensity of the effects. The combination of risk severity with the vulnerability of the targets produces the actual risk. Risk severity can be represented for each scenario in a geographical way, as a function $S_{RAS}(d)$ of the distance from the source term.

$$S_{RAS}(d) = \sum_{i=1}^{n} \left(P_{DP_i} \cdot S_{DP_i}(d)\right) \qquad \textbf{Eq. 1}$$

In this equation n is the total number of dangerous phenomena *(DP)* associated to the RAS; P_{DPi} is the probability of occurrence of each DP_i; and $S_{Dpi}(d)$ is the specific severity index associated to the DP_i.

The final mapping of risk severity is then obtained by multiplying the frequency of each RAS with its **specific** risk severity index:

$$S(d) = \sum_{i=1}^{n} f_{RASi} \cdot S_{RASi}(d) \qquad \textbf{Eq. 2}$$

Where n is the total number of dangerous phenomena considered taking into account all the RAS corresponding to the installation. More elaborated formulas were proposed for **anisotropic** risks.
Risk severity mapping as it is defined makes sense and gives very useful information to a decision-maker to elaborate relative priorities for land-use or emergency planning purposes. It also makes sense to disconnect the vulnerability study from the hazardous installation for the same reasons. However, the range of values obtained with such an approach still requires to be interpreted. We now rely on the case studies to help characterize the magnitude of this value and eventually define some references for the global risk severity index by the end of the project.

3.6 Assessing the vulnerability

The last innovative attempt from ARAMIS is to address the vulnerability of the environment independently of the hazardous site [Tixier **04**]. This has the fundamental interest of allowing the local authorities to take useful decisions to reduce the global risk level by reducing the vulnerability whereas the industrialist only can act on the potential hazard or risk of the installation.

The vulnerability is calculated on the basis of a **multicriteria** decision-aiding approach **(AHP, Saaty)**. With the development of new ways of governance involving local population in risk-informed decisions, the main interest of this approach is to base the vulnerability study on any stakeholder risk perception through expert judgement elicitation. On a given spot of the environment, the vulnerability is thus characterised by the number of potential targets and their relative vulnerability to different phenomena. The global vulnerability is a linear combination of each target's own vulnerability.

$$V_{global} = \alpha.V_H + \beta.V_E + \gamma.V_M \qquad \text{Eq. 3}$$

Then, each type of vulnerability is a linear combination of the vulnerability to each type of effect.

$$V_H = a,.V_H^{surp} + \alpha_2.V_H^{tf} + \alpha_3.V_H^{tox} + \alpha_4.V_H^{poll} \qquad \text{Eq. 4}$$

For each effect, the vulnerability is a linear combination of vulnerabilities on different types of impact (health, economical, psychological impact).

$$V_H^{surp} = x_1^H.VH^{surp,san} + y_1^H.VH^{surp,eco} + z_1^H.VH^{surp,psy} \qquad \text{Eq. 5}$$

For each type of impact, the vulnerability is also a linear combination of the numbers of different types of target components. For example, the human target is composed of staff onsite (H_1), local population (H_2), population in an establishment receiving public (H_3), users of transportation ways (H_4).

$$V_H^{surp,san} = a_1^{H\ surp,san}.H_1 + b_1^{H\ surp,san}.H_2 + c_1^{H\ surp,san}.H_3 + d_1^{H\ surp,san}.H_4 \qquad \textbf{Eq. 6}$$

The quantification factors Hi are normalised to fit into a 0 to 1 scale.

The application of the methodology has generated a questionnaire that can be used or adapted very locally to elicit from any stakeholder judgement their own perception of vulnerability. The equations have been then interfaced to **GIS**[1] tools **(MapInfo, Arc** View and Geoconcept) for easiness of target inventory and **quantification.** The GIS allow a very quick mapping of felt vulnerability (figure 5).

