INDEX

This paper, presented at the World Conference on Natural Disaster Reduction (Yokohama, Japan 23-27 May 1994), was prepared with the contribution of many Italian Agencies and researchers In particular the followings were involved in the discussions, elaborations and editing: ALENIA (C. Lunardi) CNR Gruppo Nazionale per la Difesa dai Terremoti (V Petrini), ENEA (G. Borrelli, C Margottini, A. Paciello, D Rinaldis), Istituto Nazionale di Geofisica (E Boschi, A. Rovelli) Protezione Civile (M. Simonelli), Regione Piemonte (E. Gatti), Telespazio (G. Cannizzaro) The paper was presented by C. Margottini (ENEA) in the topical session 6, "Inter-relationship between natural and technological hazards"

NATURAL AND TECHNOLOGICAL CATASTROPHES AND POLICY OPTIONS: A REVIEW OF SOME ITALIAN EXPERIENCES.

Abstract

Many people have long understood, at least intuitively, that continuing natural and technological (Na-Tech) catastrophes and the consequent environmental degradation would eventually exact a heavy economic toll and a strong negative influence on the process of development. Unfortunately, no global economic models incorporate the depletion and destruction of the earth's natural support system. Only now we can begin to piece together information from several recent independent studies to get a sense of world wide economic and social effects of Na-Tech hazards. In the mean time, natural and technological hazards show a very complex intersection, the comprehension of which is of basic importance to identify correct models of industrialisation based on a global and safe environmental perspective.

Planning, mitigation and response are the main aspects to consider in a correct political perspective. Planning is looking forward (development), mitigation is looking backwards (to reduce effects on existing man made structures and population), while response include the capability of the social system to react to Na-Tech catastrophes (prevention, preparedness, post-disaster operations, etc.) In planning aspects we have to consider that the expected outputs (hazard maps, microzoning maps, site selections) are depending on the scale of the problem and from the scope:

- regional scale requires the realisation of hazard maps (for example the Italian project for the definitions of areas not disregarding the possibility to host Energy Power Plants, in the light of different natural hazards and technological consequences of these) that are mainly based on long term history on natural processes (understanding the evolution of natural phenomena through geological, archaeological, historical and early instrumental investigations, during the quaternary - last 2 million years - and particularly focused in the Holocene - last 10.000 years -);
- local scale requires the realisation of microzoning maps (for example the Italian experience after the 1980 Irpinia earthquake, or the studies on the town of Rome) that are also based on long term history of natural processes, but also on geological, geomorphological, geophysical, etc., investigations, as well as on a back fit analysis based on past or recent post disasters field surveys ,to check the expected theoretical results;
- site selection requires specific experimental investigations to understand the behaviour of soil f.i. under seismic load for example the ENEA project in the Gioia Tauro plane - South Italy - to define the vertical modification of seismic signals due to geological and geotechnical elements in vertical array) and, in general, to understand the capability of hosting high risk plants (for example the investigations for siting Nuclear Power Plants). Particular attention must be paid also to the mitigation of major accidents (for instance the "Seveso" directive emanated from the

European Union).

In the mean time, parallel to technical operations, the socio-economic impact analysis (understanding the individual and social effects of technological and natural hazards) is of basically importance and requires:

- global perspective with respect to natural and technological hazards;
- dynamical perspective; the demographic explosion of developing Countries and, above all, the urban explosion (half a billion people live today in cities, a figure which is expected to be double in the next 20 years) is dramatically making every master plan of development old, just after a few years;
- promoting environmentally sustainable development; environmental protection policies which in the short run may lead to a slower growth of income per head would be necessary, to ensure the long-term sustainability of income growth and improvements in the quality of life. In fact, because employment plays a key role in the environmental degradation processes, particularly in least developed Countries, the central role of employment creation in the environmental processes by introducing a new co-operational concept of sustainable development it has to be emphasised.

Nevertheless, it is worth of while that the implementation of above mentioned actions needs a strong communication system addressed to public participation. Very important for the final result, it is also the synergism among Public Administration (central and local), Industry and the Scientific Community (ENEA was able to realise this synergism in specific projects, all over Italy).

The realisation of the different outputs proposed (hazard maps, microzoning maps, site selection), cannot be performed in a crude analytical way; they require a certain degree of "professional judgement", that is an other important component of the mechanism. In practice, even if we are now in the "society of knowledge", we have to consider that our uncertainties are still very high and we cannot overcome our doubts by using sophisticated computer equipments and software. Only a severe collection of data, interpreting and final professional judgement may support high quality computer elaborations.

Finally, considering the difficulties to get all States at the same level of organisation, we have to emphasise the role of international community (technical and political) for supporting Countries afflicted by Na-Tech disasters and for transferring experiences and methodologies in planning and mitigation. UN co-ordination will be essential.

1. Introduction

Although disasters are divided into those created by geophysical processes (earthquakes, volcanic eruptions, tsunamis, etc.) climatic processes (floods, landslides, typhoons, droughts, etc.) and those caused by human error and failure of technology (accidents), it is now recognised that human activities also increase the impact of geophysic and climatic hazards.

