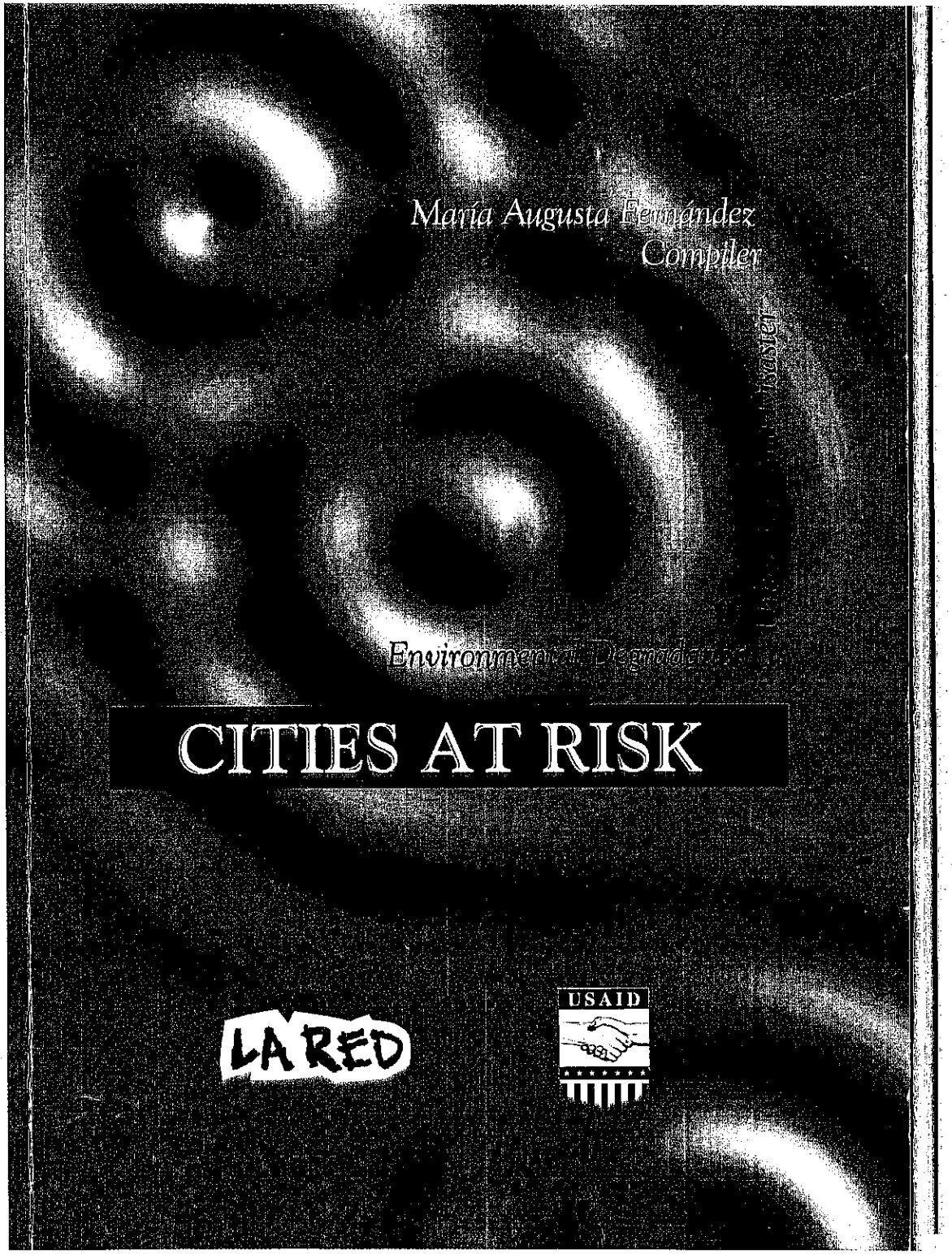

CHAPTER 4 ENVIRONMENTAL MANAGEMENT AND DISASTER PREVENTION: TWO RELATED TOPICS

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INTRODUCTION

In the international arena, it is widely accepted that during the upcoming decades and due to the inertia in the bio-geo-chemical and the socioeconomic systems, some environmental trends will not change, unless unexpected events with the necessary intensity to modify them occur. Such trends include an increase in global warming as a result of the greenhouse effect; endemic water pollution; a relative increase in agricultural production and in energy consumption as a consequence of population growth (although the per capita increase is smaller); greater environmental degradation in developing countries (Biswas et al., 1987); and, an increase in the occurrence of disasters of both natural and man-made origin.

As a result, worldwide interest for the environment and its accelerated degradation has intensified during the past decades. The exhaustion of renewable and non-renewable natural resources, population growth and its spatial concentration, the demand for species required to satisfy urgent needs, and the escalating increase in the occurrence of disasters are worrisome situations whose accelerated growth surpasses the available scope of its solutions.

The United Nations Environment Program (UNEP) has adopted the postulates of Sustainable Development proposed by the International Union for the Conservation of Nature (IUCN). These postulates establish the interrelationship among several factors that imply restating po-

litical, economic, social, productive, technological and administrative systems, as well as a new world order for international relations (Blanco-Alarcón et al., 1989). On the other hand, and as a result of a situation that has affected developing countries with greater severity, the UN General Assembly proclaimed the 1990s as the International Decade for Natural Disaster Reduction (IDNDR). The objective is to promote risk mitigation through the incorporation of disaster prevention in the social and economic development policies of all the nations of the world.

