INTER-AMERICAN DEVELOPMENT BANK

Universidad Nacional de Colombia - Sede Manizales
Instituto de Estudios Ambientales
- IDEA -

INFORMATION AND INDICATORS PROGRAM FOR DISASTER RISK MANAGEMENT

IADB - ECLAC - IDEA

EXECUTION OF COMPONENT II

Indicators for Disaster Risk Management

OPERATION ATN/JF-7907-RG

THE NOTION OF DISASTER RISK

Conceptual Framework for Integrated Management

Study coordinated by
Instituto de Estudios Ambientales

Manizales - Colombia
August 2003

INFORMATION AND INDICATORS PROGRAM FOR DISASTER RISK MANAGEMENT

IADB - ECLAC - IDEA

EJECUTION OF COMPONENT II

Indicators for Disaster Risk Management

OPERATION ATN/JF-7907-RG

THE NOTION OF DISASTER RISK

Conceptual Framework for Integrated Management

Prepared by
Omar D. Cardona
Technical Director

With
Jorge Eduardo Hurtado **Ann Catherine Chardon**
Gonzalo Duque **Luz Stella Velásquez**
Alvaro Moreno **Samuel D. Prieto**

Taking into account
The expert meeting on disaster risk conceptualization and indicators modeling, Barcelona, July 9, 10 and 11 of 2003

Ian Davis **Allan Lavell**
Alex Barbat **Philippe Masure**
Lino Briguglio **Louise Comfort**
Terry Cannon **Andrew Maskrey**
Neil Doherty **Tova Solo**
Caroline Clarke **Kari Keipi**

Manizales - Colombia
August 2003

THE NOTION OF DISASTER RISK

Conceptual Framework for Integrated Management[1]

1. Summary

Collective risk means the possibility of future disaster. The term "disaster risk" suggests that there is a possibility that a dangerous phenomenon or event will occur and that there are exposed elements predisposed or susceptible to being affected. The reduction of risk therefore means the reduction of the possibility of future disaster.

Risk management involves three different public policy components or strategies: risk identification (which includes individual perceptions, social representations and objective estimations); risk reduction (prevention-mitigation); and, disaster management (response and recovery). Risk transference (insurance and financial protection) comprises an additional policy measure, but significant advances have only been achieved in developed contexts. These different policy areas imply different disciplinary approaches, values, interests and strategies and involve different social actors. Effectiveness in the use of these approaches can only be achieved through interdisciplinary and integrated approaches. The reduction of collective risk implies intervention in causal factors. Disaster management signifies efficient response when risk is materialized as disaster. And, risk transference implies risk evaluation for economic units. Therefore, risk management inevitably requires an understanding of how risk is perceived by society, how it is represented (models, maps and indicators) and how it is measured or dimensioned.

Psychologists, sociologists and historians generally consider risk a social phenomenon. This approach may be termed "constructivist". From this perspective, understanding of risk requires knowledge of individual perceptions and social representations and of the interactions between different social actors. On the other hand, engineers, geologists, geographers, economists and epidemiologists generally adopt an approach that may be described as "realist" or "objective", based on the hypothesis that risk can be quantified or objectively assessed.

The antagonism between the "objectivist" and "constructivist" paradigms must be transcended and more confidence must be placed in both qualitative and quantitative methods. Action and decision, implicit in the definition of risk, require a compromise between subjective risk perception and the scientific need for objective measurement. There is the need for a common language and holistic theory of risk. While the objective approach lacks the social dimension, which is an important consideration when assessing disasters, subjective definitions are equally

[1] This document is the result of inputs and discussions of the local group of experts of the Instituto de Estudios Ambientales, IDEA, Universidad Nacional de Colombia, Manizales, and the contributions made during the expert meeting on disaster risk conceptualization and indicators modeling, held in Barcelona in July 9,10 and 11, 2003, for the execution of the Component II, Indicators of Risk Management, IADB Operation ATN/JF-7907-RG. This report has been developed by Omar D. Cardona, technical director of the project and the opinions expressed herein are only those of the authors and do not necessarily reflect the position of the Inter American Development Bank. The document is located in: http://idea.unalmzl.edu.co

unsatisfactory, since this implies that risk is a matter of personal interpretation only. This position is totally inoperable when intervention in risk becomes a must from the public policy angle.

The estimation of future effects and/or losses in determined material and social contexts allows the design of measures that avoid or attenuate the consequences of future disasters. These may then be included in development plans and investment programmes. Methodologically, the identification and analysis of natural and anthropogenic hazards and physical, environmental, social, economic and cultural vulnerability comprise a diagnostic tool that facilitates the classifying of development problems and deficiencies. It also facilitates the prioritization of political, economic, social and environmental actions that may be taken in order to achieve balanced development.