In considering the influence of the development models in specific area, therefore, it must be considered that:

- every human activity interacts with the environment and offers risks, particularly for human health;
- there are adequate methodologies for evaluating and comparing risks, but the data generally used in this way are excessively aggregated, often not updated, even as regards technologies employed, and limited as to origin; uncertainties in the data should always be noted (but this is often not done);
- there are reliable data on the amounts of the various pollutants discharged into the environment; the effects on the environment are, however, little known. Similarly, extreme natural occurrences have rarely been considered as a direct cause of the release of polluting agents;
- significant evaluations have been obtained only for specific plants in specific locations (e.g the nuclear industry), with a hardly significant comparison between the various technologies;
- a comparison among the risks of different human activities, from various energy sources in particular, has a meaning only when risks of the same kind are being considered. In particular, certain effects of limited importance are often accompanied by possible risks, for example, in concomitance with its external natural factors (e.g. earthquakes), in some cases even having a great potential severity. There are no universally accepted criteria for comparisons among these different types of effect or for the importance to be given to each. This causes difficulties and an insufficient degree of reliability in comparative evaluations;
- the demographic explosion and the consequent anthropic pressure on the area, the ever greater need for energy and for industrial and technological installations, the risks of technological accidents connected with the installations (see table 1), natural events that, even within the framework of the non-stationary nature of the circumstances, inevitably have greater anthropized areas on which to weigh compared to the past, all induce one to believe that planning which includes natural risks, as well as induced technological ones, is indispensable.

The danger on the natural environment is dealt with subsequently, according to possible methods of investigation (geological, archaeological, historical, historical-instrumental, monitoring networks). With respect to high-risk plants, it is important to emphasise that the application of probabilistic analysis supplies the criterion for establishing the level of confidence with which this objective is pursued. The occurrence and the severity of natural events must obviously be considered in the evaluations.

The above-mentioned evaluations are, however, deeply conditioned by the objective to be attained, which leads to a different kind of emphasis on some natural phenomena, according to the scope. The need for territorial planning and effect mitigations of natural calamities on the other hand leads to the need for a "fund of knowledge" in which all the elements have the same dignity and reliability.

On the basis of such concepts, some Italian achievements are illustrated below, that belong to the logical process of an integrated approach to natural and technological catastrophes (Na-Tech), the need to reconstruct a cognitive scenario of the environmental dynamics that is as exhaustive and correct as possible (long term history), the need to evaluate the aim of the objective and thus operate with different methods and approaches (hazard and risk maps, microzoning maps and site selections), the need to consider the socio-economic effects of territorial planning and the populations' acceptance of risk, concluding with the beneficial effects that a policy of environmental protection may have.

2. Long term history of natural phenomena

Ever since the mid-18th century, scientists of earth and nature sciences have emphasised, in general, that the geographical landscape and natural phenomena occurring upon the earth's crust were nothing but an immediate representation of a grandiose sequence, forever in movement, of an interminable and multiform evolution of the world. This concept, after the first announcements by James Hutton, as early as 1783, emerged in a very clear way in the works of Karl Lyell (1797-1875), according to whom, "ever since the remote past up to the present day, no other cause has ever operated other than those which are operating today; and they have never manifested themselves with any greater force than that with which they unfold themselves today". These assumptions, which were to open the way to Charles Darwin (1809-1882), until the science of the period would accept the evolution of the world of living beings as well as that of the physical world, still keep their validity today, even if the most recent scientific knowledge makes it possible to draw in greater detail the scenarios within which such processes move. The above-mentioned theory of actualism is countered by that of catastrophism, originated in the thought of Jean André de Luc (1727-1817), but above all, by Georges Cuvier (1769-1752), according to whom none of the agents operating now is able to produce the deformations in the earth's crust that are to be found in the earth's geological series, so that the history of the earth was divided into two periods: the formative one, during which the great catastrophes occurred that led to the present configuration; and the second one, which began - according to de Luc - 4000 years ago, after the Universal Deluge and in which subsequent events are included.

Originating from these conceptions, we have the modern idea, which says that if it is true that the forces which operated in the past are still operating, it is also true that the planet's physical conditions have been modified during the geological age, so that it may be objectively difficult for determined phenomena in certain areas to occur at the present time. At the same time, our limited ability to reconstruct the way the natural phenomena occurred in the past in inverse proportion to the time, which is therefore much more sensitive to what occurred in more recent epochs, induces us to believe hat the "immediate representation" of a precise moment could not exhaust the environmental dynamics occurring now; they represent only a fraction of a process that has much more complex courses.

The above implies that geographical scenery and natural landscape were fundamentally conditioned either by extreme natural events, with the possibility, however, that they do not occur entirely during the periods of time under observation, or by extremely slow processes, and therefore imperceptible to our conventional units of measurements. Since well-known examples of the first family are given by the landslide in the Valtellina (Italy) in 1987, or the volcanic eruption of Nevado del Ruiz (Columbia) in November 1985, where just one natural event permanently changed the morphological conditions of the landscape, besides causing a large loss of human life.

As regards the second group, variations in the sea level may be mentioned, for which we have proof even over the last 2000 years from archaeological settlements sited at coastal areas and partly submerged today.

Thus it may be deduced that information about exceptional natural events occurring in the past, like those working now on the earth's crust, are a basic element for understanding the mechanisms that regulate the phenomena themselves, as well as for forecasting the occurrence of similar events in the near future and, therefore, for protecting the environment, the population and infrastructures.

The sources from which information and relevant data about natural events occurring in the past may be subdivided into three large families: geological, archaeological and bibliographical-archive.