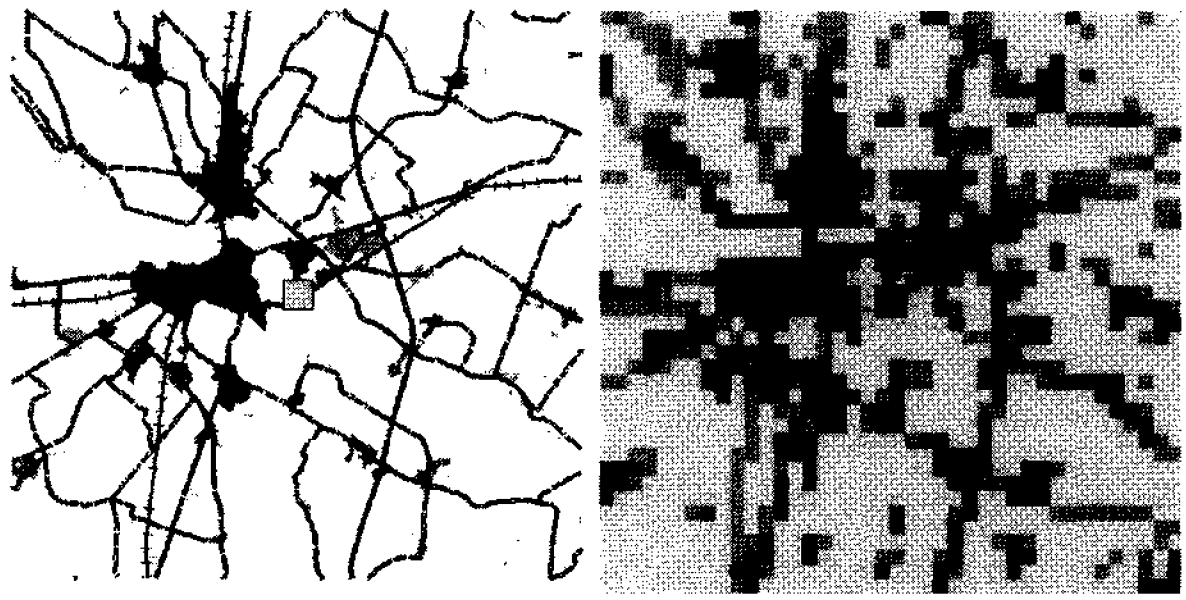


Figure 5: human vulnerability map (right) obtained from the land cover information (left)

The tool is very flexible and offers a large range of available maps considering the type of decisions to be taken: per type of target, per type of effect or overall maps. The figure 5 shows an example of human vulnerability drawn from the available land-cover information.
Even though it is interesting to base the vulnerability study from the stakeholders risk perception, the outcomes (i.e. the quantification factors) can be discussed. For a relevant discussion, a sensitivity study should have been carried out within the project. The case studies will be used to some extent for that purpose but will not be developed in-depth enough to get precise answers during the project.

4 Cases studies

ARAMIS has now reached a certain degree of completeness, which allows to consider its test through different case studies. These are now under progress in different countries of the European Union. The following paragraphs make a summary of what is expected from these case studies and how they will be carried out.

4.1 Objectives of the case studies:

The case studies have several complementary objectives. The first one seems obvious. It is to check the applicability of the method. This will be done by addressing the following issues:

a **Is the global method understood by the users ?** The different modules of ARAMIS were developed by partners of different European countries and different scientific or industrial cultures. It is now a big challenge that the global method be understood and applied by industrialists, competent authorities and local authorities.

a **Are the data needed by the method easily available ?** A particular focus will be put on frequencies of events for which it was very difficult to obtain **trustable** generic data and on data about the confidence levels of safety barriers. But the same can be true with the geographical information required for the evaluation of the vulnerability, or even information on the process needed for the calculation of consequences.

a Are the links between the different ARAMIS modules easy ? Different partners developed the modules of the method and, despite a good communication during the development process, only the case studies can give the evidence that the outputs of one module really are an input to the next module. No doubt that some adjustments will be made after the case studies.

[1] GIS : Geographical Information System

Beyond the applicability, the case studies will also consider the efficiency and the relevance of the whole methodology:

- **Is the method as efficient as already existing risk analysis methods ?** This question will be answered by comparing the results obtained by using **ARAMIS** with the results obtained by methods such as **H AZOP** or **FMEA.** Even if no other method has the same level of integration as ARAMIS, which treats in a consistent way all the process of risk management from the source to the vulnerable environment, it is important to check that basic needs covered by traditional tools are also well addressed by ARAMIS.
- **Does the method answer the needs of its end users?** Can the results be easily exploited? This question is of course a major one. As mentioned in the introduction, ARAMIS has several potential users with different needs. Now a key aspect of the methodology is to answer these different needs with a unique method because all actors need to be able to communicate and discuss on common results and information. To answer satisfactorily this question, the case studies take place in different national and industrial contexts. In each situation, the expectations of the local actors were characterised. These will be discussed in the next paragraph.
- **Is the method adapted to different types of industries, different sizes of plants ?** SEVESO II sites can have very diverse activities and **configurations.** The composition of the case study set aims at reproducing this diversity.
- **Is the method adapted to different national contexts?** As a European Methodology, ARAMIS must comply with the requirements and uses of all the countries of the European Union. A particular focus is put on the Newly integrated countries where industrial risk issues may differ from those in the western part of Europe.