The development of techniques that permit a permanent monitoring of territorial and social accumulation of vulnerability or the evolution of physical trigger processes is conducive to the application of realistic and dynamic planning techniques. This should be flexible enough to adjust to continuous or abrupt changes in the natural, economic and social environment. This type of corrective and prospective approach is more appropriate than the uni-dimensional approaches, given the levels of uncertainty and instability that characterize existing processes of change and which render long term plans almost impossible to realise. In many developing countries economic, social and cultural factors are becoming increasingly relevant to the dynamics of growth and progress. In view of this, we need to develop less rigid planning models that allow us to more adequately incorporate uncertainty, instability and surprise, using diagnostic and follow up techniques that permit the monitoring of the social environment and possible perturbing agents. In other words, we need a preventive vision of development.

2. Introduction

Differences in the meaning of risk may impede successful, efficient and effective risk reduction. The conceptual frameworks used to understand and interpret risk, and the terminologies associated with these, have not only varied over time, but also differ according to the disciplinary perspective considered. Despite the refinement with which risk is considered in the different fields of knowledge, there is, in reality, no singular concept that unifies the different approaches, or that brings them together in a consistent and coherent manner.

Risk is a complex and at the same time, curious concept. It represents something unreal, related to random chance and possibility, and which has not yet materialized in real damage and loss. It is imaginary, difficult to grasp and does not exist in the present. If there is certainty there is no risk. Thus, risk is something mental and closely related to personal or collective psychology. But, it is often analyses as if it is only an objective phenomenon (Elms 1992). Moreover, it is a complex concept and a composite idea. In a more integral notion of risk, three separate aspects converge: eventuality, consequences and context. These three aspects all contribute in attempts to estimate or grade risk. In risk analysis, the context (management capacity and related actors) determines the limits, reasons, purpose and interactions to be considered. Analysis has to be

congruent with context and this must be taken into account when analyzing the sum of the contributing factors. If not, analysis would be totally irrelevant or useless.

Historically, risk analysis has been used informally in innumerable human situations. Risk has always been associated with decision and with purposeful action; with the execution of actions that range from trivial to important. The notion of risk has a performance character. In all cases, an action must be decided upon. The results of these actions are in the future and these imply uncertainty. The selection of a future line of action implies possible adversity or contingency. For this reason, risk should be evaluated such that a decision can be taken. Discussions on risk can be found in the history, knowledge base, values, emotions and even the very existence of society. These include reflections as to the nature of scientific knowledge, an understanding of the visions that substantiate different arguments and rationalization as to what we fear and as to the ways we should act. The ability to comprehend, despite uncertainties in the analysis of physical systems, is one of the circumstances that define if a given model provides an adequate representation of the problem under consideration. This means transiting from the concept of truth to the concept of control or management. This decreases the need to obtain true predictions of future scenarios, with or without the estimation of uncertainties, and motivates a move in favor of the control of future events, accepting the existence of unavoidable uncertainties. Thus, despite the fact that engineering science can make certain predictions about risk, such predictions will unavoidably be partial or incomplete. For this reason emphasis should be placed on managing or handling security (Blockley 1992).

Although, recently, economic, social and environmental consequences of a physical phenomenon have been considered in for risk management purposes, risk has not been conceptualized in a comprehensive way. Rather, fragmentation has been common and risk has been estimated or calculated according to different disciplinary approaches. In order to estimate risk on a multidisciplinary basis, we need to be aware not only of the expected physical damage and of the victims or economic losses, but also of social, organizational and institutional factors. At the urban scale, for example, vulnerability, seen as an internal risk factor, must be related not only to the exposure of the material context or the physical susceptibility of the exposed elements, but also to the social frailties and lack of resilience of the prone communities. This means looking into the capacity to respond or absorb the impact. Deficient information, communications and knowledge among the social actors, the absence of institutional and community organization, weaknesses in emergency preparedness, political instability and the absence of economic health in a geographic area, all contribute to greater risk (Cardona 2001). That is why the potential consequences not only relate to the impact of the event, but also to the capacity to absorb the impact or bounce back from it.

3. Differences between risk and disaster

Disaster is a social context or process, triggered by a natural, technological or anthropogenic phenomenon, which on interaction with a vulnerable medium causes intense alterations in the normal functioning of the community. These alterations may be expressed, amongst other things, as loss of life, serious health problems, damage or destruction of individual and collective goods

or severe damage to the environment. For this reason, rapid response is required by the authorities and the population in order to restore the well-being of affected persons and to re-establish adequate levels of normalcy.

Disaster implies loss and damage and consequential impacts that the affected community is unable to absorb or to cushion the effects and recover using its own resources and reserves. This suggests that there are levels and types of loss and damage that do not signify disaster for society. Disaster is a given situation, a product that is tangible and measurable.