The geological information or evidence is mostly found in the residue of great paroxysms, such as ground deformed by ancient orogenetic movements and earthquakes, landslides, extended alluvial covers, stratigraphic sequences that suddenly no longer show animal or vegetable species which were particularly abundant up to that moment, rapid changes of climate and consequently also of sediment, etc.

Archaeological information concerns information about the construction and/or the destruction of important archaeological evidence following natural phenomena; this is inferred from the observation of remains, commemorative tablets and inscriptions, from the observation of the construction typology following reconstructions, from excavation stratigraphy and from even more evidence.

Information and bibliographic-archive data consists mainly of documentary material, manuscripts and printed works having descriptions of man, his environment and his manufactures, of the natural phenomena that concerned the area in past centuries. This latter family of information, in an area such as the Mediterranean basin that has developed culturally for over 2000 years, is probably an inexhaustible mine of data upon which to reconstruct the evolution of the environment on the basis of testimony given by contemporary chroniclers. The instrumental data on climatic indicators are also particularly important (for example, temperature, rainfall, river levels, etc.), available since the XVIII century.

The integrated use of historical, archaeological and geological data makes it possible to create a humanistic-naturalistic corpus, which may be defined as "historical monitoring", to use a metaphor that may seem illogical. In fact, the single natural events may be compared to the photograms of a film in which the scenes are modified according to a slow and continuous evolution of the environment, for the last hundred years; in this context, our limited time window does not often allow us to appreciate significant variations even if we are operating with the instrumental monitoring of the various environmental components. These, in fact, besides involving a wait of years before arriving at a significant result, might also not represent exhaustively the evolutionary process taking place, especially in the case of extreme events that primarily represent the evolution of the planet.

Contemporary with these studies, monitoring networks are being created; they will become a fundamental step to obtain checks on the behavioural models envisaged, while taking into due consideration the limited time span of observation Only an overall examination of the data collected (geological, archaeological, historical, historical-instrumental, monitoring networks, etc.) will be helpful for reconstructing the course of the natural dynamics of the territory Simplified approaches may also be sources of serious errors.

demonstration project:

The ENEA/Ev.A. Data Bank for Natural Catastrophes in Italy since the year 1.000 A.D.:

Knowledge of the environmental dynamics has led ENEA to gather and organise news and information about historical events of an exceptional character that have concerned Italy since the year 1000 until today (landslides, earthquakes, floods, rain, meteorites, etc.) The selection has been made by gathering all those documents referring to natural events considered exceptional in the historical-socio-economic context of the period. The historical documents have been filed according to procedures that permit forms of simple yet at the same time exhaustive interrogation, as well as being memorised in bulk at high density on optic technology (optic disks). The EVA system, also defined as an electronic library for the natural catastrophes of the past, now comprises about 18,000 bibliographic texts, of which over 6,000 have already been stored. The texts refer to over 50,000 natural events of the past (mostly earthquakes), that have involved over 60,000 places in Italy.

The initiative was begun in 1987 by ENEA , also within the context of industrial promotion activities promoted by them. Once the project scheme had been defined, on the one hand basic historical research was begun, while on the other hand innovative technological systems were created.

Today, ENEA has developed projects around this technological pole, financed by the EU, the International Atomic Energy Authority of Vienna , by state bodies and in synergy with UNESCO. The final result is given by the possibility of contributing to the knowledge of the long-term dynamics of the country and thus propose ENEA as the direct contact with the organs of state administration (e.g. Ministries, local government bodies, etc.), defining general frameworks of intervention in Italy that can then be developed in detail by the national industrial bodies. Such applications are valuable because of both their wide scenarios (e.g. reconstruction of the hydroclimatic scenario of the Tiber basin in the last 1,000 years, through the course of documented exceptional natural events and by the instrumental data available), and also their small local concerns (e g., the geomorphological characterisation and developing tendencies of residential settlement of particular artistic merit sited in places with a great risk of landslides).

3. Hazard and risk maps

A global approach in investigating natural hazard and technological consequences was firstly developed in Italy (ENEA, former CNEN in 1979) for identification of areas not disregarding the possibility to host Nuclear Power Plants After that, several deeper investigations on a regional scale were performed in the specific category of natural phenomena, but without a comprehensive view and interrelationship among them.

Main problems in multi-hazard hazard and risk investigations may be identified in the following points.

- need for a common level of reliability among the different input parameters;
- need of common methodology for data treatment (f.i deterministic approach, probabilistic approach).

An analysis of hazard permits the subdivision of the territory into zones of different risk, as well as evaluating the value of engineering parameters required for the correct planning of residential homes, plants and infrastructures within each area. The naming of hazard is also a fundamental step in the evaluation of risk, meant as the result of a logical product between hazard, vulnerability and exposure. The evaluation of risk is indispensable for the correct land planning , for identifying and classifying the necessary medium and long term interventions on the artistic and infrastructural heritage and for the arrangement of plans for a rapid intervention in case of emergency.

There is an important difference to be outlined between hazard and risk. The two are most easily distinguished by answering the question. can the actions of people have any effect on the situation? Hazard cannot be lessened or increased but risk can. The earthquake hazard, for instance in a specific city, is due to the village proximity to the seismic zone: it cannot be changed by man. Earthquake risk is the immediate danger posed to population and it can be substantially altered by a number of actions, most significantly improved construction and siting of buildings.