Crisis scenarios

The environment can be understood as a system whose elements are in permanent interaction, or as a network of active relationships among such elements, which determines the conditions of their existence and the totality of the system. A crisis emerges when changes, transformations, or alterations that cannot be absorbed by the system - because of the lack of flexibility or adaptation capabilities - occur within the dynamics or process of interaction (Wilches-Chaux, 1989). This crisis, which might result from a chain reaction of influences, is known as *disaster.* This designation depends on the social value that the community assigns to it, and in all cases, it refers to a negative environmental impact.

Except in the case of short-term approximations, the evolution of complex social and bio-geo-chemical systems cannot be adequately depicted neither by linear functions nor by soft and continuous curves. Usually, the real evolution of these systems contains positive feedback and shows non-linear and even discontinuous behavior, which is difficult to predict, although in retrospect it can be easily explained (Merkhofer, 1987). The concepts of *vulnerability*, or the predisposition to be affected, and *resiliency*, or the capability to recover, play fundamental roles due to their significant relationship with the possible occurrence of discontinuities. When altered by a sufficiently strong disturbance, a system may change from an almost constant state to another. Such a change depends not only on the magnitude of the event, but also on the presence of system instabilities that are difficult to perceive.

Crisis scenarios are the manifestation of existing conditions of risk, which consequently depend not only on the action of an external disturbing or trigger agent such as an accumulative degrading event or process, but also on the conditions of vulnerability. The conditions of vulnerability are agents that facilitate the development of a crisis scenario once the trigger event occurs, or the critical point of degradation processes is surpassed. The social and environmental conditions that characterize the vulnerability or frailty of a human settlement, for example, usually result from the models of development adopted and the debt that has been generated with nature, which yield to a process of incubation. In other words, crisis scenarios and even disasters are non-resolved problems of development that must be analyzed not only from a technocratic viewpoint, but also from the perspective of political economics. Vulnerability in its diverse manifestations is nothing but a deficit of development. It represents a negative green account towards which preventative management efforts with planning perspective must be guided in order to reduce or avoid negative social, economic and environmental consequences.

Cardona (1995) argues that, methodologically, the potential presence of a crisis scenario during the development process can be expressed as:

$$Cp = Ta \cdot Vc$$

Cp (Potential crisis) represents the possibility of the occurrence of a crisis. Ta represents the probability of occurrence of an external trigger agent, which might be a disturbing event or the surpassing of a critical point in the process of continuous degradation. Vc represents the conditions of vulnerability or *instability of the system* exposed to the trigger event.

The conditions of vulnerability are weaknesses or deficiencies that may be, among others, of environmental, ecological, demographic, social, economic institutional, political, cultural and/or ideological character. These characteristics are related to the fragility or susceptibility of the elements and the activities or relationships that contribute to the generation of a crisis when an event or process difficult to absorb occurs.

ENVIRONMENTAL PHENOMENA

" It would seem that, like the ancient Roman god Janus, nature has two faces: the smiling face, which must be protected, and the threatening face, against which we must protect ourselves... both faces belong to the same entity, and the rituals performed for any of the two faces will have repercussions on the other..." Michel Hermelin.

Environmental phenomena may be classified into three types: those that have never occurred and whose occurrence is very remote, such as the appearance of a "hole" in the ozone layer over Antarctica; those that have never occurred but whose occurrence is probable, as the global warming due to the greenhouse effect; and, those that can be anticipated due to their historic analogy or to a reasonable understanding of them. Among the latter are natural and/or man-made events such as earthquakes, volcanic eruptions, hurricanes, the degradation of hydrographic basins and the subsequent events, such as floods, avalanches or landslides, pollution and technological events.

In the first case, preventative actions have not been carried out due to the lack of historic precedents and information about the generating processes. Although in the second case it is possible to take preventative measures, these have not been implemented with determination since the degree of uncertainty regarding the generating factors is significant. The phenomena grouped in the third case are characterized by the increasing body of knowledge that has been gathered with respect to them and in many cases, by the possibility of forecasting them. Their effects can be mitigated through the implementation of preventative measures. Non-modifiable natural hazards refer to the intervention of conditions of vulnerability and resiliency of the elements exposed. Socio-natural and technological hazards refer to the prevention of their generation by modifying the processes of environmental degradation and by improving the safety of hazardous technologies.

A conceptualization of the environment is limited and unreal if it restricts its management to aspects such as protection and preservation, and if considers human beings as threatening external agents (Hermelin, 1991-92). Such a theoretical trend has led to an incomplete definition of what is understood as environmental impact, as it excludes those natural

and man-made events that may affect intensely not only human beings but also renewable and non-renewable resources.

Hazards, Risks and Disasters

The term *hazard* is frequently used to describe the latent danger that characterizes a wide variety of phenomena. Its range goes from those whose occurrence is considered to be exclusively of natural origin, such as earthquakes, hurricanes and volcanic eruptions, to those whose origin is considered to be exclusively human, such as wars and technological accidents. In between both extremes lies a wide spectrum of phenomena such as famine, floods, and landslides that result from a combination of natural and human factors.

