

The Environmental Risk Analysis: Risk Assessment and Public Institutions Role

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The term "polluted zones" refers to all those areas in which, after several human activities, it has been assessed the alteration of the natural ground characteristics, determining by a presence of higher concentrations of a polluting agent (the limits in Italy has been established by Italian Ministerial Decree D.M. 471/99 and DLgs. 152/06). The phenomena could be characterized by strongly superficial ground contamination produced by human activities or relevant industrial accident, and the clear activity could only partially giving back to the ground matrix its original functionality.

The environmental risk analysis is a modern technique used for the risk evaluation associated to a polluted area, useful to define different priorities situation during the clear operation, and to characterize different area in the polluted zone.

With this methodology several human and environmental risk connected to the polluting release can be estimated, and make possible to elaborate an appropriate management of the risk.

1. Introduction

The risk assessment is very complex and generally a multidisciplinary approach is needed, using technical-scientific support implemented with many procedures and models.

Also specific protocols and guide-line predisposition are useful to identify human and environmental risk, through appropriates inspecting assessments relative to the characterization and identification of the distance of last positioning of the released dangerous substance, to appraise released dangerous substance toxicity, to estimate the exposure risk for the population, to perform correct communication of the risks, and in general to the risk "management".

The environmental risk assessment is a process that engages several competences and consists in the critical collection of data and information useful to estimate, qualitatively and quantitatively, the impact of dangerous substances and the effect on the population health.

Beginning with the Italian Ministerial Decree n. 471/99 adoption, in Italy, we have been adopted technical and administrative procedures in order to reclaim and to produce environmental restoration of polluted sites. The 471/99 decree collects different criteria and procedures regulations in application of the art. 17 of the D.Lgs. 5 February 1997 n. 22, base-law of waste regulation.

The norm explicitly provides the "Environmental Risk analysis" as a method to realize a reclamation procedure, in case in which the reclamation goals are not succeeded, in terms of Acceptable Limits Concentrations Value (VCLA) for the environmental matrices "with the adoption of the best available technologies and acceptable costs". In particular the term "Analyses of Environmental Risk", considers all the activities useful to determine the risk generated from a polluted site versus public health and environmental state.

After the reclamation activities actuation, the lacked attainment of the VCLA can involve for the polluted site some limitations in terms of urban planning.

The risk assessment is very complex and generally considers several aspects:

- a multidisciplinary approach;
- a technical-scientific support, using several procedures and models;
- operating strategies adoption, focusing the attention to the local specific problematic;
- specific protocols predisposition and guide lines to individuate the risk factor, through appropriate analytical inspecting assessments application useful to discover hazard substances, to appraisal their toxicity, to characterize their last positioning distance in the environmental matrix, and to estimate the population exposure. Finally to perform the communication of the risks. "ASTM (1995)".

The sanitary and environmental risk analysis is an important method in order to resolve the problem of the reorganization of polluted sites and to define specific-site reclamation goals: with this method is possible to calculate the Acceptable Residual Concentrations (CRA), less restrictive of the Acceptable Concentrations Limit (CLA) fixed by the European norm.

Analogous application is possible also for various situations, as the sites interested from incidental events.

In Milan Municipalità, "Comune di Milano et al. (2002)", for a very complex case of territory reclamation activity, a reclamation plan has been written, in which the only sustainable alternative to the site reorganization has been individuated using the environmental risk analysis.

In this context, the application procedure of risk analysis, carried out second using the ASTM E1739/95 RBCA and PS104/98 methodology, has allowed to characterize the necessary safety action, and to estimate different environmental impacts through analytical and numerical previsional models implementation.

Plan COSIMA, "Bollini et al. (1997)", financed by the European Union, has been realized by Bologna municipality, is an ArcView GIS application, useful for the polluted sites census organization. The support system collects and organizes the data to perform the environmental risk analysis, and has been implemented also to assist environmental expert, urban planners, and public administrators in order to identify, and to inventory polluted industrial sites and discharge.

The Regional Agency for environmental protection of the Tuscany, "Franceschini et al.(2004)", examined different software for the environmental risk analysis, verified some models, and subordinate some of these to a sensitivity analysis.