The attainment of a "multi-hazard" type global approach is particularly complex, since it requires: a common level of quality in the input data, relative to the different types of natural events; a common method of statistical treatment of the input data. These requirements are almost never fulfilled in a univocal set, while very often individual approaches of danger or risk may be very developed. For instance, the seismic hazard analysis is mainly based on the postulate that the effect of past earthquakes may repeat in the same area in a defined span of time. Common procedures define these effects in term of intensity (ancient cultural region of the world) or magnitude, while forecast effects of next events may have the "dimension" of either intensity or vibratory ground motion (P.G.A., P.G.V., duration, etc.). Ground motion prediction should also take into consideration a large number of geological, geophysical, seismological and geotechnical parameters. These parameters are physically related to the earthquake occurrence, earthquake source, the wave propagation path, and the local ground response.

demonstration project:

The ENEA sites map for Nuclear Power Plants:

In facing the task demanded of it by art.23 of law 393, ENEA (then CNEN) moved within the framework of planning sites for nuclear power plants, on a national scale. The process carried out was not meant to substitute an approach qualifying the precise site, but it made it possible to indicate areas characterised by favourable features for installation in relation to the analyses performed. Successive precise choices within these areas obviously had to be optimised at the time when the site was qualified.

The basic criteria of the work identified a series of parameters (demographic, geological, seismic, seismotectonic, volcanic, morphological, technical feasibility, exceptional events, ecology) taking into consideration the systematic reconnaissance of the land. Every variable has been represented for the purposes of the territorial study on a grid of 1 km. per side, with one or more parameters (population indices, seismic intensity, percentage of slope, etc.), the course of which has been studied.

The cut values for the rejection of the portion of land characterised by unfavourable values were studied and thus the "site maps" (with yes-no or exclusion criteria representations) were created, that determine the suitable areas for the installation of nuclear power stations, according to the particular parameters considered.

The intersection of the various site maps supplies a series of areas that prove to be suitable for nuclear installations, within the safety framework of the work, dependent on the detailed site study for qualifying the precise locations. A subsequent survey was made of the results of this intersection, identifying in particular those areas characterised by intensive residential or tourist exploitation of the area, by ecological restrictions or by intense military restrictions.

4. Microzonation

The microzonation can be defined as an elaboration and application of a methodology for land utilisation, taken up to prevent or contain, into acceptable limits (e.g. lack of human life, losses and damages to infrastructure and environment) the adverse effect due to natural events into a zone of limited extension.

The choice of the methodology requests an approximate evaluation of the "answer" of the territory under study about the greatest natural events of reference, opportunely defined on the basis of its historical vicissitudes, taking into account all the useful parameters: i.e. physical, geomorphologic, antropic aspects. Then, we can deduce that important implications are evident:

- microzonation needs interdisciplinary work among experts;
- there is not any methodology universally accepted and definitively consolidated, since, in all the Country where the problem has been dealt, the way to operate has been involved and specified according to the different condition to contour.

demonstration projects:

The "Rome "project of ING

The territory occupied by the town of Rome is characterised by low energy local seismicity, with low frequencies, as well as far field resentment of farther shocks. With respect to the first, it has to emphasise that some of ancient earthquakes mentioned in the historical sources as occurred downtown are probably connected with external seismogenetic sources; the not correct localisation of these event is likely due to the tendency to associate the earthquakes with the most important town (centre of cultural political and social activities), even if characterised by lower damaged with respect to other less "political" important villages. Nevertheless it has to be mentioned that in some recent case local earthquakes seems to be triggered by underground cave collapses, more than tectonic activity.

The earthquakes occurred in the past (within 100-200 km), caused damages in the town, remarkable too. Most dangerous seismogenetic sources are located in the Apennine chain (Lazio, Umbria, Abruzzi), in the Albani hills, and, secondary, in the coastal areas. A large resentment in some part of the town occurred in occasion of the Avezzano earthquake of 1915, which killed about 30.000 people only in the village of Avezzano (92% of population) In Rome were recorded intensities till VII-VIII of Mercalli-Cancani-Sieberg (MCS) scale, even the epicentre were located 80 km far. Damage distribution seems to be connected with Tiber alluvial materials and related thickness.

Due to the growing up and extensive urbanisation of the town since 1915 if an earthquake like the 1915 should happen again, the expected damage are very high.

Other cases of strong far field effects occurred in the past, like the 1895 November 1 earthquake (epicentre in the coastal area) with intensity VI MCS in Rome, the event of 1899 July 19 (epicentre in Frascati) affected the town with intensities up to VII MCS, and the local one of 1909 August 31 with intensities among IV and VI MCS.

In general vibratory ground motion it is not uniform in the town of Rome, but amplified in particular areas strongly characterised by local conditions, as well as on typology and age of buildings.

Local conditions consider the presence of surface soft ground laid upon hard basement. The availability of geological data coming from more than 3.000 drills allows the modelling of seismic response for all the potential "high risk microzones".

ENEA planning of an integrated environmental informatic system for the global management of the Vesuvius area.

