LOCAL EMERGENCY AND LAND USE PLANNING IN HAZARDOUS AREAS: AN ITALIAN EXPERIENCE FOR THE MANAGEMENT OF INDUSTRIAL RISKS

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SUMMARY

The paper discusses a number of results about methodological advantages and organizational difficulties in the development of preventive integrated processes to manage chemical risks in Italy, including emergency management procedures and urban planning practices.

Particularly, this paper presents a real case-study concerning prevention activities to manage the chemical risk within a municipality in Lombardia Region, where a significant number of Seveso plants are located. As National and Regional legislations state, the administration where these plants are located has to develop an External Emergency Plan to manage chemical accidents and has to elaborate a Technical Study to define the land use planning around them.

The study is part of a research activity, developed by Politecnico of Milan for the local administration, for the elaboration of prevention strategies on chemical risk that include both emergency procedures and land use planning. This project, which represents how local administration can absorb European and National obligations as far as chemical risk is concerned, was aimed at creating a coordinated chemical risk prevention policy among different competent institutions to manage chemical emergencies. The project took two years under a few intermediate steps, covering methodological aspects as well as applications.

1. AN ITALIAN EXPERIENCE TO MANAGE CHEMICAL EMERGENCIES AND LAND USE PLANNING IN HAZARDOUS AREAS

In order to prevent and minimize the consequences of potential major accidents in hazardous plants, a new jurisdictional context is under development both in Europe and in Italy. Major accidents in chemical industries have occurred worldwide and European Member States have to reinforce their legislation on dangerous activities, as European Seveso Directives state. They are implementing differently, in their legislation, European guidelines and directives in order to safely control and preventing policies for chemical risks.

The Seveso accident in 1976 prompted for the adoption of a legislation aimed at preventing and controlling such industrial activities. In 1982 the first EU Directive 82/501/EEC (so-called Seveso Directive) was adopted. Afterwards, the Seveso Directive was replaced by the EU Directive 96/82/EC (Seveso II) and, more recently, by the EU Directive 2003/105/EC (Seveso III). These Directives introduced a system of prevention from major accidents hazard for industrial activities to reduce the consequences on exposed workers and on the population living outside of the plant.

The first Directive was passed following tragic accidents that occurred in Europe in the Seventies, such as the Seveso disaster and the Flixborough accident, provoking quite serious damages to the plant workers, the local population and to the environment in the surroundings of the installation. This directive aimed at unifying measures adopted by Member States to prevent risks associated to dangerous processes and storage of toxic and flammable substances in some industrial categories within the European Community.

In the following, the 96/82/EC Directive abrogated the previous one while redefining the entire prevention system, by the introduction of a new set of principles, coherently with the development of

the European environmental policy developed in the last two decades. The Seveso II Directive aims at preventing major-accident hazards that involve dangerous substances and at limiting the consequences of such accidents for man (safety and health aspects) and for the environment, when an accident occurs.

This Directive brought several important changes, such as: the enlargement of its application field; the obligation for managers to fully inform competent authorities regarding activities and related risks; the obligation for the industry to draw up a document illustrating the prevention policies and the safety management system adopted; the possibility of domino effects. Moreover, the Seveso II enlarged the scope of prevention to areas outside of dangerous facilities, requiring the local administrations to perform and use planning activities as well as defining guidelines for external emergency plans. The Directive introduced also a new system of inspections and audits to be held by competent authorities and better procedures for informing and involving the local population in decision making processes regarding their residential area.

Since its second amendment, the Seveso Directive applies to industrial sites (industrial activities and storages of dangerous chemicals) where dangerous substances are present in quantities exceeding two sets of thresholds. The recent Seveso III extended the scope of Seveso II Directive to the risks arising from storage and processing activities in mining, from pyrotechnic and explosive substances and from the storage of ammonium nitrate and ammonium nitrate based fertilizers. Starting with the Seveso II Directive some obligations became mandatory for the industries as well as the public authorities of the Member States responsible for the implementation and enforcement of the Directive.