2. The Public Institutions Role In The Environmental Risk Assessment

The DM 471/99 specify the control and the verification for the reclamation activities. In particular the principal Municipality role is to pass the reclamation project and to perform first control phase. The agency deputy to execute the main activity in terms of control is the Province, that draw up the preliminary and definitive characterization plan prepared by the responsible of polluted site. The Province finally attest, with an appropriate certificate, the site reclamation and restoration. To the Region the verification and coordination competences are up.

Regional Agencies for Environmental Protection (ARPA) are involved in the management of contaminated zones after industrial activities or relevant incident and assure the technician, scientific and engineering support, to the Italian Environmental and to the other local Administrations involved in the emergencies management, "APAT (2005)". ARPA assure moreover the ready participation of the emergency teams for the emergencies management support coordinated with the Prefettura (Civil Protection Department, National fire brigades.).

2.1 Polluted sites reclamation

The D.Lgs 496/1993 promoted the total reform of environmental control in Italy, and D.Lgs. n 22/1997 defined the discipline in this field. The art. 17 of the D.Lgs. n. 22/1997, in fact, prescribes the causes of the overcoming concentration values limit, also in accidental way achieved, or the case that could create a concrete contamination risk and give the indication to realize the polluted areas reclamation and restoration. The reclamation global normative system has been established the reclamation obligation, active in the pollution cases for the soil, sub-soil and waters, in the case of only one of the parameters overcoming contained in table 1 of the D.M. n. 471/1999. "Repubblica Italiana (1997-1999)".

3. Development Of The Environmental Risk Analysis

The procedures set useful to evaluate polluted sites, with the analytical techniques and interpretation data criteria, are indicated with the term "site investigation.

The principal steps of this analysis can be summarize:

RISK SCENARIO RECONSTRUCTION - Site Conceptual Model implementation is the preliminary consideration, characterizing sources of contamination, the distances of exposure to the contamination and finally human and environmental targets.

Risk scenario can be reconstructed through the examination of the following points:

- SITE CHARACTERIZATION - It consists in the identification of the source and the dimensions of the site contamination, and it is based on the physical characteristics that can have influenced and to still influence the dangerous substance "destiny".

- ANALYSIS OF COMPOUNDS DESTINY - In this phase the distances and the final destination of polluting agents have to be estimated using the migration speeds data. For this purpose, it is necessary to determine the site and compounds physical characteristics.

EXPOSURE APPRAISAL - Definition of the targets exposed, humans and/or environmental them. The human target can be identified in residents and/or visitors in the logical area of influence or working in the same area.

ACTIVITIES IDENTIFICATION AND USE OF THE SITE

POINTS and WAYS OF EXPOSURE IDENTIFICATION – The polluted points have been identified relative to the targets, the contact modalities and the time (duration) of the exposure. This methodology allows to identify the substances potentially dangerous concentrations and to estimate the projection on the sensitive population.

RISK ASSESSMENT - Contamination sources, exposure scenario, and contamination receivers have been indicated. The final result consists in the “real risk” assessment, by means of which the level of calculated risk can be confronted with the defined risk “acceptable”. In the case of unacceptable levels of risk, the process of risk analysis comes applied to the appraisal of acceptable “residual” concentrations (CRA) for all substance.

The risk has symbolically defined: $R = S \times P \times B$

that is the result of the interaction between the source (S), the distances of migration (p) and the target (B). The acceptable levels of risk come generally fixed confronting the levels of exposure and are quantified to you through the esteem of the hazard index.

In the Fig. 1 is presented a scheme to reproduce an environmental risk analysis.

4. Risk Assessment

The procedure RBCA (Risk Based Corrective Action) directly extracted from the EPA methodology emitted to the end of 1980, allow to the reorganization of the so-called “Superfund Sites”. It’s a graduate approach, with three levels of analyses that differ essentially for difficulty of application and analysis representative. The passage to levels succeeded more care characterization site and consequently a greater engagement of technical and economic resources. It is important to emphasize that the degree of protection of the human and environmental health not varied in the various levels of analysis and the principle of the “worst case” is respected, “EPA (1986-1987)”.

1° Level: Comparison with CLA (Concentrations Limit Acceptable) in order to verify the contamination presence and to evaluate the necessity to pass to the 2° analysis level;

2° Level: Definition of CRA (Acceptable Residual Concentrations) using software for the transport and exposure model;

3° Level: Definition of less conservative CRA, using more detailed lists and more complex equations.

During last years many decisional support systems have been proposed to manage the risk in polluted site, and the most famous are: Giuditta. 3.0, RBCA Tool Kit , ROME 2.1, BP-Risk.