Disaster supposes the prior existence of determined risk conditions. That is to say, disaster is the materialization of pre-existing risk. On the other hand, when defined as the probability of future loss, a disaster can be explained by the prior existence of a latent threat and certain intrinsic or constructed characteristics of society that predispose it to suffer determined levels of damage. Disaster risk may be considered a collective or public risk. It is the type of risk, which signifies a threat to all members of the prone community. Once this risk is recognized as such by the community something must be done about it. Commitment by public and private institutions and the community itself becomes a must. But, collective risk supposes a series of interdependent, dynamic and uncertain problems that require collective action in order to solve them. Unfortunately, it is not uncommon for communities that are exposed to and aware of dangerous phenomenon to do nothing about it due to resource restrictions, or because perception of the danger is insufficient to stimulate collective action. On occasions, some community members are conscious of the danger and carry out individual actions to reduce it, but the community as a whole still remains vulnerable. The risk level of a society is related to its development level and the ability to modify the risk factors that affect it. In this sense disasters may be considered unmanaged risks. Risk is constructed socially, even where the physical phenomenon is natural.

Definitions and concepts may hide many different aspects and vary notoriously with scientific discipline, ideology and ontological viewpoint. As with almost all conceptual processes, the epistemological foundations and context are crucial for understanding the way a topic is dealt with. For example, “the reduction [or mitigation] of natural disasters” has been a useful slogan for mobilizing support in general, but from a conceptual viewpoint this terminology is imprecise and confusing. What is it precisely we search to reduce or mitigate? Although it may seem to be a subtlety, it is a very different thing to talk of “disaster risk reduction” as opposed to “natural disaster reduction or mitigation”. From a decision-making viewpoint or from the point of view of the public in general, different ways of defining the same term will elicit different responses. Moreover, the risk *of* disaster used to refer to a probability is different to risk *from* disaster, which refers to feasible consequences. Concentrating on “risk” clearly allows us to discriminate between activities *ex ante* and *ex post*, and between the needs and activities relevant to one or another of these situations. Here, it is clear that the management approach has been long dominated by consequences (interest in humanitarian response) and not be an interest in the probability that these will occur (interest in prevention). Although these approaches have common objectives, they signify different things in terms of funding, methods, functions, interests and expertise. In other words, it is not the same to visualize the problem from a social

and economic development perspective, for example, as it is to look at it from the perspective of preparedness for humanitarian emergencies

In spite of the fact that confused perceptions exist as regards the notion of *vulnerability*, this expression has helped clarify the concepts of *risk* and *disaster*. These conditions or notions were for a long time associated with a single cause: an inevitable and uncontrollable physical phenomenon. On the other hand, the notion of vulnerability was borne out of human experience in situations where it was often difficult to differentiate normal day-to-day life from disaster. Vulnerability may be defined as an internal risk factor of the subject or system that is exposed to a hazard and corresponds to its intrinsic predisposition to be affected, or be susceptible to damage. In other words, vulnerability is the physical, economic, political or social susceptibility or predisposition of a community to suffer damage in the case a destabilizing phenomenon of natural or anthropogenic origin occurs. Differences in the vulnerability of the exposed social and material context determine the selective character and severity of the effects associated with a particular phenomenon.

A series of extreme and many times permanent conditions exist that make life extremely fragile for certain social groups, even under normal circumstances. The existence of these conditions depends on the level of development attained, as well as the success in planning development. In this context, development may be defined as a process that includes harmony between humankind and the environment. Human development as such, allowed society to gain an adequate understanding of the elements of its own built habitat and the natural environment, and of the possibilities of harmonic interaction between them. In this context, vulnerability in social groups could then be understood as lack of capacity to 'adapt' or adjust to a determined set of environmental circumstances. With this the door may be opened for an understanding of risk and disaster based not only on the existence of threatening physical phenomenon but also on a maladapted society.

4. Revision of definitions and concepts

The formulations of the problem owe a lot to the original ideas of the so called "human ecology" school of thought first proposed by geographers at the University of Chicago during the second decade of the 20th century and further developed by White (1945/64/73), Kates (1962/71/78) and Burton (1962/68/78) in their studies on hazards and disasters.

Prompted by these ideas, UNDRO and UNESCO organized an expert meeting in July 1979 with the objective of proposing a unification of disaster related definitions. The report which came out of that meeting, *Natural Disasters and Vulnerability Analysis* (UNDRO 1980), included the following definitions:

a) Natural Hazard (H): the probability of occurrence, within a specific period of time in a given area, of a potentially damaging natural phenomenon.

b) Vulnerability (V): the degree of loss to a given element at risk or set of such elements resulting from the occurrence of a natural phenomenon of a given magnitude and expressed on a scale from 0 (no damage) to 1 (total loss).
c) Elements at Risk (E): the population, buildings and civil engineering works, economic activities, public services, utilities and infrastructure, etc. at risk in a given area.
d) Specific Risk (S): the expected degree of loss due to a particular natural phenomenon and as a function of both natural hazard and vulnerability.
e) Risk (R): the expected number of lives lost, persons injured, damage to property and disruption of economic activity due to a particular natural phenomenon, and consequently the product of specific risk and elements at risk.