Despite two decades are passed, the panorama of the implementation of the Seveso Directives within European countries is still deeply inhomogeneous, because of different industrial backgrounds and different morphological, political and social contexts. In the majority of the European Countries a regulation has been enforced only recently, influenced by the national culture of risk that determines the governmental definition of risk acceptability as well as its implementation in the local planning procedures. Countries like Italy are facing several problems in applying this European Directive because of the rules and regulations included to define emergency preparedness procedures and land use planning in hazardous areas at the different administrative levels (Region, Province, Prefecture, and Municipality). An example to manage these difficulties is reported in this paper where an Italian experience concerning emergency preparedness process is described.

In order to minimize the consequences of a potential major accident, the Italian Legislation absorbing the Seveso II Directive, states that Prefectures (as local authorities of Public Security) have to develop an External Emergency Plan to manage serious crisis situations caused by industrial accidents that have repercussions beyond municipal borders. Moreover, the local Municipality has to develop a Municipal Emergency Plan, for any kind of risk existing in the concerned area, to localize hazards and urban vulnerability and to define a general model of intervention in case of emergency. With reference to the applied case study of this manuscript, the Mayor competent for the Municipality decided to develop a specific Local Operating manual to assess the emergency preparedness as a consequence of possible chemical accidents. The Mayor assigned this complex activity to external researchers (the Authors of this paper) that formed a multi-disciplinary task force to address all the multi-faced aspects of the emergency plan.

During an emergency, the Mayor has to direct and coordinate rescue services and to assist the population. Consequently, the Local operating Manual defines the specific behaviors that the competent organizations and institutions have to apply and implement in case of a serious crisis following an industrial accident. The manual represents a support to the Municipal Emergency Plan, specifying procedures and actions that different local departments and administrative offices have to provide during an industrial emergency.

The design of safe structures and systems determines a satisfactory safety coefficient that is used to achieve reliable systems within the factories. It is nevertheless true that emergency plans and operating manuals, to manage crisis situations inside and outside hazardous plants, represent a valid tool to

increase the control of an industrial accident. Their goal is to prepare institutional organizations and competent subjects so that they make the best possible use of available resources and technologies in order to mitigate the effects of a disaster. Recently, urban and regional planning have been recognized as processes ensuring that land use and urban function control can both reduce the vulnerability of already exposed systems. Also, the Seveso II Directive prescribes the adoption of a preventive policy devoted to the urbanization around hazardous installations.

2. LOCAL TOOLS FOR THE EMERGENCY PREPAREDNESS

The Local Operating Manual was outsourced by the administration to the external competence of a technical university. It specifies the tasks that must be accomplished by civil protection organizations and indicates what the citizens, working or living close to the plant, should to do to protect themselves in case of accident.

In order to define the correct actions and behaviors that the involved actors have to take in case of an accident from a Seveso installation, complete scenarios of event were developed considering the possible effects due to local risks characteristics. Firstly, accident scenarios were simulated by the ALOHA software (from EPA and NOAA, USA [1]), for each Seveso installation considering security systems, chemical substances and products. Secondly, complete scenarios of event were analyzed by considering both expected chemical accidents (or accident scenarios) and elements of urban vulnerability (population distribution, urban development, schools, malls, infrastructures, hospitals, etc.) in order to forecast the expected effects of a possible accident caused by the hazardous release in the surrounding area. Thirdly, emergency procedures for each civil protection subject (Local Administration, Fire Department, Teams of Emergency Care, Police Departments, etc.) were identified on the basis of the elaboration of extended scenarios.

An extended scenario is a more comprehensive typology of scenario, which includes physical, systemic and organizational vulnerability factors. The estimated effects are not only the physical damage, suffered by industry and people, but it is also the entire chain of failures and functional interruptions due to a given level of physical damage on one hand, and to complex interrelations among different systems, on the other hand. These direct and indirect effects affect an industrial area and its population both in terms of time and space.

Starting from these scenarios the Manual was elaborated by defining the actions to be carried out and the behaviors to be adopted, human and material resources to be mobilized, times and places where the emergency is managed. Specifically the manual was articulated in the following sections: Rules, Users, Logistics, Times of the emergency, Instruments and resources, Scenarios, Records and Annexes (see also Table 1).