The Vesuvius volcano has been in a quiescent state since 1944, when the last eruption occurred. This volcano must therefore be considered active and particularly dangerous owing to the type of eruption (explosive). In particular, there would seem to be several hundred million cubic metres of magma at present in the magma chamber. If this mass were to be ejected in the course of a violent and rapid explosion, the event would be classifiable as a sub-Plinian eruption. The eruption would be able to lay the area waste because of the pyroclastic flows, the streams of mud and the abundant fall of ashes and lapilli. A plan for the correct management of the Vesuvius area has been prepared for such a massive event, taking into account the risks associated with any eruptive activity. In particular, we have envisaged:

- the study of data on the natural environment (morphology, meteorology);
- the study of data on the anthropogenetic environment (data on the agricultural heritage, the productiveness, data on public buildings, data on the use of land, data on the essential health services, sociodemographic data, data on road conditions and transport);
- the acquisition and transfer of data to informatic support with appropriate checks and validation;
- the planning and creation of data banks; the study development and checking of models describing and interpreting the event's impact;
- the planning and creation of an Integrated Environmental Informatic system for the global management of the area and the intervention plan;
- the planning and creation of the Emergency Simulation and Intervention Model; studies of structural improvements for mitigating the risk;
- the application of the Integrated Environmental Informatics system to the event planned for

(expected eruption); technical suppositions for an emergency plan;

The available data in the system will make it possible to define an emergency plan based on the indications that will result from the possibility that the event will happen, together with the different meteorological situations and with the zones chiefly at risk, identified by means of the Integrated Computer Mapping System

5. Site selection

The problems of safety and risk management for critical facilities, such as energy plants, chemical plants, etc., must be approached on the basis of anticipating every possible scenario, so as to take preventive action in the design to eliminate possible technological hazard on man and on the environment due to natural events, or to reduce those hazards to an acceptable minimum. In consequence, the safety standards required necessarily involve the introduction of conceptual and methodological approaches to lead to the definition of specific and appropriate lines of behaviour methodologies and techniques to be adopted in the various stages of investigation and analyses of site selected for high risk plant.

The need to define a line of behaviour appropriate to the severity of the safety standards required derives from the fact that, in the fields of knowledge in general and in earth science in particular, the result of research leads to an increase of knowledge but not to a full understanding of phenomena or a complete solution of the problems studied. In other words, there are always margins of uncertainty, conditioned by the quantity and quality of data collected and the congruence and validity of the consequent processing and interpretation, which can never represent the whole of the natural reality.

Knowledge of the foregoing requires the introduction of a reasonable conservatism (safety margins) into the various stages of the process that starts with site characterisation and ends with facility design. In effect, the expert's attention to identifying the methodology adopted and in the state of knowledge attained is the key to an approach which is conceptually correct in safety terms. The above, however, involves the introduction of subjective judgements. However much the expert tries to follow a rigorously deterministic itinerary, he must necessarily start from axioms and postulates. From these, through a collection of data on the natural reality and logical sequences of processing, he arrives at interpretations of phenomena which can not, however, include complete knowledge of the topics under study and which are inevitably, to some extent and in some aspects subjective, even when generally accepted as correct in the scientific world on the basis of the current state of knowledge. The passage to the application of the results of the studies therefore requires subjective evaluations and decisions. In practice, these are considered more valid the greater extent to which they are expressed by a team of experts of different specializations and experiences and sound judgement through *professional judgement* which takes account of all the factors involved through the participation of the various forms of expertise available and provide parameters that can be used in engineering. The professional judgement must intrinsically contain an expression of the knowledge that geophysical and climatic events enter a design process which proceeds by analytical or numerical representation of structures (in the broad sense) in order to predict their behaviour.

demonstration project:

The selections of sites for nuclear facilities in Italy.

The information relating to the evaluation of the geological and geotechnical stability of the site and the seismic parameters for the siting and planning of nuclear power stations are regulated by ENEA's Technical Guide, no. 1, 1st March 1975, modified and enlarged for these aspects in 1984. The information requested and the procedural processes are subdivided into:

- base data (identification of the geologically and seismologically significant area; definition of the area of the site and its seismotectonic characteristics; the geology of the site and its surroundings; hydrogeology of the site and its surroundings; geotechnical characteristics of the site);
- seismic parameters (identification and characterisation of the geological structures important for the site from the seismotectonic viewpoint; evaluation of the seismic character of the maximum earthquakes potentials connected with the structures; evaluation of the vibratory motion on the surface in a clear field; comparison with the probabilistic approach; correlation with the project analyses);
- evaluation of the geological and geotechnical phenomena; stability of natural and artificial slopes; stability of the foundations);
- final report.

6. Socio-economic aspects

Assessment of the socio-economic impacts is one of the many expressions of science's possible contribution to the management of development and technological development The start point of socio-economic assessment is the fact that the lines of technological and social change in our society is restoring a capacity for analysis and evaluation of their interactions. In order to contain the tensions that are released within physiological limits towards a whole and more harmonic development the socio-economic assessment is requested.

Management of technological risks is at the same time one of the most difficult tasks and an inescapable challenge that governments have to tackle. The difficulties are rooted in the fact that a management strategy of technological risks must be able to balance advantages and disadvantages over a very wide spectrum of factors, many of which are of an imponderable kind and for which there is no agreement on the evaluation criteria.

Among the factors that can be defined as being imponderable, there are certainly those events connected with natural catastrophes that are found to interact with the presence of infrastructures and services in the area, also having an impact on the existing natural environment.

The modern industrial societies are characterised by such a high degree of interdependence among economic, technological, environmental, social and political parameters; the results it is a system highly sensitive to the changes deriving from unexpected events, sometimes even unimportant ones.