Disasters are social processes that unchain as the result of two concomitant and mutually influenced factors: hazard and vulnerability. The hazard is characterized by the imminent or actual manifestation of a trigger agent. Vulnerability is the weakness of the elements exposed to that trigger agent, that is, those conditions that facilitate the severe effects - once materialized- that the hazard will have over the urban, environmental and social context. Considering urban and social factors as components of the ecosystems, a crisis is always a disaster in itself more than merely the generator of one. Therefore risk evaluation or the estimate of the possible occurrence of future crisis or disasters whether of natural, social or socio-natural origin, must be an integral part of development planning.

In other words (Cardona, 1986), risk (Rie) can be determined once the *hazard* (Ai) - the probability of occurrence of an event of equal or higher intensity than (I) during a period of exposure (t) - and *vulnerability* (Ve) - the intrinsic predisposition of an element (e) to be affected or susceptible to suffer a loss when exposed to an event of intensity (i) - are identified. Thus, risk can be understood as the probability of the occurrence of a loss in the element (e) as a consequence of the occurrence of an event with an intensity equal or higher than I,

$$Rie = f(Ai, Ve)$$

That is, the probability to exceed determined social, economic or environmental consequences during a given period of time t.

Several countries are located in zones of tectonic complexity and high levels of seismic and volcanic activity, as evidenced by a historic record of destructive earthquakes, *tsunamis* and the recent activation of volcanoes. In addition, the slopes of the mountainous regions are affected by the action of man-made, biological and meteorological agents such as the rain, the winds, temperature changes characteristic of extreme climatic conditions. A significant number of countries are highly prone to the effects of severe events such as erosion, landslides, avalanches and floods (Colciencias, 1990)

In those countries where the population is concentrated in large cities located in areas with high exposure to hazards, the potential for the occurrence of a natural disaster is significantly high.

Environmental Degradation and the Generation of Risks

Even when from the urban perspective it has been common to recognize that the process of environmental degradation may become a trigger of supposedly natural events that affect the habitat of human settlements, disaster prevention and mitigation have not been explicitly associated with environmental degradation. Environmental experts have paid little attention to the topic of disasters, perhaps because of the bias towards the emergency response that during years has characterized the discussion of disasters. Some researchers limit their definition of habitat to artificial aspects of the environment, for instance, they do not include human settlements into their conceptualization of the ecosystems. Human settlements could be understood in a holistic way as social-ecosystems, allowing a synthesis and a more integral vision of the urban and environmental question. Unfortunately, a similar position is taken by risk reduction and disaster prevention experts, who support an incomplete perspective on the question of risks and the urban habitat since they do not incorporate into their models and conceptual frameworks those aspects related to environmental management and protection.

It could be argued that besides technological risks, there are the usually incorrectly named *natural disasters*. Many of the so-called natural disasters have a man-made origin, whether because environmental degradation may stimulate or induce natural hazards, or because the increase

of vulnerability of human settlements notoriously influences the occurrence of disasters.

In South America, for example, the Andean region is highly exposed to the processes of soil instability or landslides. Because of its complex geomorphology, it also presents a high number of rivers of torrential behavior that continuously present flash floods and avalanches, which result from the damming in the upper basins. In most cases, these types of events result from the environmental unbalance that leads to the degradation of nature and also affects human settlements. Hydrographic basins deteriorate, and consequently the hydro cycle is interrupted. Water is exhausted, the soil dries up, and crops lose their irrigation source. Both deforestation and fires destroy the vegetation that protects soils and stabilizes the climate, causing erosion and instability in the mountainsides; agricultural soils are vertiginously drained by the unstoppable passing of water runoff, generating the sedimentation of valleys, watercourses, dams, and cities where the sewerage systems have surpassed their capacities. The sources of water are reduced due to the destruction of the vegetation, which also strips the fauna from its niches and habitats; the disappearance of mangroves from the coastal areas, which facilitates flooding and diminishes fishing; and the annihilation of the vegetation of the highlands called «paramo.» Lakes, marshes, and downstream watercourses are being dried up and embanked to prepare land for inhabitation and agriculture. Mining has sterilized the land and contributed to the sedimentation of watercourses and the destabilization of mountainsides. In the inter-Andean region, these processes originate intense hydrodynamic events, such as landslides, floods, and avalanches that destroy housing units and infrastructure works and generate loss of life. Industrial and farming activities carried out in poorly chosen sites pollute cities, valleys, water, vegetation, and the atmosphere, as well as it can potentially become serious technological hazards for neighboring human settlements. Urban sprawl has been polluting the best agricultural, pasture and forest soils, while generating subnormal human settlements in degraded areas as a result of social maladjustment in the land tenure structures (Blanco-Alarcón et al., 1989).

Vulnerability: Deficit of Development

The *vulnerability* of ecosystems, of human settlements or of the urban environment depends on the population concentration. It is intimately linked to the social processes developed in the cities and is usually related to the frailty, susceptibility or lack of resiliency of those elements exposed to different types of hazards. The convulsion of these two circumstances determines the degree on the conditions of risk of the exposed elements. Consequently, risks are intimately linked not only to the degradation of the urban environment, but also to the degradation of the natural environment that has been intervened or is in the process of being transformed. In conclusion, environmental degradation, impoverishment and crisis situations are nothing but environmental events, and their manifestation is the result of the social construction of risks, that is, the incubation of vulnerability and/or hazards.