The first part of the Manual considers the procedures and actions that have to be applied in case of chemical emergency. Rules and Users sections define actions and behaviors that, respectively, institutional organizations (Mayor, Prefect, Firemen, Health Rescuers, Industrial Managers, Police, Local Health and Environmental Authorities) and groups of population (residents, industrial staff, schools, malls) have to adopt during a crisis. A third paragraph describes the places, times and material resources that must be used under emergency. Quantitative and qualitative characteristics of places (Operations Room, Emergency Areas, Roadblocks, etc.) and human resources in terms of abilities, competences and rules (for technical assessments, for communications with media and population, etc.) are reported as strategic elements for the management of the crisis along with distinct moments characterizing the emergency (emergency preparedness, alert, response, etc.). A fourth section reports the extended accident scenarios for each Seveso industry. These scenarios report information regarding chemical substances and their characteristics, areas of damage, etc. Finally, additional information that can be useful to manage an emergency is reported: addresses of lifelines administrators; local survey on industrial activities; extracts from the Municipal Emergency Plan; etc.

In order to integrate both emergency preparedness and response within the manual, a coordination effort was exerted by the Mayor who involved several actors throughout the development of the Local

Operating Plan. At the beginning, collective meetings showed discrepancies between what every actor thought about its role, in case of crisis, and what the others expected him/her to do. Nevertheless, the organization of several meetings produced a collaborative activity and propensity among the actors, based more on mutual knowledge and information exchange, rather than on theoretical expectations derived from abstract laws and regulations. The coordination and the integration of difficulties between distinct institutional organizations (Fire Department, Police Department, Administrative Authorities, etc.) and among institutions and plant managers represented the main organizational effort of the study. The actors were involved along the prevention and planning procedures that are geared to make plans and programs both efficient and reliable. Conversely, the different cultural and scientific backgrounds made comparisons and integrated decisions difficult to develop.

Table 1. Scheme of the Local Operating Manual

Sections	Objects	Contents
RULES	Actions to carry out	Definition of actions that institutions have to perform to manage a crisis
USERS	Behaviors to adopt	Definition of actions that ordinary people have to perform
LOGISTICS	Areas and resources for the emergency management	Identification of strategic areas to manage a crisis
TIME	Scheduling of the emergency phases	Definition of the temporal phases that characterize an industrial accident and the subsequent emergency.
INSTRUMENTS AND RESOURCES	Materials and human resources to use	Description of the tools and competences to manage an industrial accident
SCENARIOS	Scenarios of event	Definition of the main industrial accident scenario accidents for each Seveso installation and its synergies and interactions with the environment.
RECORDS AND ANNEXES	Other information	Extracts and annexes

There are a number of peculiarities, which must be addressed nationally and sometimes even locally, that take into account the specific context where emergency preparedness and urban planning are developed and implemented. For this reason, to develop these tasks and procedures, a number of meetings were organized between local administration and industrial managers. Other “internal” meetings were also organized among the different municipal offices and subjects competent in case of a local emergency. The Mayor, the Technical Office, the Local Police Department with its commanding officer, the Local Responsible for Civil Protection and the Officer of the Local Military Representative collaborated with the authors to develop the Manual and its coordinated procedures. The Manual was completed about one and a half year after the start-up of the project. Nevertheless, it constitutes a risk management tool that should be updated frequently, as it has been conceived and created in a rather flexible fashion.

3. THE CONTROL OF URBANIZATION AROUND MAJOR INDUSTRIAL INSTALLATIONS

The most important innovation promoted by the Seveso II Directive is the requirement of taking into account the risk of major industrial accidents in land use planning. Planning becomes a tool to increase the safety of citizens. Nevertheless, the way to achieve this goal is not clear at all. Safety distances are often mentioned, but there is not a conventional and universally accepted methodology to calculate

such quantities under the European legislation. Treating industrial risks by the adoption of planning tools is a rather challenging task, which can be hardly reduced to the making of distance standards. At the moment, however, it is difficult to think of much better tools capable of providing ideal solutions.

As the Italian law states, areas liable to land use control, for the prevention of industrial risks, are those belonging to the damage areas assessed in the Safety Report developed by the industry for each accidental scenario. These areas are localized and regulated by considering: land use destinations (residences, services, productions, green areas, etc.); urbanization indexes; type of accidental event (fire, BLEVE/fireball, flash-fire, VCE, toxic release, etc.); thresholds of contamination for human health and structures (levels of mortality, reversible and irreversible injuries, domino effects). Starting from these areas a Technical Study is drawn by the Italian Municipalities where a Seveso installation is located (for each Seveso installation), with the final objective of specifying the land use incompatibilities while suggesting directions for new settlements.