All these software allow the conceptual model site implementation, guiding the user to insert environmental and exposure parameters. It is possible to derive the effective concentration in the exposure point using numerical models, (generally it differs from the source concentration because of attenuation phenomena deriving from the migration

distance). Software RBCA Tool Kit rationalizes the determination of the contamination risk and supplies different suggestions in order to mitigate the risk or to eliminate it. RBCA Tool Kit has been used generally in order to develop plans of final levels of reclamation.

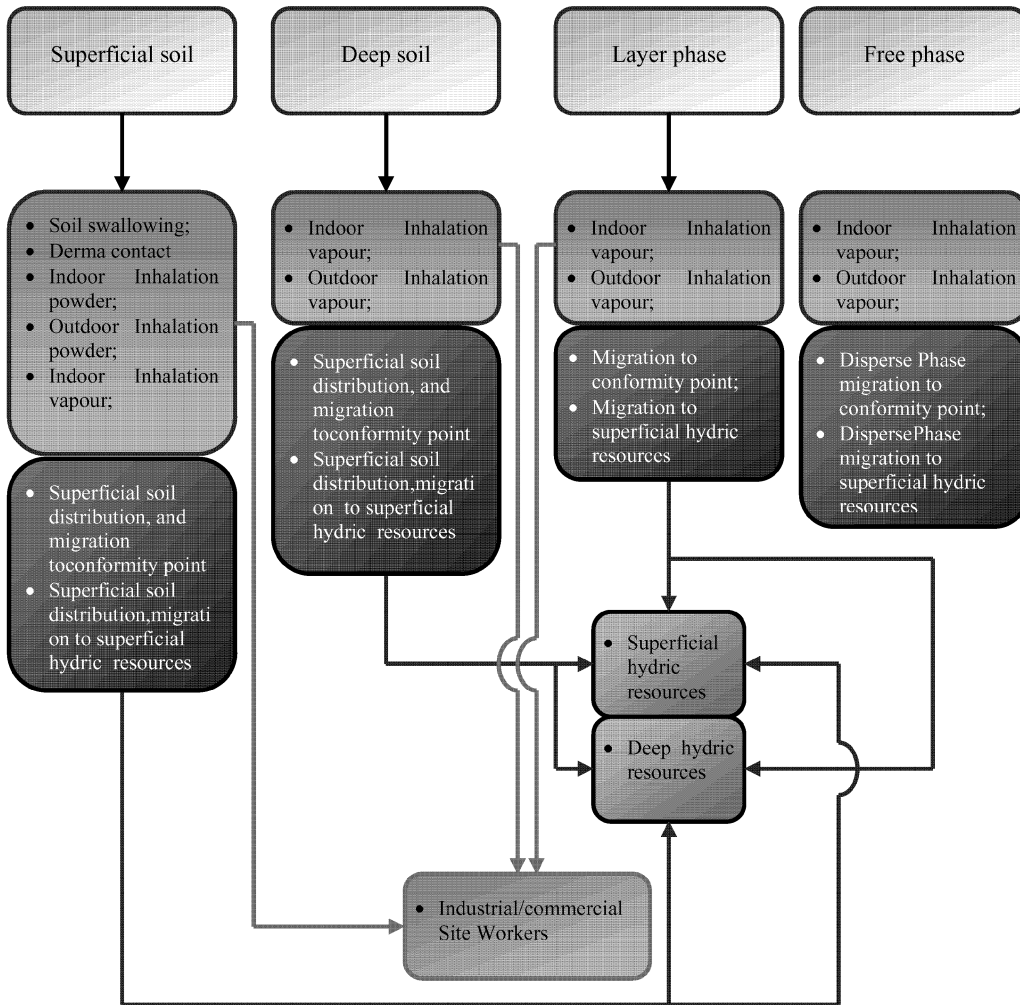


Fig. 1 – Environmental risk analysis scheme

The Giuditta 3,0 software allows to the statistics approach of the physical - chemical data available for the polluted area, distinguishing different characteristics of sub-areas. The software peculiarity allow to elaborate, through external GIS instruments the risk analysis results obtaining user friendly contamination representative maps.

Software ROME (ReasOnable Maximum Exposure) is the result of a project started from ANPA (National Agency for the Environmental Protection) in 1997, used to define a methodology elaboration of Environmental Risk Analysis and to determine the

limits of acceptability of the contamination in soil and waters. This methodology is inspired to ASTM/RBCA standards.