4.2 Sites and contexts of the case studies

Five establishments were chosen in five different countries: Czech Republic, Denmark, France, The Netherlands and Slovenia. Each of these countries has its own culture for risk assessment and risk management and faces particular stakes in prospect of a convergent European methodology. France and Denmark have a rather deterministic approach, which has shown some limits, particularly in France with the Toulouse accident. The approach does not allow for flexibility and does not give the opportunity to enforce land-use planning regulations appropriately. The Netherlands is in a different situation. The country has been for a long time a pioneer of the risk-based approach. But the outputs of risk assessment (risk contours or F-N curves) are difficult to visualise then to communicate upon towards decision-makers. For both countries, a barrier-based approach and a distinct mapping of risk severity vs. vulnerability is easier to communicate and structure local negotiation among stakeholders. Czech Republic and Slovenia joined the European Union in May and will face different challenges in applying the Seveso II directive.

The industrial sites are also of different kinds:

- A **refinery,** where fire and explosion hazards will prevail.
- A chemical plant, with hazardous reactions and storage of chlorine and phosgene.
- A chemical plant using ethylene with polymerisation hazards as well as fire hazards.
- A paper mill, with explosion and toxic hazards.
- A hydrocarbon storage facility, with fire and VCE hazards but simple process.

These case studies are only a first step to assess the exhaustiveness of the method by checking whether it can apply to different types of activities and industrial cultures. It will also show to a limited extent the capacity of the method to answer different local needs such as competent authority control or land use planning. From a scientific point of view, the validation process should be much longer and wider but unfortunately cannot extended within the framework of the project.

5 Research issues emerging from the ARAMIS project

The risk assessment method described in this paper, ARAMIS, is the result of a voluntary step towards a harmonised approach of risk analysis on SEVESO II industrial sites. ARAMIS has the ambition to solve some of the difficulties encountered with traditional approaches by providing very practical tools in an integrated methodology. Of course, everything is not completely consolidated yet. Some aspects of the methodology will be clearer after the case studies. But the ARAMIS project already points out the need for an increased research effort in a series of specific fields.

The first of them is linked to the difficulty to find reliable data for the calculation of accident probabilities. Even if the solution proposed in ARAMIS, the barrier approach, reduces the consequences of such a lack, a lot could be done by unifying the efforts of the industry and research institutions to build accessible databases containing useful information that would be complementary to traditional reliability databases. The quantification of the influence of management on the probability of accidents is also a key question, which will not be resolved in the course of the project.

A third field of research relates to the evaluation of vulnerability. ARAMIS already proposes an interesting definition of vulnerability and a set of screening tools to build vulnerability maps. A next interesting result could be to provide more detailed tools to help decision-makers identify what can be done explicitly to reduce the vulnerability.

Other questions were raised by the project such as the definition of the unique risk severity index, which implies to be able to compare different types of effects among them. Suggestions were made in the framework of ARAMIS. But the project also highlights the remaining questions and lack of common agreement on many effect thresholds. The interest of ARAMIS is also to provide the right frame to define both requirements and means of valorisation for this future research.

6 Conclusion

The ARAMIS methodology was briefly described in this paper. It aims at offering an alternative way to the traditional risk-based and consequence-based methodologies for risk analysis by providing a series of integrated tools. These were designed to answer the specific needs of potential ARAMIS users who are industry, competent authorities and the local authorities. They were also elaborated to solve some of the difficulties raised by the lack of reliable data, namely concerning the accident frequencies. By promoting the barrier approach, ARAMIS helps the users define the safety requirements, which apply to its plant, and therefore helps the competent authorities verify the explicit control of risk by the operator. This approach also allows an easy and explicit identification of the reference accident scenarios, making the communication between the stakeholders easier or at least more straightforward and structured. The same should be true with the approaches of the severity and the vulnerability, which are exploited through a clearly understandable graphical representation.

The case studies, which are now under progress, will confirm the achievement of these goals and help resolve some of the difficulties, which remain for a complete integration of the method. They will take place in five European industrial sites. These were chosen to reflect the cultural and industrial diversity that can be encountered now in the newly expanded European Union.

Eventually, ARAMIS also sets the framework and the objectives of future research on diverse specific fields among which are the production of reliable accident frequency data, the quantification of the influence of management on the accident probability, the vulnerability reduction options or the effect threshold definition.

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