Integrated Regional Risk Assessment, Vol. II

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Integrated Regional Risk Assessment, Vol. II

Consequence Assessment of Accidental Releases

by

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PREFACE

Industrial development is essential to improvement of the standard of living in all countries. In a given region, old and new plants, processes, and technologies have to coexist. Technological penetration and substitution processes are generally taking place; they are entirely dynamic and this trend is going to stay like this.

People's health and the environment can be affected, directly or indirectly by routine waste discharges or by accidents. A series of recent major industrial accidents and the effect of pollution highlighted, once again, the need for better management of routine and accidental risks. Moreover, the existence of natural hazards complicate even more the situation in any given region. In the past effort to cope with these risks, if made at all, have been largely on a plant by plant basis; some plants are well equipped to manage environmental hazards while others are not.

Managing the hazards of modern technological systems has become a key activity in highly industrialized countries. Decision makers are often confronted with complex issues concerning economic and social development, industrialization and associated infrastructure needs, population and land use planning. Such issues have to be addressed in such a way that ensures that public health will not be disrupted or substantially degraded.

While hazard managers and risk assessors have been successful at identifying hazards and reducing overall risk exposure, economic growth and technological development have led to a new risk situation characterized by:

- an increasing number and variety of hazards
- hazards giving rise to a broad range of partial and temporal risks
- public dissatisfaction with hazards managers and hazards' owners.

Due to the increasing complexity of technological systems and the higher geographical density of punctual hazard sources, new methodologies and a novel approach to these problems are challenging risk managers and regional planners. Risks from these new complex technological systems are inherently different from those addressed by the risk managers of the 1960's and 70's. Recent awareness of environmental problems by a large public has led worldwide to dissatisfaction and to the formation of all kind of pressure groups that do exert a strong political influence and are quite often not ready to accept any compromise. As a result of such approach, interesting and vital research project were stopped (Swiss nuclear moratorium), plans are buried and decisions delayed for many years (i.e., repository for nuclear wastes). Nowadays it becomes increasingly difficult to site new plant facilities which are perceived as risky or undesirable by the local population. Project of national interest cannot be launched or even achieved, once started. On the other hand distrust has become so problematic, that at times, risk managers are no more considered as impartial person, or as reliable source of information regarding risk protection aspects.

It was felt that existing hazard management techniques need to be supplemented with concepts and methods that are integrative at a regional level. Integrated regional risk assessment and safety/hazard management (IRRASM) represents a coordinated strategy for risk reduction and safety/hazard management in a spatially-defined region across a broad range of hazard sources (during normal operation and accidental situations) that includes synergistic effects.

Integrated Regional Risk Assessment and Safety/Hazard Management (IRRASM)

IRRASM is a multi-disciplinary process: engineers, computer scientists and modelers play a central role in the risk assessment stage. Social scientists can contribute with practical advice to the embedding process concerning hazard sources and help communal organizations to deal with such problems, taking into account local economic conditions and political reality. They can make important contributions towards a better understanding of how the practice of regional risk management can meet the needs and expectations of society/community. In this way other kinds of regional planning tasks (for emergency preparedness or remedial actions) or the implementing of utilities as part of the infrastructure (such as canalization network, sewage plants, waste disposal units, power plants and drinking water distribution, etc.) can be integrated more easily after reaching the consensus of agreement of the population.

In view of the above mentioned optic a joint project, *PPR&S (Polyproject on "Risk and Safety of Technical Systems)*, was launched together with the participation of the following institutions:

- ◆ Swiss Federal Institute of Technology, ETHZ (Zürich, Switzerland)
- ◆ Paul Scherrer Institute, PSI (Villigen / AG, Switzerland)
- ◆ EAWAG (Dübendorf / ZH, Switzerland)

There are a number of national and international efforts to deal with risk assessment at the regional level. The ETHZ (Swiss Federal Institute of Technology - Zürich) - "Poly-project on Risk and Safety of Technical Systems" took the initiative to research on various aspects related to regional risk assessment and safety management. A series of basic questions had been asked. Answers had to be given; they had to comprehend the following main issues:

- what is integrated area risk assessment and safety management
- how to define a region/area for study
- type of activities and targets at risk
- objectives and scope
- the need for risk impact indicators
- the need for a comprehensive methodology.