From this perspective, risk may be defined as shown in equation 1

$$R = E \cdot S = E \cdot H \cdot V \quad (\text{given that } S = H \cdot V) \qquad (1)$$

Whilst essentially retaining maintaining this conceptual framework, Cardona (1985) during the Institute for Earthquake Engineering and Engineering Seismology meeting, held in 1985 in Skopje (previously Yugoslavia), proposed the suppression of the variable "exposure" given it is implicit in the notion of vulnerability. In other words, one cannot be "vulnerable" unless one is "exposed". Originally, this formulation was presented by Fournier d'Albe (1985), Milutinoviç and Petrovsky (1985) and later, by Coburn and Spence (1992). The expression of risk as a function of hazard and vulnerability now widely accepted in the technical and scientific fields, and increasingly in the social sciences, was formulated by Cardona (equation 2) as follows:

$$R_{ie} \mid_t = f(A_i, V_e) \mid_t \qquad (2)$$

This signifies that once the *hazard* or *threat-Ai-* is known (expressed as the probability that an event with an intensity greater or equal to *i* will appear during a period of *exposition t*), and the *vulnerability-Ve* is also known (understood as the intrinsic predisposition of an *element-e-* to be affected or to be susceptible to damage with the occurrence of an event with an *intensity i*), the *risk- Rie-*, is expressed as the probability of loss to the element as a result of the occurrence of an event with an intensity greater or equal to *i*. That is to say, risk in general may be understood as the probability of loss during a given period of *time-t* (Cardona 1985; 1986).

In general, the concept of hazard[2] is now used to refer to a latent danger or an external risk factor of a system or exposed subject. Hazard can be expressed mathematically as the probability of occurrence of an event of certain intensity, in a specific site and during a determined period of exposure time. On the other hand, vulnerability may be understood, in general terms, as an

[2] Although in English hazard refers to a threat or danger, or the susceptibility to suffer the random action of something, herein we chose to use the term "hazard" in an equivalent form to the way "amenaza" (it's natural translation into that language) is used in Spanish. "Amenaza" in Spanish transmits the idea of warning, presage and potential occurrence. In English, the term hazard is more directly expressed through use of the word "threat" which is in fact used by some authors as a substitute for hazard. Here, we will use the term hazard to refer to what other authors call danger, threat or dangerousness. These words may be considered synonyms in the context of the present conceptual framework.

internal risk factor, mathematically expressed in terms of the feasibility that the exposed subject or system will be affected by the phenomenon that characterizes the hazard. Thus, risk is the potential loss to the exposed subject or system, resulting from the "convolution" of hazard and vulnerability. In this sense, risk may be expressed in mathematical form as the probability of surpassing a determined level of economic, social or environmental consequences at a certain place and during a certain period of time.

It should be noted that equation 1.2 assumes the simultaneous determination or "Convolution" of hazard and vulnerability. Stated differently, one cannot be vulnerable if one is not threatened, and one cannot be threatened if one is not exposed and vulnerable. Hazard and vulnerability are mutually conditioning situations and neither can exist on its own. They are defined independently for methodological reasons and in order to achieve a better comprehension of risk. Thus, when one or another of the factors of risk is altered we are intervening risk itself. However, due to the fact that it is not possible in many cases to modify the hazard, risk reduction can only be achieved by modifying the vulnerability of the exposed elements. This is why emphasis in the technical literature is frequently placed on the study of vulnerability and on vulnerability reduction as a measure of prevention-mitigation. However, what is really intended by this is, risk reduction.

The term vulnerability has been employed by a large number of authors to refer directly to risk and they have even used it to refer to disadvantaged conditions. This is particularly true in the social sciences. Thus, for instance, people refer to vulnerable groups when they talk about the elderly, children or women, without specifying what these groups are vulnerable to. However, following on from what we have stated above, it is important to ask ourselves: Vulnerable to what? In other words, hazard and vulnerability are mutually concomitant and lead to risk. If there is no hazard it is not feasible to be vulnerable when seen from the perspective of the potential damage or loss the occurrence of an event might signify. In the same way, no hazard can exist for an element or system if such an element is not 'exposed' and vulnerable to the potential event. Even though this might seem to be an unnecessary subtlety, it is important to make this distinction, given that the adjective vulnerable is employed in different ways in problem areas other than the disaster field (Psychology, Public Health, etc). A population might be vulnerable to hurricanes, for example, but not to earthquakes or floods.