Following the high degree of industrialisation attained, the potential of modern technologies and the intensity of their interaction with the environment, the magnitude of the effects of natural events may reach catastrophic levels, owing to the work of man.

There is, therefore, a need to insert studies of socio-economic assessment into the analyses of the possible consequences of natural occurrences, since any catastrophe happens on an environmental context already modified by human action and well-formed in both social and economic relations.

This kind of action can help to reveal false assumptions or conclusions and prove that certain convictions and expectations are wrong. It can identify and shape the causal structures that link many events and thus supply information about possible consequences. It can also describe directions and the probability of future developments in technology and society and trace probable futures.

The need for an interdisciplinary approach and collaboration among various experts where there is the need to link the demands for development to intrinsic weaknesses of the territory (for example, at risk from earthquakes or other natural catastrophes) becomes a determining factor.

The starting-point may be summarised by the following items:

- any analysis that aims at the possibility of mitigating natural catastrophic effects must start from knowledge of the territory;
- in planning, two essential elements must be borne in mind: the possibilities offered by the territory on the one hand, and on the other hand the demands in terms of development coming from the society;
- socio-economic planning cannot be an "independent" variable but must take into account the possibilities offered by the territory: among the possibilities, expressed in terms of advantages and disadvantages, possible catastrophic events must be kept in mind.

Besides a knowledge of the socio-economic fabric of the territory, of a precautionary value, there is also a second aspect no less important. Having studies available on the socio-economic planning for the areas at risk makes it possible to evaluate in a short time the impact of an unexpected event. Many times, following catastrophic events, the governments have drawn up in financial plans, even large-scale ones, that, by intention, should have made it possible to resume productive activities in the area within a short time afterwards and by means of well-focused interventions. The lack of knowledge about the existing conditions before the calamity, has often led to a marked dissipation of these interventions, which were distributed practically without any criterion to guide them. Since a catastrophe causes very marked socio-economic reactions, having this kind of analysis on maps of areas at risk would make it possible to evaluate such reactions and, as a result, be able to act.

In conclusion, we think it important to stress the two essential points of this brief paper.

- the necessity for knowing the territory at risk in its relationship to both the natural environment and the antrophogenic environment, in order to be able to arrange activities in line with the existing vocations (precautionary actions);
- the socio-economic characterisation of the territory at risk, in order to be able to operate with efficiency and effectiveness after the catastrophe.

demonstration project:

The Pilot Project of Regione Piemonte

Starting from individual and group experiences, the Regional Administration of Piemonte has developed a pilot project to define basic guidelines in emergency situations (socio psychological attitudes). The results are expected to contribute to prevention, through a collective learning strategy.

A specific "dynamic laboratory" of anti-emergency behaviours operating in "the field" will develop and carry on a prevention policy of the estimated risk by exploiting

- techniques (to develop and increase safety culture; to provide information on self-protection and check actual learning, actions and behaviours which can save human lives; to generate documents of easy and quick understanding);
- psycho-social dynamics (to encourage research on the risk of one's own territory; to learn to become familiar with any emergency).

Local schools and teachers are involved in a specific branch of the project (life and safety) that is aimed to amplify safety culture in the whole community. It shall originate; from school to family and vice versa a talk model of risk communication. In this way "the rounding off" of social relations can be completed and utilised for the final product called Risk Communication.

Geographical Information System by TELESPAZIO, as an information support for integrated Environmental and Socio-Economic Analysis

Geographical information systems are computerised geographical data bases to organise manage, and display geographic data or any data with spatial attributes. The utility of environmental and socio-economic data greatly increases when they can be compared and integrated with data from other sources, such as: altimetry, hydrography, administrative limits, transport infrastructures, soil surveys, geological maps, census, economic indexes, etc.

A number of these "layers" can be suitably derived from Satellite Remote Sensing data.

Friendly user interfaces are quite common in new GIS application to make this system understood by a widespread number of potential users The combination of various sources of information has a synergistic effect and it is the correct technological effort to solve operational problems and to improve the quality of the results. Application of GIS in Telespazio includes coastal zone pollution, monitoring, environmental impact analysis and, agricultural statistical assessment.

7. Planning and tools of Civil Protection for disaster management

Several plannings and tools have been developed all over the world for risk and disaster management. Following it is described a project for multi-hazard assessment, for which the IDNDR official approval was given.

demonstration project:

The P.E.A.C.E. project from ALENIA

Within the IDNDR, ALENIA proposed a project for the protection of environment and control of emergencies due to natural disasters (PEACE). The project is mainly addressed to soil and environmental degradation, desertification, climate changes, floods, earthquakes, storms, drought, and forest fires. The main scopes in PEACE project include.

- disaster mitigation and vulnerability mitigation,
- optimisation and co-operation of intervention forces;
- monitoring and comprehension of natural phenomena;
- standardisation of the methodology and technology for: data collection, processing and management; forecasting, prevention and planning models; risk evaluation, data communication; system implementation; fighting measures procedure;
- cultural fertilisation;
- collection and dissemination of information on technological development;
- synergy among different systems and technologies.

The PEACE structure can be summarised in local, national and international centres, to which are connected with the individual components and surveying and monitoring systems. The standard local module, telemetered with the national centre, is organised in a regional airborne intervention centre, a weather radar site, a telemetering network, a regional early warning operational system and users. The interconnection of different centres (local, national and international) also allows a differentiation of duty and expertise due to the different "size" and affected areas of the problem to be considered by each individual centre. In other words, global change aspects will be mainly considered by international centres while short term local modelling will be supplied by local centres.