Regional risk assessment and safety management seems to be a medium which helps to integrate people, issues and decisions in area risk assessment.

PPR&S is the discursive description of knowledge in addition to the development of interdisciplinary and practical methods for the application of risk management for a

large variety of technological systems (e.g., rail and road transportation of dangerous goods, chemical plants, nuclear power plants, biotechnology, landfill, etc.). The scope of these applications are to be presented as a book series and is intended to be an integrated regional risk assessment and safety management guideline manual complemented by specialized software, databases, literature reviews and a novel methodological framework with due regard to the existing conditions prevailing in Switzerland. Further goals aimed at in this project are namely:

- i) encouraging and promoting multi-disciplinary work among the different departments and institutes at the Swiss Federal Institute of Technology (ETHZ), Zürich, and among other research institutions;
- ii) establish and confirm the technical competence of the ETHZ in the field of risk and safety of technological systems including their relationship with natural disasters;
- iii) encouraging scientific and academic contacts to other polytechnic institutes universities, industry, governmental agencies, and political institutions within Switzerland and internationally;
- iv) supporting the teaching aims in the interdisciplinary field of risk analysis at ETHZ.

Plans are underway to develop together with the Swiss Federal Institute of Technology of Lausanne, EPFL, a postgraduate study program in the field of "Risk and Safety". For the most part, the PPR&S has now developed from a local to a National interest in disasters' prevention and emergency planning activities.

In the framework of the PPR&S it was decided to collect and review basic technical information and topics concerning the *Integrated Regional Risk Assessment Process* and to publish the results in book form, as being part of a books' series presented under the auspices of PPR&S. This series forms a whole and covers different aspects of risk assessment, management, risk acceptance, as well as legal and societal aspects thereof. The present book, entitled " INTEGRATED REGIONAL RISK ASSESSMENT " is subdivided into two volumes:

- Vol. I : "Continuous and Non-point Source Emissions: Air, Water, Soil", and
- Vol. II : " Consequence Assessment of Accidental releases "

Assessing the risks of a region implies the use of a complex methodology dealing with risks to health and to the environment, normal operation and accidental situations, a large variety of industries, impacts, regulations and actors involved in the decision making process.

As opposed to other existing approaches (e.g., UN- interagency project on risk assessment of large industrial complexes), the PPR&S project took the initiative to design procedural guidelines for IARASM implementation by means of identifying tasks and integrating them into a comprehensive and systematic approach. By contrast, other existing guidelines take a problem solving oriented approach which is too global and does not always assist systematically the analyst or the project manager.

This approach (i.e., task oriented approach) allows a systematic analysis of the problem of regional risk assessment, offers flexibility and efficiency in the implementation process, allows initiatives and ad hoc modeling and simulation.

Integration of risk can not be done through a single risk indicator. Integrated regional risk assessment should be considered as a process whereby decision aiding techniques (ranging from simple brainstorming, the Delphi method to Multicriteria Decision Analysis, and Decision and Knowledge Support Systems) should play an important role. Various techniques have to complement expert judgment, public participation and risk communication. It is a need to balance hard approaches (models, calculations) versus soft approaches (acceptability) in regional risk analysis. In the process of risk integration an important role should be played by the task of comparative risk assessment. PPR&S made successful experiments in working with such tools and approaches.

The advent of new information technology, e.g., artificial intelligence (expert systems, fuzzy logic, neural networks), multimedia, virtual reality, GIS, specialized relational databases, computer graphics, or ISDN technology, would play a significant role in the future of regional risk assessment and safety management practice. The experiments made within the PPR&S with some of these techniques are showing promising results.

The PPR&S project has had important inputs from existing Swiss practice and legislation. The need for a comprehensive regional risk assessment methodology has been highlighted in different occasions during the time of the Poly-project.

Some of the Poly-project lessons we have learned, when dealing with above issues are:

- When getting involved in a regional risk assessment do not take a simplistic approach
- On regional risk assessment, try not to exclude political or human interactions at all stages. Develop a risk triplex, namely: *"safety culture, environmental awareness, and emergency culture"*.
- When running a research or a case study on regional risk assessment do not entirely rely on a self-organizing effect within the project / case study. A strong interactive project management framework is needed from the beginning.
- Due to technical accidents or natural disasters, or their synergism, there is an emerging need for national and international organized research and activities in the above field. Risks from normal operation or from accidents may have some transboundary effects.
- Legal issues at the local level / national level have to be solved and harmonized before any implementation of a comprehensive regional risk assessment methodology.
- There is a need for specialized databases; their use might diminish the uncertainty in results.
- Recent advancements in information and telecommunication technologies (GIS, ISDN), multimedia, virtual reality, neural networks) could play an important contribution to the modeling of various risks.