Timmerman (1981) has shown that "vulnerability is a term of such broad use as to be almost useless for careful description at present... its better use is as a rhetorical indicator of areas of greatest concern". In his work on vulnerability and resilience he concludes, with a touch of irony, that real vulnerability may lie in the inadequacy of our models of social systems and of the concepts we use (Liverman 1990).

4.1 The importance of the concept of vulnerability

Although social circumstances may be associated with vulnerability to disasters, they should not be considered the same thing as vulnerability. A clear example of this is the case of poverty, which may well be considered a factor or contributing cause of vulnerability but it is certainly not vulnerability in itself. With regards to the factors that make populations vulnerable when faced

with hazards, there can be no doubt that many disasters are the result of economic and political factors, at times exacerbated by pressures that lead to high population densities in prone areas (Cardona and Barbat 2000). In such cases, the reduction of vulnerability is closely linked to the provision of basic needs. Conversely, there is a relation between social and economic marginality or exclusion and vulnerability to disasters. But, poverty is not vulnerability and the ways that poverty contributes to vulnerability must be studied in different contexts and cases.

Vulnerability of human settlements is intrinsically tied to different social processes, but it also relates to the fragility, the susceptibility or the lack of resilience of the exposed elements. It is also closely tied to natural and built environmental degradation at the urban and rural levels. Thus, degradation, poverty and disasters are all expressions of environmental problems and their materialization is a result of the social construction of risk, brought about through the construction of vulnerability or hazard, or both simultaneously. Thus, when seen from a social viewpoint, vulnerability therefore signifies a lack or deficit of development. In this regard, risk is constructed socially, even though it has a relationship to physical and natural space. In developing countries, increases in vulnerability are likely to be related to factors such as rapid and uncontrollable urban growth and environmental deterioration. These lead to losses in the quality of life, the destruction of natural resources and landscape and loss of genetic and cultural diversity. In order to analyze vulnerability as part of wider societal patterns we need to identify the deep rooted and underlying causes of disaster vulnerability and the mechanisms and dynamic processes that transform these into insecure conditions. All this leads to the conclusion that the underlying causes of vulnerability are economic, demographic and political processes that affect the distribution of resources among different groups, which in turn reflect the distribution of power in society.

Some global processes require more attention than others. These include population growth, rapid urban development, international financial pressures, degradation of the earth, global environmental warming and change, and war. To take but a limited number of examples, urbanization processes have been an important factor in damage caused by earthquakes in urban areas; population increase helps explain increases in the numbers of persons affected by floods and prolonged droughts; and deforestation increases the chances of flooding and landslides (Blaikie, Cannon, Davis, Wisner 1994). Adhering to the hypothesis that the lack of development and vulnerability are correlated, Cardona (2001) suggests that vulnerability originates in:

a) *Physical fragility or exposure*: the susceptibility of a human settlement to be affected by a dangerous phenomenon due to its location in the area of influence of the phenomenon and a lack of physical resistance.
b) *Social fragility*: predisposition to suffer harm resulting from the levels of marginality and social segregation of human settlements and disadvantageous conditions and relative weaknesses related to social and economic factors.
c) *Lack of resilience*: limitations in access to and mobilization of the resources of the human settlement and the incapacity to respond when it comes to absorbing the impact.

This kind of thinking attempts to integrate in an holistic way the contributions of the physical and social sciences with the idea of obtaining a more complete vision of the factors that create or exacerbate vulnerability This method takes into account physical resistance and prevalent aspects of individual and collective self-protection (Cardona and Hurtado 2000).

4.2 Dimensions and types of vulnerability

Vulnerability may have various dimensions. Wilches-Chaux (1989) proposed the notion of global vulnerability in order to integrate the different facets or dimensions that characterize vulnerability. These dimensions are briefly described below.

a) *Physical dimension:* This depicts locations in susceptible areas and deficiencies in the resistance of the exposed elements. The latter affects the capacity to absorb the shocks associated with dangerous phenomenon. Examples of the physical dimensions of vulnerability can be found in inadequate levels of seismic resistance of buildings located in earthquake prone areas, the location of a community in a landslide or flood prone area etc.

b) *Economic dimension:* More economically depressed sectors are more vulnerable in general. Poverty can increase vulnerability. At the local and individual levels this is expressed in unemployment, lack of income, and difficulties in gaining access to services. At the national level, this is expressed in terms of excessive economic dependency and lack of control over external factors, lack of diversification of the economic base, restrictions on international commerce, and the imposition of retrograde monetary policies.

c) *Social dimension:* The higher the levels of social integration of the community, the easier it will be for the community to absorb the consequences of a disaster and react more rapidly. Societies may be less vulnerable when they react as an organized group or according to group interests, and more vulnerable where individual or circumstantial interests prevail.