New software ROME 2,1, developed from the National Agency for the Environmental Protection and technical systems (APAT) is a modern instrument for the risk environmental analysis and for the appraisal of reclamation goals. This software includes an important database (chemical and physical and toxicological data relative to a great number of dangerous substances and has been inserted), supplies useful elements for the risk management of the risk and to choice the best reclamation solution.

4.1 The sanitary risk

Cancerogenous Risk (r) is defined as the probability that a case of cancer takes place during the life caused from the exposure to the polluting substance, respecting usual living conditions.

Three level of cancerogenous risk has been defined:

- inferior R risk to 1×10^{-6} (1/1.000.000), any restoration action isn't required;
- R risk comprised between 1×10^{-6} and 1×10^{-4} (from 1/1.000.000 to 1/10.000), estimating case to case restoration action;
- advanced R risk to 1×10^{-4} (1/10.000), necessary reclamation activity, in order to bring back the risk value within acceptability interval.

The value of risk R is acceptable generally at 10^{-5} , that is one probability on one hundred thousand to contract the cancer during the life.

The not cancerogenous risk index (HI) is expressed as the maximum dose for day of exposure to a substance (MDI) ratio the acceptable dose (TDI), indicative for the substance, $HI = MDI/TDI$ is risk condition when this value is >1 . When more compounds are considered, the risk index is a summary of the HI. If this value is <1 , adverse effects for the human health are excluded.

5. Methodology And Results

The automatic or partially automatic realization of environmental risk analysis involves several data implementation into the support system, in particular those relative to contamination site data. The site contamination data determination can be defined as a result of direct measures but in general because of these are not always available, it is possible to use historical data or indirect esteem criteria parameters.

In presence of a not much data, with the software ROME it's possible to considerate the maximum contamination concentration in the site, otherwise, to use the statistics data in Handbook Unichim n° 196/1. The software, actually does not allow automatically to carry out statistics parameters.

GiudittaROME 2.1 e GIUDITTA 3.0 give frequently place to marked differences in sanitary risk analysis realization for the same site. At the moment some waste industrial site have been verified.

Software results compared, have been reported in the mentioned study of APAT-ARPA-APPA-ISS work group study ("LineeGuida per l'applicazione dell'analisi del rischio per la salute umana derivante dai siti contaminate. 2005"), where a qualitative results valuation is proposed.

5.1 Critical aspects

Data deficiency in the preliminary plans is the principal difficulty. At the moment, the environmental risk analysis is rarely considered in the preliminary characterization plans realization, then the risk analysis suffer without the support of specific site investigation, "Beretta (2001)". Default parameters are usually not very representative for the studied area. Moreover for the tested laboratory parameters introduction not always it is possible to bring back the technical modalities for the parameter location. The use of specific site parameters allow to define a conceptual site model more connected to real site condition and therefore to carry out a more detailed risk esteem. Finally, for the software ROME, some problems relative to the transport phenomena in deep water matrix has been emphasized.

6. Conclusions

The environmental risk analysis is a decisional support and a justification for the use of reclamation systems management and the monitoring systems used to restore polluted sites. The methodology allow to characterize the corrective measures and the actions to reduce or to manage the identified risk. Moreover, the same instrument can be considered as support to the control and monitoring environmental systems project, contributing to characterize in specific case the risk levels for several contamination representative substances.

Environmental Risk Analysis present some limits: the methodology is relatively recent and needs detailed studies and verifications; the mathematical models used are many complexes and involve a large imputation number and much parameters; polluting agents of transportation models are "stationary": that means that, they estimate maximum attended exposure, but present limit to simulate variable concentrations to the source and transport variable processes.

In the specific italian normative, the application of the environmental risk analysis is a usable instrument in order to justify reclamation less important (a reclamation to obtain acceptable values, but from those cited in D.M. 471/99). The main condition demanded by the law, to proceed with environmental risk analysis in a remediation project, is the difficulty, relative to economics consideration, to apply the best available techniques.

With the recent law (November 2004) is possible individuate the quality target reclamation of different environmental matrix using the sanitary and environmental risk analysis. In this consideration it would be opportune that more characterization site parameters (in particular chemical-physicists and geo-technical data) can be experimentally previewed.

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