- In regional risk assessment, all risks (local, regional, global) should be taken into consideration.
- Safety culture, public participation and risk communication are relevant issues in the overall landscape of the regional risk assessment process. Emergency culture, preparedness, and planning is an integral part of regional safety management.

Within the Poly-project we experimented various aspects as previously highlighted. As compared with similar projects in the world (e.g., the UN Inter-Agency on Risk Management), the present work brought new answers to this interdisciplinary subject. Work done within the PPR&S is complementary to the numerous activities developed in Switzerland.

Further information on the Poly-project and its publication series can be obtained from:

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FOREWORD

In recent years, the community has become increasingly aware of the risks of locating hazardous industries near heavily populated environmentally sensitive areas. This new awareness means a novel approach to safety planning for hazardous industries, looking at the problem from the point of view of integrated regional risk assessment, which should include beside the risks arising from natural events (like earthquake, flood, forest fires, etc.) also the risks arising from processing plants, storage and transportation of dangerous goods.

The purpose of *Volume I* is to highlight the main procedures for risk assessment of health and environmental impacts from continuous emissions of pollutants into air, water, and soil referring to normal operation conditions.

Volume II is concerned with the assessment of the consequences of accidental releases. The matter treated should help to find an answer to questions, such as: - what can go wrong?; - what are the effects and consequences?; - how often will it happen?. The main procedural steps are supported by relevant methods of risk assessment recognized on an international level; this document gives also an overview of criteria and guidelines for implementation of risk assessment and management at different stages.

Information contained in Vol. I and II is based on a wide range of scientific publications and references, and particularly on contributions provided by the *Biomedical and Environmental Assessment Division of Brookhaven National Laboratory, USA; UN Inter-Agency Programme (UNEP / WHO / IAEA / UNIDO) on the Assessment and Management of Health and Environmental Risks from Energy and other Complex Industrial Systems.*

Both volumes shall be valuable to students, engineers, and scientists in charge of developing new methodologies for hazard analysis and risk assessment; practitioners active in the field of environmental protection; local or governmental Authorities in charge of implementing environmental risk impact assessment procedures and guidelines.

It should be noted that, although consideration of the continuous emissions from nuclear power stations and other nuclear facilities form an important part of the assessment of the integrated risks from large industrial areas which contain nuclear facilities, they are not considered here. This is because nuclear risk assessments are currently carried out at a higher level than that used for other facilities (e.g., in Switzerland by the HSK, *Hauptabteilung für die Sicherheit der Kernanlagen*, Villigen, CH) and would be available for use in integrated risk assessment at community level.

Complementary readings which are strongly suggested are: "Management and Control of the Environment, (WHO, 1989)" and "Rapid Risk Assessment of Sources of Air, Water and Land Pollution, (WHO, 1982, 1993)", Guidelines for "Integrated Risk

Assessment and Safety Management for Large Industrial Complexes and Energy Generating Systems" (IAEA, 1995).

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LIST OF ABBREVIATIONS

BLEVE	: Boiling Liquid Expanding Vapor Explosion
CEC	: Commission of European Communities
DNIOH	: Danish National Institute of Occupational Health
EDMZ	: "Eidgenössische Drucksachen- und Materialzentrale", Bern, Switzerland
EIA	: Environmental Impact Assessment
FEMA	: Failure Mode and Effect Analysis
HAZOP	: Hazard and Operability Study
HIP	: Hazard Identification Phase
IRASM	: Integrated Area Risk Assessment and Safety Management
NFPA	: National Fire Protection Association
PHA	: Preliminary Hazard Analysis
PHI	: Potential Hazard Index
PSC	: Probabilistic Safety Criteria
QRA	: Quantitative Risk Analysis
RA	: Risk Assessment
SRD	: Safety and Reliability Directorate of the United Kingdom Atomic Energy Authority
UVCE	: Unconfined Vapor Cloud Explosion
WHO	: World Health Organization