d) *Educational dimension:* The lack of knowledge of causal factors and effects of disasters, the lack of a sense of community history and the lack of preparation and understanding of individual and group responses to disaster are all aspects that make a community more vulnerable. Deficient education or lack of educational coverage in a susceptible community and the lack of socialization of information also increase vulnerability.

e) *Political dimension:* This may be expressed in terms of the level of autonomy of a community in the use of resources and decision-making. The community is more vulnerable under centralist schemes of decision-making and government. Lower levels of regional and local autonomy impede actions that respond to the felt needs of the population at these levels. Participation in decision-making that affects the community will help reduce vulnerability.

f) *Institutional dimension*: This relates to the difficulties faced in undertaking risk management. The lack of preparedness or of efficient and effective mitigation actions when collective risk is known to exist are sources of vulnerability. Institutional vulnerability is also expressed in

the lack of flexibility and in excessive bureaucracy and in the fact that political decisions and the desire for protagonism prevail over more rational ways of dealing with problems.

g) *Cultural dimension*: This relates to the way individuals see or perceive themselves and the groups or collective units they belong to. This may at times negatively influence behavior given the existence of pernicious stereotypes that are neither questioned nor changed. The communication media play a crucial role in this given they contribute to the slighted use of images and the transmission of imprecise or inconsequent information related to the environment, society and disaster.

h) *Environmental dimension:* There is an increase in vulnerability when the development model is not based on an adequate relationship with the environment and promotes or fosters the exploitation and destruction of natural resources. These circumstances inevitably lead to deterioration in ecosystems and an increase in vulnerability. Self-adjustment in order to compensate the direct and indirect impacts of human activity, or of natural events, may become very difficult.

i) *Ideological dimension*: This relates to the ideas and beliefs that exist as regards the world, its existence and future. It is at times expressed in passive and fatalistic attitudes and religious beliefs that limit action under certain circumstances. Dogmatic perceptions may generate confusion as regards purpose and a lack of reaction or loss of motivation that limits the undertaking of transforming actions.

The notion of global vulnerability proposed by Wilches-Chaux helps us visualize vulnerability from different angles and perspectives. The proposal facilitates an understanding of vulnerability as a dynamic and changing circumstance or condition. Moreover, we can also see it as an accumulative process of permanent fragilities, deficiencies and limitations that play a role in the existence of higher or lower levels of vulnerability. From a risk management perspective, actions that reduce these vulnerabilities and stimulate the strengths and capabilities of exposed communities must be the objective of risk reduction planning (Aysan 1993)

These concepts, as has been pointed out earlier, are based, in good part, on notions derived from human ecology approaches proposed in geography by Gilbert White, Ian Burton and Robert Kates. These authors put forward the notion of adjustment, which they differentiate from adaptation, as a mechanism to reduce the impact of natural phenomenon. Moreover, they also emphasised the difference between a natural phenomenon and a disaster. The contribution of the human ecology school of thought will be more thoroughly discussed later on in this document.

5. The concept of risk: frameworks and evolution

Notwithstanding the efforts made by social scientists since the mid twentieth century (Kates 1971; White 1973; Quarantelli 1988), issues relating to disaster risk assessment and prevention have only been dealt with more or less recently. Systematic conceptualization and analysis were originally based on a practical basis by experts and specialists in the natural sciences basing on studies

relating to geodynamic, hydro meteorological and technological phenomena such as earthquakes, volcanic eruptions, mudslides, floods and industrial accidents. In other words, emphasis was centered on the understanding of hazards given the existing investigative and academic biases and the efforts of those who first studied these issues (Cutter 1994). It is important to point out here that this bias still exists, particularly in the highly developed countries, where professionals, armed with advanced technological knowledge and equipment, have attempted to delve in greater detail into the physical processes that generate threatening phenomenon.

As already argued, if what is sought is risk estimation, there is no doubt whatsoever that the study and evaluation of hazard is a very important step. However, in order to achieve such an aim it is equally important to study and analyze vulnerability. This consideration led various specialists to conduct studies on physical vulnerability, which was basically related to the degree of exposure and the fragility of the exposed elements. This led to the widening of the work to a more multidisciplinary basis, given that this required the involvement of architects, engineers, economists and planners. With the passing of time, they found that the consideration of hazard and vulnerability are fundamental variables for physical planning and related matters, such as the delimitation of building standards.

Despite the notable levels of conceptual development achieved by researchers and academics, this approach has been overly technocratic in the sense that it remains focused on the hazard and not on the conditions that favor the occurrence of the crisis: i.e. global vulnerability; which offers a far more holistic and encompassing concept that goes well beyond issues of physical vulnerability. In developing countries, social, economic, cultural and educational vulnerability are, in most cases, the originating cause of potential physical damage (physical vulnerability). In contrast to hazards, which act as detonating agents, global vulnerability is a condition that accumulates over time, and is closely linked to social aspects and to the level of development of the communities.