Little has been done to create an adequate theoretical framework that relates environmental degradation with the generation of risks and crisis, perhaps because such a relationship is widely accepted or is simply considered being evident. The current parameters for the transformation of society and the environment indicate that it is progressively harder to separate the so-called natural hazards from other human and environmental trigger agents. Consequently, it is widely accepted that environmental degradation generates risks since it represents a reduction in the (natural, physical and social) productivity of nature and society. To review the origin of crisis or disasters and to admit that they represent the materialization of the conditions of risk that arise from the action of hazards and the exposure of vulnerable elements may facilitate finding the relationship among these macro concepts. For example, the acceptance that, in many instances, hazards may be classified other than strictly natural, as socio-natural, man-made pollutant or man-made technological, conducts us to the idea that hazards arise from the interactive processes between human beings and nature. It also leads us to think that environmental degradation generates conditions of risk, as it contributes to an *increase of the vulnerability* of human settlements or ecosystems and of hazards themselves (Lavell, in the present volume).

Disaster: Severe Environmental Impact

In accordance with the previous arguments, a disaster is then the materialization of risk. It represents an environmental impact with a variable dimension in terms of volume, time and space. Some disasters cause few deaths; others affect millions of people. Some are short-lived; others are slow and may last years. Some physically affect a few square kilometers; others cover several countries.

Although scientifically environmental impact could be considered as disaster, most people interpret as disasters only those manifestations that significantly modify the volume or distribution of the human population. This explains why those events that occur in "empty" regions, where no human settlements exist, are rarely perceived as disasters. A highly populated settlement might be more affected than a smaller settlement in absolute terms, but less affected in relative terms (Clarke, 1989).

Although widely accepted, the degree of a disaster depends not only on the number of people affected but also on the ecological, economic and social characteristics of a settlement. An event that does not affect people directly but damages other renewable and non-renewable natural elements, would be classified as a disaster.

From a time perspective, disasters are commonly interpreted as the serious consequences of a "sudden" event, a quality whose perception varies according to the context in which it is used. "Sudden" acquires a different connotation when its point of referral is a lifetime, than when it is related to the timeframe of the history of humanity. As an analogy, when related to public health, there is a trend to use the term *disaster* to refer to emergencies and even to epidemics, rather than to endemic diseases that has persistently been part of humanity.

Defining the duration of a disaster presents a real difficulty although, as previously mentioned, many relate it with its demographic effects. On the one end of the time scale are those disasters of instant impact caused by events such as earthquakes, volcanic eruptions and airplane crashes. On the other end are those disasters of long-term impact caused by phenomena such as drought, famine and wars, events that usually have the worst demographic impact. Sudden and unpredictable disasters whose causes are historically well known generally produce greater fear and

are perceived as catastrophic, precisely because they are unexpected and cause sensationalism.

Another aspect related to time is the frequency of the phenomena. For example, some societies are adapted to an environment highly prone to disasters, where the occurrence of events is almost part of their lifestyle. On the other hand, those societies that are settled in an environment where the occurrence of events is sporadic consider them to be fortuitous contingencies.

The spatial impact of hazards is particularly varied. Therefore, some disasters are isolated and affect a very specific region, while others are scattered and widespread. Some disasters are the result of the effects over one settlement, while others sufficiently extensive affect several settlements.

The area of influence of an airplane crash or of a volcanic eruption is generally considered to be small and discrete, while that of a drought, famine, or epidemics can reach great proportions, even of continental scale, usually trespassing political borderlines.

In conclusion, the concept of environmental impact or disaster is relative to the way in which it is described (time, spatial and volumetric dimensions), and depends on the social value that the community assigns to it. I have elaborated during the past years a list of definitions that seeks to associate the concepts used in disaster prevention with those used in environmental management. It takes into account some of the definitions used by international agencies. Its objective is to contribute to a coherent and unified use of terms. This glossary is in the accompanying appendix.

THE APPROACH OF THE NATURAL AND SOCIAL SCIENCES

Despite pioneer efforts of social scientists during the mid 20th century, risk evaluation and disaster prevention have been addressed internationally only during the past few years. Researchers of the natural sciences practically have taken upon themselves the task of systematically conceptualizing and analyzing them. They elaborated studies about geological (i.e. earthquakes, volcanic eruptions), hydro-meteorological

(i.e.hurricanes, floods) and technological (industrial accidents) events. That is, during most of the time and particularly recently, the emphasis was directed towards the knowledge about *hazards*, precisely because of the academic and investigative bias of those who generated the most recent theories on this topic.

It is important to mention that such emphasis still prevails particularly in developed countries, where because of the level of technological development, research seeks to learn with greater detail about the phenomena that generate hazards. This marked trend became evident during the first years of the "International Decade for Natural Disaster Reduction," declared by the United Nations as closure for the last years of the present millennium.

If the intention is to estimate risk, undoubtedly hazard research and evaluation is a step of fundamental importance. However, to reach such an objective it is equally important to study and analyze vulnerability. This is why more recently several specialists started to raise the need to study *physical vulnerability*, which was basically associated with the degree of exposure and the fragility or capacity of the elements exposed to the action of phenomena.

This last aspect permitted the opening of the field to a multidisciplinary arrangement because of the need to involve other professionals, such as engineers, architects, economists and planners. Eventually, these professionals have found it particularly important to consider both hazards and vulnerability as fundamental variables for physical planning and for generating housing and infrastructure construction codes.