With reference to the specific case study, the Regional law contains both the clues reported in the national legislation (regarding the official accidental scenarios and the classes of damages) and a specific hazard score of the industrial activity (operator safety index). Areas exposed to land use control were defined through the official accident scenarios described in the industrial Safety reports. Within these areas, land use control is regulated by the evaluation of the urban and environmental compatibility between the plant and the surroundings. The compatibility is determined on the basis of the definition of classes of use according to the legislation (residence, service, production, green areas, etc.) and the existent urban classes as factors of vulnerability. As far as limitations for new buildings and urbanizations are concerned, the land use control is defined and implemented via the technical (qualitative and quantitative) indication of land use destinations. These indications are then introduced in the ordinary Town Plan.

In general, it can be said that the goal of land use planning in the proximity of hazardous installations is to ensure that the consequences of potential accidents are taken into account every time the decision process deals with: authorization of new installations; extension or modification of existing plants/processes; determination of land uses and proposal of new settlements close to existing installations. In fact, decisions concerning urban development should consider the two dimensions of severity for expected disasters: on one side, the characteristics of the hazard source adopted (technology, chemical/industrial processes, involved substances) and on the other side the vulnerability of the systems exposed to potential accidents (typology and morphology of urban settlements, lifelines, networks, population, etc.). It should be underlined that land is a scarce economic good and that the determination of safety distances must satisfy principles of social sustainability. The determination of land uses in areas next to hazardous installations should deal with the control of risk receptors. Within the decision making process of urbanization control, several conflicting objectives arise whenever hazard control has to be integrated into land use planning. Whilst the main purpose of emergency plans and programs is to reduce organizational and systemic vulnerabilities, land use planning can effectively achieve effective damage reduction, including physical damage to infrastructures and buildings. Land use planning and urban and regional policies adopt what are generally referred to as non-structural and long-term preventive measures [2]. They are non-structural in the sense that they do not correspond to physical engineering works but rather to norms and regulations intended to reduce existing or future levels of exposure and vulnerability.

Land use control, with respect to industrial risk prevention, states that dangerous plants cannot be isolated from their geographical context, since a potential accident may impact large areas outside of the plants. In principle, separation distances between installations and urban areas are enough to guarantee a certain level of safety to human beings and to sensitive environments. High concentrations of dangerous substances in the environment are not the result of emissions only, they depend also on other natural conditions, like winds and meteorological factors determining how long contaminants persist in the same place, or like geological and geo-morphological factors determining infiltration in the water table.

It cannot be forgotten that the origins of modern planning are strictly connected to the outset of epidemiological studies: the so called “hygienists” greatly contributed to the first urban regulations, designed to improve the living conditions of working classes by controlling the causes of epidemics [3]. The latter had to be found in the bad maintenance or even the lack of sewerage systems and of aqueducts, in badly ventilated indoor spaces, in the high concentration of fumes rising from factories. This interconnection, between the two disciplines, provided urban planners with tools to intervene and mitigate the tragically unhygienic conditions of large parts of XIX cities while permitting doctors to verify the recent theoretical achievement regarding bacteria and contagious infections. Both disciplines were looking for solutions to a radically new situation of crowding and rapid urbanization following the Industrial Revolution. The Industrial Revolution had dramatically changed living conditions in urban areas, quantitatively and qualitatively, forcing to find new strategies and new tools for analyzing and evaluating reality. Those tools were granted by medical studies, explaining the many and frequent epidemics in urban areas and the high children’s death rate through the presence of pathogenic agents carried by elements like water and air.

The later development of urban planning, as an independent body of knowledge and technicalities, made planners concentrate on the built-up environment, on urban functions and buildings, while forgetting the relations to the physical systems on which the cities necessarily rely. The conflict between cities and factories was solved by pushing away the latter from urban outskirts, without tackling the problem of how they could be made compatible with residential areas or with other functions. As a result, modern cities have been progressively de-industrialized, but at the price of distributing small and medium industries in the countryside and near minor settlements. Those minor settlements developed following the new job opportunities, thus spreading the mixing of residential and potentially noxious productions over very large areas, posing at a larger scale the same compatibility problem.