It is only over the past few years that the social sciences have shown a greater interest in the field, but there are still huge vacuums that impede a full understanding of the problems of risk and of the real options for mitigation. The meaning of vulnerability and risk can be different for geophysicists, hydrologists, engineers, and planners when compared to the meaning assigned to these terms by the general public, the exposed communities and the government authorities in charge of the decision-making relating to reduction or mitigation of risk. That is the reason why there is a need for greater study of individual and collective perception of risk, and for research on the cultural characteristics, development and organization of institutions that favor or impede prevention and mitigation. These aspects are of fundamental importance if we are to find efficient and effective means to achieve a reduction in the impact of disasters worldwide (Maskrey 1994).

5.1 Visions emphasizing the hazard

The term "natural disaster" is very frequently used to refer to the occurrence of severe natural phenomenon. Events such as earthquakes, tsunamis, volcanic eruptions, hurricanes, floods, landslides, among others, have been directly considered synonyms of disaster. Unfortunately, this

interpretation has favored the belief that there is nothing to be done when faced with disasters. Given that they are natural phenomena they are considered unavoidable. On the other hand, this interpretation has also led to disasters being considered events of destiny or bad luck or even the result of supernatural or divine causes. This could help explain why certain communities take a religious viewpoint, consider these events unalterable and resign themselves to their occurrence. In the same way, vestiges of this kind of interpretation can be found in the legislation of certain countries, where the definition of "fortuitous acts" or of *force majeure* are still used along with statements such as “the occurrence of a natural disaster, like an earthquake or a volcanic eruption...” In some cases these kinds of events are directly called "Acts of God", as in certain legislation of Anglo-Saxon origin.

On the other hand, as already explained, geophysicists, seismologists, meteorologists, and geologists, among others, have tended to the idea that disasters are a topic exclusively associated with the physical phenomena that generate these natural events. Unfortunately, on many occasions people consider disasters as the detonating phenomena. In addition, despite technological advances in geophysical, hydrological and meteorological instrumentation, it is usually difficult to accurately predict the occurrence of a future event. Due to these reasons decision-makers and affected communities sometimes justify lack of action, arguing that damage and loss are unavoidable. Some political authorities have gone as far as fomenting religious fanaticism in order to elude responsibilities, due to negligence or omission.

During the second half of the twentieth century, when technological advances contributed enormously to our knowledge of natural phenomena, it was commonplace to define risk as the estimation of the possible occurrence of a phenomenon. This definition of risk is still commonplace among specialists that study phenomena such as earthquakes, landslides, and storms. In the 70s, and even in the 80s, the probability of an earthquake was usually considered to be synonymous with estimating seismic risk. Towards the end of the 80s and particularly in the 90s the concepts of seismic hazard and threat started to be more frequently used, to refer to what was previously termed seismic risk.

The declaration of the 90s as the International Decade for Natural Disaster Reduction, IDNDR, by the United Nations General Assembly was, without doubt, directly influenced by the natural sciences. In fact the idea for this initiative was first promoted in the USA to specifically foster the study of natural hazards and was promoted by Frank Press, a well-known Earth Science specialist.

5.2 Socio-technical approach

Research in and the development of the concept of risk in the applied and physical sciences commenced with the modern development of probability theory. In this context, the concept of probability, had quasi-deterministic overtones, where probability scores were influenced by an epistemic lack of knowledge or, in other words, uncertainty. This can, in principle, be overcome by more experimentation and learning exercise. But the need to formulate statistical physics in order to study certain complex phenomenon introduced a component of irreducible uncertainty,

which has been called “randomness”. These two types of uncertainty reflect the duality that underlies the concept of probability.

The ‘risk transfer’ approach employed by insurers (understood as feasible loss and the analysis of the probability of failure or ‘accident’ in mechanical and industrial systems) favored the consolidation of a new paradigm as regards risk analysis, security and trustworthiness of systems. This contribution of engineering and the hard sciences to the study of vulnerability, promoted the concept of vulnerability using probabilistic modeling methods. This approach was clearly established in the report published on *Natural Disasters and Vulnerability Analysis* by United Nations Disaster Relief Office, UNDRO, in 1980.

Disciplines such as geography, physics, urban or territorial planning, economics and environmental management helped to strengthen what can be called socio-technical or applied science approach to disasters. ‘Maps’ became more and more common due to the ever greater participation of geologists, geotechnicians engineers, and hydrologists who contributed raw materials for the adequate identification of the danger or hazard zones, in line with their area of interest natural phenomena. Computer science tools such as geographic information systems, (GIS), have facilitated this type of identification and analysis.