Despite this step forward, the technocratic approach still prevails, as it continues to emphasize the trigger event of the disaster. It pays little attention to the conditions that make possible the occurrence of the crisis, which include not only the conditions of physical vulnerability, but also those related to *social vulnerability*. In most cases in developing countries, social vulnerability generates the conditions for technical vulnerability. Different from a hazard that acts as the trigger event social vulnerability is a condition that prevails through time, and is intimately linked to cultural aspects and to the level of development of the communities.

It has only been in the past few years that a greater number of social scientists have become interested once again in the topic. Thus, there are still theoretical vacuums that prevent us from understanding completely the problem of risk and the real possibilities for its mitigation. The interpretation of vulnerability and risk given by geophysicists, hydrologists, engineers and planners can be extremely different from that of the people and communities exposed. Therefore, it is necessary to study further the individual and the collective perception of risk, and to investigate the social, developmental, and organizational characteristics of the societies that either favor or hinder prevention and mitigation. These are two aspects of fundamental importance in finding efficient and effective methods to reduce the impact of disasters in the world.

PREVENTION AND SUSTAINABLE DEVELOPMENT

The concept of *development* intends to communicate that the environment can somehow be more productive or "better," depending on ecological, political, cultural and technological factors. *Sustainable* refers to the endurance or prolongation of a process or activity over time. The term *development* and *sustainable* seem to be contradictory; however, it does not take too much optimism to believe that development can be sustainable through technological innovations and the implementation of management strategies such as *prevention*.

An advantage derived from improving the living conditions of human beings is to obtain a greater degree of safety and survival with respect to the actions and reactions of the environment. And this may be achieved by understanding the interaction between them (Duque, 1990). Thus, it may be inferred that *prevention is a fundamental strategy for sustainable development*. It allows the natural ecosystem and the society that inhabits and exploits it to coexist harmoniously by regulating and directing human action upon the environment and vice versa.

The challenge that sustainable development currently faces is to change the approach of environmental management from reaction to prevention. This implies reducing eventually the need to correct problems on the run and to recommend attenuating measures, as well as consolidating the implementation of previously evaluated alternatives whose

advantages, disadvantages, and interaction scenarios have been foreseen (Wathern, 1988). For planning purposes, both risk and environmental impact analyses share great similarities and relate to each other. Both analyses seek to determine the consequences of environmental change (Clarke and Herington, 1989).

In general terms, considering the knowledge, use, conservation, preservation, and promotion of natural resources as activities inherent to environmental management, the concept of prevention is linked to each and all of them. In other words, prevention can be clearly defined as a strategy of environmental management.

The Planning Perspective

In a significant number of countries, phenomena of natural and man-made origins continuously and severely affect human settlements. Such effects fundamentally result not only from the occurrence of phenomena, but also from the high levels of vulnerability that characterize these settlements as a result of disorderly urban growth and the type of technologies utilized.

Risks may be reduced if they are understood as the result of relating hazard, or the probability of occurrence of an event, with vulnerability, or the susceptibility of the elements exposed. Protective measures, such as the use of non-vulnerable appropriate technologies, land use regulation, and environmental protection, are the foundation to reduce the consequences of natural and technological hazards (Cardona, 1990).

Population increase and densification in large urban centers, the development of vulnerable technologies, and environmental degradation worsen the effects of natural phenomena such as earthquakes, volcanic eruptions, floods, and landslides, on the people, their goods, and infrastructure. The losses can severely affect the economic and social development of regions or countries whose recuperation can take several years (Cardona, 1991).

Therefore, *the reduction of vulnerability must become an explicit goal of development*, understanding development as the improvement of not only the living conditions but also of the quality of life and social welfare. Beyond ideological arguments, the objective of development must be to meet the needs of mankind and its environment, as well as

growth with quality. In general terms, safety is a fundamental component of a human sustainable development. Thus, *prevention* is a *fundamental strategy* towards achieving equilibrium between human settlements and nature. Conventional development indicators - i.e. economic growth, the accumulation of wealth and generation of income - usually promote short-term actions with consumption/production purposes that impel the degradation of natural resources and do not consider prevention and mitigation. On the other hand, indicators such as the Human Development Index (HDI, proposed by the UNDP) present further elaborated criteria by which development can be elaborated.

The natural environment may be characterized by the existence of extreme trigger events, which may be of a sudden and intense nature or advanced degradation processes that frequently surpass the critical thresholds. In such cases, identifying the vulnerabilities of the elements exposed and analyzing their origin and social and territorial accumulation across time would allow for the establishment of priorities regarding which physical, environmental, and social measures to be taken to neutralize or reduce vulnerabilities. The identification and analysis of physical, environmental, social, economic, and cultural vulnerabilities, among others, is a tool of diagnosis that facilitates the classification of the problems and deficiencies of development. It leads to establish priorities as to which political, economic, social, and environmental actions must be implemented to achieve a balanced development.

It is necessary to elaborate techniques to monitor, on the territorial, the social accumulation of vulnerabilities. The early identification of the development of trigger processes would facilitate the dynamic application of realistic planning techniques. This type of preventative and prospective approach may be promising due to the degree of uncertainty and instability that currently characterizes the processes of change. It is due to the new postmodern conditions of the world and the inability to propose medium and long-term plans that techniques can be implemented without major traumatic effects.