8. Role of research community, public administration and industry for environmental safeguard

Even regarding more specifically the earth sciences and safeguarding the environment, the above points maintain their validity, except for the appropriate scale factors. We have witnessed the realities pursuing political, scientific and industrial policies coming unstuck in Italy, particularly in the past, when they had to absorb the results attained at both the conceptual and practical levels. The development of the "society of knowledge (i.e. found of knowledge)" today is actually widening the gap between these two components, especially in the South. In practice, wishing to exemplify the relationship between the various state institutions, we can state that faced with a cultural framework characterised by the "society of knowledge", we have state funds for research, partly counterbalanced by co-financing from private companies that finances basic research, applied and experimental developments, in which Universities, State Bodies and Major Industries participate.

The results are both theoretical behavioural models, very often emerging from researches developed within typically applied framework. A typical example is the study of the Val Tessina (Veneto) landslide, when an excellent piece of work produced by CNR IRPI of Padua in collaboration with CNR GNDCI, permitted the development and application of highly advanced and efficient monitoring systems. A similar example is also given by the Valtellina landslide in 1987, where both state and private bodies (e.g. ISMES) created a very advanced monitoring system to check the instability of the hazard area. In both these examples, it was above all a pressing need that justified the massive use of technology (and the relative up-to-date technology), also through recourse to private industry.

The results of the researches (basic, applied, experimental development) must be transferred to the state administrative bodies, that unfortunately prove to be the least aggregated element in the system, even today. The state administrative bodies (both central and local), in fact, play a basic role; that is, on the one hand they finance the activities, and on the other, they should assimilate to themselves the results of the researches and studies. Then, carrying into effect the lines emerging from the researches being carried out should allow the industrial and professional worlds to perform an operative supporting role for the application of environmental policies. In safeguarding the territory, in fact, several cognitive elements may be identified, understanding of which is generally entrusted to the whole research (state and private). In fact, it is a question of defining what is the evolution of the territory, by means of an analysis that is no longer minutely precise but at a planetary level, following the "globalization" of the problems.

De facto, it is no news to anyone that the evolutionary phenomena of the planet are those which lead to the occurrence of natural catastrophes and that these are linked to a general mechanism connected on the one hand to the atmospheric circulation, and on the other to earth geodynamics (one could almost say, to the earth's circulation). Understanding these evolutionary tendencies is therefore essential for defining works of mitigation and protection from extreme natural events. The most correct approach is the one which, on a deterministic basis, tries both to reconstruct the past evolution of the territory (historical, archaeological and geological monitoring) and also to check by means of instruments the tendencies in progress (instrumental monitoring). The integration of these components can make it possible to define works for protection and safeguarding, as well as planning future developments of society. In both cases, an initial cognitive stage is followed by a moment of decision and application, in which there must be state elements operating in the area Within this framework, it is thus made clear that there is no difference between the tasks and roles of the various elements of the state, but only the need for a synergism that, unfortunately, does not yet exist in our national society.

The above observations have emphasised the fact that there is not actually any difference among Research, State Administration and Industry, but if anything the differences are to be sought between those who finance scientific and industrial research and those who applied the results. The correlation is not a very simple one, especially in a society characterised by a strong cognitive and cultural commitment ("society of knowledge") in which the results of the research and the technological innovations should help to define behavioural rules and regulations for safeguarding the territory in the face of exceptional natural events. Such rules should be absorbed by the local Administrative Bodies, that should unite the scientific efforts with the optimum exploitation of the territory, even through small industries and the professionals.

Furthermore, a nodal point is the intersection between scientific and industrial policies and the local professional realities connected with the State Administrative bodies. In order to favour the spread of knowledge and methodologies from the world of research to the people working in the sector, one could hope for a greater degree of involvement by the State Administration, also in the sectors of community research in the environmental field, as occurs in other parts of the EU. Such involvement could occur either through formal participation in the activities, as beneficiaries of the results of the research.

demonstration project.

The ENVIRONET project from Telespazio

The Environet project was performed in the framework of the European Nervous System Initiative with the goal of setting up a prototype network for environmental data exchange between the Public Administration for environmental risks and crisis management Until recently environmental issues in Europe have largely been handled as isolated national or regional problems whit limited or no exchange of information across country or nation borders. The need for exchange of environmental data has long been recognised but due to lack of administrative and technical tools for co-operation only minor tasks have been handled on a transboundary level.

Environet aims at establishing a user friendly technical platform for exchange of mail, alarm message and relevant data within the field of environment in its broadest sense. The purpose is partly to increase the efficiency and lower the expenses of environmental administration, partly to stimulate the development of standardisation in administrative routines, technical methods and formats; Three pilot scenarios, called ECASE (Emergency Control and Alarm System based on Environet) have been chosen to demonstrate technical feasibility and applicability

ECASE AIR to demonstrate the alarming and event handling in case of an incident with subsustance concerning air pollution as well as the standard requirements for periodical and ad-hoc data exchange.

ECASE RIVER to demonstrate the alarming, reporting and decision support for authorities involved in a river alarm caused by pollution;

ECASE COAST to show the alarming and event handling in case of pollution of coastal water.