Industries and houses sharing the same areas pose today similar problems to those experienced in the XIX century, as a spontaneous process, requiring however new analytic and intervention models, in order to take into account the potential disastrous effects on human health and on the environment. The increasing number and frequency of accidents in the last years can be explained with the fragmentation into smaller units of the huge industrial installations characterizing the economy of the Fifties and the Sixties of last Century [4]. The splitting of risk among a large number of smaller plants reduces expected events magnitude; however, it partially undermines the validity of norms like the Seveso Directive, addressing industries classified on the basis of the quantity of stocked dangerous materials.

Conversely, when analyzing the problem from an urban planning perspective, an area exposed to industrial risk should be considered whenever a dangerous plant is located next to other industries, no matter if they are not classified as “Seveso installation”. Some accidents could in fact originate in one of those close industries and involve the hazardous plants through indirect failure chains (domino effects). But it can be even stated that an external emergency plan should always be an “areal plan”, as it should take into account all the interactions with urban functions existing in the surrounds of the Seveso installation.

When considering existing plants within densely populated areas, a list should be created for prioritizing among the more and the less urgent situations. Each case should be carefully examined to decide which should be relocated: if industries or residential houses or other urban functions involved in case of an industrial accident. It is obviously impossible to take prompt decisions in those cases. However, by knowing the problem it becomes easier to control it while designing a set of alternative solutions, whenever a final decision must be taken. Risk analysis is an important step towards prevention, especially if practical solutions are foreseen on the basis of attended accidental scenarios.

4. SOME CONCLUSIONS: HOW TO INTEGRATE EMERGENCY PREPAREDNESS AND LAND USE CONTROL IN INDUSTRIAL AREAS?

The experience shows that both emergency preparedness and land use planning should be considered as strategic tools to prevent chemical risks. Both these activities should implement a set of technical tools aimed at managing industrial accidents as well as reducing possible damages by means of emergency preparedness, response, recovery procedures, hazard mitigation and vulnerability reduction.

In the proposed method, both the Local Operating Manual and the Technical Study for the land use control are based on scenarios that use maps and forecasts of what may happen to people and the environment within the area of a potential disaster. A choice has to be made concerning the accidents that may occur in a Seveso plant, including fires, explosion and toxic release in air, water, and soil. Consequently, the effects of selected accidents on vulnerable elements must be analyzed and studied. Vulnerable elements should be considered ranging from buildings and networks to the built-up environment and to social and organizational systems. This typology of scenario integrates traditional quantitative hazard analysis with a semi-qualitative vulnerability assessment resulting in a description of forecasted events and chains of events useful to plan and co-ordinate civil defense organizations and to test alternative mitigation strategies.

Starting from these scenarios, procedures of emergency and long-term technical interventions were developed. These activities required different phases of work:

- hazard analysis, involving not only the estimation of accident probabilities but also the severity of the expected event, etc;
- vulnerability analysis of the social, organizational, environmental systems exposed to chemical and industrial risk;
- scenario analysis, resulting from the combination of the expected accident with the vulnerable environment while taking into account the intervention of civil resources;
- analysis of available resources, in terms of civil defense aid, health care system, firemen, etc;
- evaluation of urban compatibility and definition of technical regulation.

Furthermore, technical procedures and interventions should be integrated with social and organizational processes, since such processes influence risk prevention activities [5]. Throughout the elaboration of operating documents, it is necessary to involve institutional and non-institutional subjects who are responsible for civil protection. The hazard communication and risk information to people are of paramount importance in defining the correct actions that should be taken under emergency.

In conclusion, the concept of risk can be summarized in a complex construct including several features regarding distinct individuals, cultural groups and areas. Risks are more collective and public than private and individual, with the consequence that responsibilities and liabilities are much more difficult to assign. These difficulties represent a kind of uncertainty related to legal, situational and social aspects that influence the way through which Society perceives the action of organizations responsible for dealing with risks. Citizens, who were considered as passive subjects to be informed and taught about correct self protection measures, may take now an active part within a more participatory decision making process [6].

The principles described above clearly show how the concept of major accidents hazard mitigation has moved from an activity mainly focused on installations to a more comprehensive approach, based on risk management procedures, internal and external emergency planning, and urban development control. Principles and norms set by the new Seveso III Directive are more effective if inserted in regional and local laws and regulations. In this regard, however, Italy and other European states, are still stepping behind expected deadlines and implementation targets. The latter would have required to translate into specific norms and regulations the general framework provided by the European Council.

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