Despite the fact that many societies in developing countries live in pre-modern conditions, modern and postmodern elements influence their dynamics of growth and development. In view of those characteristics of change, fragmentation and ephemeral images, it is necessary to propose flexible planning models that allow for a more adequate incorporation of

uncertainty, instability and surprises. These models imply dynamic planning with early alert techniques that anticipate the conditions of the social environment and the disturbing agents; that is a preventative and prospective vision of development.

Risks and the Urban Habitat

The elements of the urban habitat that are exposed to risks are resources and services that can be affected by the occurrence of an event; that is, human activities and systems such as buildings, infrastructure, production centers, services, and the people who use them.

Generally, high-risk zones coincide with those areas that present subnormal or marginal conditions. The family income of the settlers precludes them from having access to institutional housing credit, when it is available. The costs of relocating the inhabitants, the lack of technical and financial resources in the municipalities, and the limited economic capacity of the potential beneficiaries convey the need to resort to the assistance of provincial, and national governmental entities and non governmental organizations (Ramírez, 1991).

Thus, the development of new housing projects, the relocation of human settlements and the improvements to housing and to the environment require financial support and technical assistance from governmental agencies and non-governmental organizations. Adequate construction techniques should be promoted as to guarantee the protection of the investment and the patrimony of the families that participate from such programs. Not only would their use contribute to the reduction of risks, but it would also improve the quality of life of the population that is exposed to hazards, who usually live in poverty as a result of the prevailing land ownership patterns.

From the human ecology perspective, it is important to mention that risks arise from the inadequate development of human settlements. It is not only in terms of their location in areas prone to natural or industrial/technological hazards, but also because of urban disorder, the loss of public spaces and low levels of environmental sanitation (CNUAH-HABITAT-JNV, 1988).

According to the World Bank projections, in the next 30 years a considerable number of developing countries will duplicate their urban popu-

lation. As a result of this urban disorder, growing difficulties in the provision of public services and in the industrialization processes will appear. Vulnerability will probably increase dramatically. The only way to make possible a balanced process that could be interpreted as sustainable development is to incorporate preventative criteria in physical (urban and/or territorial), sectarian and socioeconomic planning, and to formulate indicators geared towards the early detection of crisis.

Institutional Organization

It is unavoidable to conclude that in developing countries there is a lack of coherent organizational institutions that carry out those activities inherent to environmental management. On the contrary, dispersed entities from different sectors and at different hierarchical levels have been performing one or several functions related to the administration of renewable natural resources or the control of environmental degradation factors (Departamento Nacional de Planeación, 1991).

Consequently, an adequate coordination among the national, provincial and municipal levels, and among those sectors involved in environmental management, is required for the formulation of policies and their implementation. The objective of this approach is to avoid the contradictions, disagreements, and vacuums that usually end up harming not only the resources, but also their users.

On the other hand, and usually as a result of a large-scale disaster, Latin American countries have created organisms whose principal objective is emergency preparedness and response planning. Under this institutional figure, civil defense or protection organizations usually administered by active or retired military officials have been created. With some exceptions, these types of organizations are of national scope, have little local presence, and have not included actions related to prevention and mitigation within their activities. Therefore, those activities inherent to risk reduction and management of the environment and the urban habitat have not been carried out coherently. In the best of cases, they have been carried out in a scattered manner by entities from diverse sectors. These entities do not have links with the localities and do not present proper orientation and coordination.

The inter-institutional organizations recently created in some countries were conceived considering the need to coordinate properly the formulation of policies and their execution among the national, provincial and municipal levels, and among sectors involved in prevention and mitigation as well as emergency response. These types of structures have been named *systems*. Contrary to the centralized models based on a single directing entity, the systems rely on a network of institutions coordinated by focal entities in each territorial level (national, provincial-departmental-state, municipal) that orchestrate disaster prevention and response activities in accordance with the expertise, jurisdiction and autonomy of each institution.

The National System for Disaster Prevention and Response of Colombia is an example of this type of institutional model, as it was established with governmental entities and existing non-governmental organizations at all levels. These institutional systems were conceived to allow the decentralization of actions and the support of both the central government and international technical cooperation agencies in the areas of environmental management for risk mitigation and the rehabilitation of affected areas. Disaster prevention and response activities are being developed under a national plan that defines for each field of action the national objectives to be promoted and developed during the International Decade for Natural Disaster Reduction. Among these objectives are: the elaboration of maps depicting hazards and high risk zones; the instrumentation and monitoring of natural phenomena; institutional and financial strengthening; the stock provision and furnishing of emergency storage centers and the elaboration of contingency plans; education and training; incorporation of prevention in regional and municipal development plans; vulnerability analysis and relocation of settlements in high risk areas; post-disaster rehabilitation; and, the recovery of degraded hydrographic basins. These objectives are promoted at the local, provincial, and national levels through the inter-institutional coordination of governmental entities and non-governmental organizations.

An inter-institutional organization is a *system* only when its structure corresponds to that of a model of entities that are interdependent for purposes of environmental management; that is, prevention, response and rehabilitation, while conserving their autonomy with respect to their individual sectarian and territorial jurisdiction and responsibilities. The

activities and results of the system are synergic, as the actions of the whole exceed the sum of the separate actions taken by each entity. Provincial, departmental, or municipal organizational schemes are replicas or versions of the national model. The different levels act as a whole, guaranteeing the coherent flow of information and the implementation of programs and projects, vertically among territorial levels and horizontally among the components of each level, which are organizations from the State, the private sector and civil society.