All scenarios especially emphasise the transnational communication and co-operation between involved member states. Requirements for the electronic data exchange between heterogeneous authorities have been identified. In order to develop the prototypes for the demonstration, necessary investigations and specification of Decision Support System (DSS) and the identification of knowledge and data requirements have been made.

9. Environmental sustainable development

The evolution of the environmental crisis over the last decade, confirmed and amplified by a great number of reports on the state of the environment, drawn up all over the planet (the Report by the World Commission on the Environment and Development speaks for all of them) has emphasised the fact that the environment and development are not separate entities in the North of the world as in the South. The "news" learned during the 80's is that development cannot occur if the base of natural resources has deteriorated, and the environment cannot be protected if economic development does not take account of environmental depletation.

Since there is a close correlation between technological industrial development, environmental degradation and catastrophic occurrences, as we have emphasised above; sustainable development becomes a theme of fundamental importance when the consequences of catastrophic natural events are analysed.

Overcoming the traditional contrast between environment and development is a new element in the debate about the question of ecology within both a national and international context; it is a novelty that has favoured and promoted the assertion of the idea of sustainable development. The fundamental principle, in fact, at the basis of the evolution of the concept of sustainable development states that economy and environment are not antithetical values, but complementary, closely connected in a mesh of cause and effect of a non-linear type.

The concept of sustainable development made its appearance on the stage of international politics at the end of the 60's. That is the period when, because of the great number of nuclear experiments and the heedless use of pesticides and anti parasites (DDT), people began to perceive that the effects of the emission of radioactive and synthetic chemical substances into the environment have a global fall-out, not restricted to the areas around the one concerned. The metabolization of these new substances in plants, their absorption through the water tables into rivers and seas, their enjoy into the food chain until they arrived into people's homes in ever-increasing concentrations, shows that any action perpetrated on the natural environment gives rise to a non-linear and non-local response and starts an unexpected course that is difficult to forecast. One begins to understand the existence of an ecological interdependence which tells us that the earth is a "global unit", formed by the continuous interaction between living beings and the physical environment. The life of every organism is part of a large-scale process that involves the metabolism of the whole planet.

Given these premises, and given the occurrence of natural catastrophes on the planet, two points are obvious:

- even if it is sometimes foreseeable, a natural catastrophe is not physically avoidable, at least not at the level of our present technical - scientific knowledge;
- in any case, the amount of damage caused by the catastrophe is closely linked to the degree, type and quality of development to be found on the area concerned

In conclusion, a well-focused policy of sustainable development, based on an intelligent use of the resources available and a precautionary tendency towards interventions on the territory, can definitely limit the damage caused by the inevitable contingency of catastrophe.

The earth science, when it becomes territorial planning, is able to offer a decisive contribution to this new concept of sustainability, that not only looks to the relationship between environment and development but also to the relationship between development and the structural characteristics of the territory.

10. Conclusion

At the end of this brief excursus, that has aimed at summarising the Italian experience of policy choices to tackle natural and technological catastrophes, we shall emphasise some points of general interest.

The first point regards the need of a holistic approach to the problem of the effects of catastrophic events. These events do not happen only in uninhabited or desert areas, but they often occur on anthropized areas; the use of a holistic approach makes it possible to face the problems in an inclusive way; that is, considering both the natural environment and the social one as a whole. An interdisciplinary approach is the instrument for this outlook and that is what has inspired us while writing this paper; when we declare the need for an interdisciplinary approach, we are definitely not thinking of a kind of organisation of work in committee, but rather of independent work carried out by various experts on the same subject. The final summary of the work must reflect the points of contact common to the various disciplines, without prejudice.

The second point, that concerns the acceptance of this working method, is of a "cultural" kind. "Churches" of science have been created in Western societies at different times, with the -sometimes undeclared - intention of keeping, or gaining, privileges for their own field of activity. This state of affairs makes collaboration between technicians and scientists of different disciplines difficult, complicating the activity of policy management which is responsible for taking decisions.

The third point concerns the possibility of transferring our work scheme to developing countries. About this point, it is necessary to confirm the difficulty, as well as the lack of occasion to transfer processes and models to realities that in terms of history, culture and social organisation are extremely different from ours. The damage done, due to an uncritical acceptance of other cultural models, is still evident: just think of colonialism, and even the acceptance of the USA culture in other countries of the industrialised West.

The fourth point regards laws and regulations, often in contrast each other or authorising different bodies in the same duty; the result is a stop of activities with an internal conflict not easy to solve.

The invitation to developing countries is not about the importation of a model, but not to commit the same mistakes committed by the industrialised countries when tackling natural catastrophes. These mistakes are due, even today, to a "reductionism" logic, by which the scientific processing is performed. The picture obtained from such processing needs to be continually adjusted, which makes a correct management of the decisional power impracticable.

An integrated approach that considers the role and the possibility of natural catastrophes and risks due to the presence of technologies as a whole, within a complete framework and on equal bases, can be an useful instrument of both prevention and mitigation of effects. In countries where the above mentioned phenomenon of the existence of groups of special interests in science, the so-called "churches", have not yet been set up and where is the technological plants are structures being evolved, there is the possibility to usefully exploit the approaches put forward in this paper.

In conclusion, we consider that a decisive role in favouring the use of integrated approaches in developing countries can be performed by scientific organisations on a world-wide scale, such as UNO, that could supply the necessary skills to those who are preparing to tackle problems such as the management of catastrophes from whatever origin.