The development of the type of organization depends on the historic circumstances and democratic tradition of each country. Nevertheless, currently it is recommended to promote systems that have the participation of concerned entities from the public and private sectors in accordance with their jurisdiction, to carry out management activities of operative, technical, scientific and planning character, in an organized and decentralized manner and through regional and local committees. In an inter-institutional system for environmental management and disaster prevention and response, each institution must define its functions and responsibilities at the national, provincial and local levels. One of the fundamental aspects of such a system is the clear function of national and provincial institutions as coordinating and advising agents of the local levels. The national planning systems of each country play a key role as structures that make policies coherent, while the municipalities act as implementing entities.

As a consequence of administrative centralism, local levels have ignored their role as environmental managers, a fact that could explain the indifference toward degradation. It is clear that when external forces prevent local levels from conditioning their environment, everything loses the sense of ownership. When an absorbing centralism assumes powers to control natural resources, these end up belonging to nobody and losing interest for everybody.

Local governments can assume the responsibility of managing the environment and the habitat, emergency preparedness, and disaster prevention and mitigation implementation. The fundamental argument is the necessity to recuperate a consciousness about the region and the locality, which also represents the beginning of a new concept about the level of acceptable risk and the value attached to environmental impact.

Such an appraisal comes from the citizenry and is developed from the bottom up, in accordance with democratic rights and responsibilities.

CONCLUSIONS

Disasters are environmental impacts that vary greatly in spatial, time and volumetric terms; reasons why their qualification is relative and depends on the social value assigned by the community. There is tendency to relate the magnitude of disasters with those events that affect demographic distribution. However, from the scientific perspective any severe environmental impact is a disaster, even when there is no direct effects over the population, goods and services, the effects can be of ecological nature, resulting from natural or man-made actions. In such situations it is valid to apply the concept that fighting nature is fighting oneself.

The only way to make possible a balanced process that could be interpreted as sustainable development is to incorporate prevention criteria into physical (urban and/or territorial), sectarian and social-economic planning, and to formulate prospective models of indicators to detect through early warnings any future crises. Therefore, any policy that incorporates the principles of ecological, social, cultural, and economic sustainability must include the following elements: an explicit planning of the use of the environment and its resources as an instrument of *prevention and regulation*; the technological response to instrument efficiency and as a complementary resource for the proper transformation and modeling of nature; education and information to generate a sense of responsibility in the population and to incorporate prevention in the culture; community organizing and participation as an instrument of adaptation of the social system with a democratic foundation; and, legal and juridical action to instrument the legalization and control of the rights, responsibilities and actions of mankind over the environment.

The reduction of vulnerability must be an explicit objective of development, as it represents a deficit in the conditions and quality of life of the population. Consequently, prevention and mitigation are a fundamental and unavoidable strategy towards sustainable development.

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APPENDIX: GLOSSARY OF TERMS AND CONCEPTS

Acceptable risk: Probability value of social, economic or environmental consequences. According to the judgment of the regulating authorities, it is considered to be sufficiently low as to allow its use in planning, the formulation of the quality requirements of the elements exposed, or to create compatible social, economic and environmental policies.

Damage: Economic, social or environmental loss, or degree of destruction caused by an event.

Development: Process constituted by activities that lead to the use, improvement, and/or conservation of the system of goods and services. It takes into consideration the prevention and mitigation of hazardous events that could generate negative environmental impacts, with the purpose of maintaining and improving the safety and quality of human life.

Direct effects: Those effects that have a direct causal relationship with the occurrence of an event, usually represented by the physical damage on the persons, goods, services and environment, or by the immediate impact on social and economic activities.

Disaster: Situation caused by a phenomenon of natural, technological or man-made origin that signifies intense alterations in the people, goods, services and/or the environment. It is the effective occurrence of an event that, as a consequence of the vulnerability of the elements exposed, causes adverse effects upon them.

Ecology: The study of the structure and function of the ecosystems. Discipline that studies the requirements that economic activity must fulfill and the external limits that it must respect as to prevent effects contrary to its objectives.

Ecosystem: Spatial unit defined by a complex of physical and biotic components and processes that interact in an interdependent manner and create particular flows of energy and cycles or movement of materials.

Elements exposed (at risk): The social, material, and environmental contexts represented by the persons, resources, and services that may be affected by the occurrence of an event. Human activities include all the systems made and operated by man, such as buildings, vital lines, or infrastructure, production centers, services, the people that use them and the environment.

Environment (Human Environment): Set of conditions or influences that affect human behavior, either as individuals or as a society. It is the shape and function of the ecosystems that surround and support human life.

Environmental impact: (Negative) The result of any developmental activity or of a hazardous event that disables, deteriorates, or destroys goods and services that could be or are used to improve the quality of life of human beings.

Environmental management (Gestión Ambiental): Integral management of the environment that incorporates the criterion of equity to obtain the welfare and harmonic development of human beings, as to improve the quality of life and maintain the availability of resources, without exhausting or deteriorating renewable resources nor squandering those that are non-renewable. The welfare of both present and future generations is considered.

Environmental management (Manejo Ambiental): Planning and implementation of actions geared towards improving the quality of life of human beings. Mobilization of resources, employment of measures to control the use, improvement, or conservation of resources and natural and economic services, as to allow the minimization of the conflicts originated by the use, improvement or conservation.

Environmental quality: Relative capacity of an environment to satisfy the needs or desires of an individual or society.

Environmental science: The study of the natural processes that make up the air, land, water, energy, and life systems, their interaction among themselves and with human beings.

Event: Description of a natural, technological, or man-made phenomenon in terms of its characteristics, severity, location and area of influence. It is the registry in time and space of a phenomenon that characterizes a hazard.

Forecast: Determination of the probability of occurrence of phenomena based on the study of its generating mechanism, the monitoring of the perturbing system, and/or the registry of events through time. A forecast might be short term, usually based in the search and interpretation of signs or premonitory events. It might be medium term,

based on the probabilistic data; or it might be long term, based on the determination of the maximum probable event that can occur in a given period of time and that can be used as a planning tool for the potentially affected area.

Goods and services: Specific components and processes of the structure and function of ecosystems that are relevant or valuable for the population.

Hazard: Latent danger associated with a physical phenomena of natural, technological, or man-made origin that can materialize in a specific place and a determined period of time, producing adverse effects on the people, goods, services and/or the environment. Technically, it refers to the probability of occurrence of an event of certain intensity in a specific place and in a determined period of time.

Hazard evaluation: The process through which the probability of occurrence and the severity of an event are determined for a specific period of time and a determined area. Represents the estimated recurrence period and geographical location of probable events.

Hazard management: Mitigation measures related to the intervention of phenomena associated with a hazard. Whenever feasible, hazard management refers to the control or channeling of physical phenomena through technical and scientific methods, protective public works, or security measures that prevent the occurrence of hazardous events.

Indirect effects: Those effects that have a causal relationship with direct effects, and are usually represented by a series of concatenate or subsequent impacts over the population, its economic and social activities, or over the environment.

Intensity: Quantitative or qualitative measurement of the severity of a phenomenon in a specific place.

Intervention: Intentional modification of the characteristics of a phenomenon with the objective of reducing a hazard or of the intrinsic characteristics of an element with the objective of reducing its vulnerability. The intervention seeks to modify risk factors. Both to control or channel the physical course of an event, or to reduce the magnitude and frequency of a phenomenon, are measures related to the intervention of the hazard. Minimizing to the extent possible any material damage through the modification of the resistance to impact of the exposed elements are structural measures related with the intervention of the physical vulnerability. Those aspects related to physical planning, land use regulation, insurance, emergency measures, and public education are non-structural measures related with the intervention of the physical and functional vulnerability.

Lifelines: Basic infrastructure of networks, pipelines, or connected or continuous elements that allow the distribution of electricity, water, fuels, information, and transportation of people and products, necessary for society to carry out activities with efficiency and quality. Energy: dams, substations, electrical lines, fuel storage plants, oil and gas pipelines. Transportation: Road networks, bridges, transportation terminals, airports, ports. Water: Treatment plants, potable water and sewerage systems, irrigation channels, and conduction. Communications: Telephone plants and networks, radio and television stations, post offices, and public information agencies.

Loss: Any negative value of economic, social, or environmental nature reached by a variable during a specific period of exposure.

Man-made: Of human origin or from human activity.

Mitigation: Those intervention measures taken to reduce or diminish risk. Mitigation is the result of the political decision of setting a level of acceptable risk, which is obtained through an extensive analysis of the risk and the understanding that it cannot be totally reduced.

Pollution: Entropy process caused by human activity against the trends that determine the proper equilibrium among living beings. It is one of the indexes that characterize the antagonism that can occur between development and the quality of life.

Prevention: Set of measures and actions taken in advance with the purpose of avoiding the occurrence of an event or reducing its consequences over the population, goods, services and the environment.

Resiliency: Capability of an ecosystem to recuperate once affected by an event.

Risk: The probability of occurrence of economic, social, or environmental consequences in a particular place and during a determined time of exposure. It is calculated by relating the hazard with the vulnerability of the elements exposed.

Risk evaluation: In its simplest form, it presents risk as the result of the relationship among hazard, vulnerability, and the elements exposed, with the purpose of determining the possible social, economic, and

environmental consequences associated with one or more events. Changes in one or more of those parameters modify risk in itself, or the total of expected losses in a determined area by a specific event.

Risk management: Integral activities taken to avoid or reduce the adverse effects on the people, goods, services, and the environment, through preventative planning and the preparedness for the response of the potentially affected population.

Subject: Component of an ecosystem that may be understood as a group of elements that represent the persons, goods and services, economic activities and/or the environment.

Sustainable development: Process of natural, socioeconomic, cultural, and institutional transformations whose objective is to insure the improvement of the living conditions of human beings and of its production, without degrading the natural environment or compromising the foundations of a similar development for future generations.

Vulnerability: Internal risk factor of a subject or system exposed to a hazard that corresponds to its intrinsic predisposition to being affected or to being susceptible to suffering a loss. The different degree of vulnerability of the elements exposed to an event determines the selective character of the severity of the consequences of such an event on them.

Vulnerability analysis: The process through which the level of exposure and the predisposition to loss of an element or group of elements that face a specific hazard are determined.