The employment of damage matrixes, loss functions, fragility curves or vulnerability indices, including those relating the intensity of a phenomenon to the degree of harm or damage to buildings, allowed for the correct estimation of scenarios of potential loss in case of future earthquakes in urban centers. This type of analysis of risk has increasingly been useful for contributing data on hazards or risks to physical and territorial planning specialists, as an ingredient for the decision-making process.

In this approach risk calculations are the result of the probabilistic modeling of the hazard and of the estimation of the damage that a system might suffer. This may also be obtained in an analytical way or based upon empirical data. One advantage of this approach is that the results may be easily translated into potential losses and may be then applicable, in terms of the cost/benefit ratio, in the development of building codes, security standards, urban planning and investment projects. The possibility of quantifying and obtaining results in probabilistic terms has made it easier to consolidate this approach given the idea that risk is an objective variable and may be quantified.

The work of Robert Whitman in Boston and of Michel Fournier d’Albe in Europe in the 70s provided new elements for the estimation of damage and loss in the case of earthquakes. Emphasis on the notion that damage was not only due to the severity of the natural phenomenon but also to the fragility or the vulnerability of the exposed elements, harnessed a more complete understanding of risk and disaster.

5.3 Socio-cultural vision

From a social science viewpoint, the issue of disasters gained special attention in the middle of the twentieth century as a result of the interest of the US government in the behavior of the population in case of war (Quarantelli 1988). As a result a social theory of disasters began to develop. This approach is mainly based on studies on individual and collective reactions and perceptions (Fischhoff, Slovic and Lichtenstein 1979; Slovic 1992; Drabek 1986, Mileti 1996). Generally speaking, in the industrialized countries, social science studies and research have focused on the reaction or response of the population during emergencies and not strictly on the study of risk. However, the contributions by the human ecology school of geographical thought from the thirties onwards (Burton, Kates and White 1978), which could also be considered as having a social-environmental perspective (Mileti 1999), inspired the development of an applied sciences approach. Emphasis on the fact that disaster is not a synonym of natural events and on the need for considering the adaptation and adjustment capacity of a community when faced with a natural or technological event was, without doubt, the springboard for the development of the concept of multi-dimensional vulnerability.

A socio-cultural approach may also be found in the anthropological and cultural theoretical contributions of Douglas and Wildavsky (1982) and Rayner (1982), and in the theory of amplified risk proposed by Kasperson *et al* (1988). This latter contribution has been widely accepted one of the more complete theoretical formulations.

On the other hand, since the 80s and especially in the 90s in Europe and certain developing countries, both in Latin America and Asia, social science researchers have critically discussed natural and applied science approaches. In general, their approach suggests that vulnerability has a social character and is not limited to the potential physical damage or to demographic determinants. It is argued that a disaster only occurs when the losses exceed the capacity of the population to support or resist them or when the effects impede easy recovery. In other words, vulnerability cannot be defined or measured without reference to the capacity of a population to absorb, respond and recover from the impact of the event (Westgate and O'Keefe 1976). This being so, for experts in political sciences, similar losses or physical effects in two separate countries with different economic and institutional conditions could have very different impacts. An event that could pass relatively unperceived in a large country could mean a catastrophe in a small one, due to the differential absorption capacity of each of the involved social systems. Similar damages in rich and poor countries have more serious social implications in the poor countries, where the underprivileged social groups are usually the most affected (Wijkman and Timberlake 1984).

As a result of this development, vulnerability started to take a wider meaning. According to Susman, O'Keefe and Wisner (1984) vulnerability "is the degree to which different social classes are differentially at risk". This definition implies that vulnerability depends on the political, social and economic conditions of the population. From this perspective what is suggested is that the conditions that characterize underdevelopment (social discrimination, expropriation, exploitation, political oppression and other processes that are often related with Colonialism and

Capitalism) render the poorest communities more vulnerable to disasters and have forced them to deteriorate and degrade their own environment.

Other researchers, such as the members of La Red (Red de Estudios Sociales en Prevención de Desastres en América Latina, or Network for Social Studies in Disaster Prevention in Latin America), stated that vulnerability is socially constructed and is the result of economic, social and political processes. Therefore, it is necessary to model vulnerability taking into account social factors such as the fragility of the family and the macro economy; the absence of basic social utilities; lack of access to property and credit; the presence of ethnic and political discrimination; polluted air and water resources; high rates of illiteracy and the absence of educational opportunities, among others (Wilches 1989; Lavell 1992; Cardona 1993; Maskrey 1994; Lavell 1996; Cardona 1996; Mansilla 1996).

Some conceptual models of risk have been developed from a political economy or Neo-Marxist perspective. For example, the model of 'pressure and release' proposed by Blaikie et al (1994) presents risk as the result of the concurrence of conditions of vulnerability and possible threats.

In a section of the literature, vulnerability has been associated with social pressures and relations emanating from different levels. At the macro level such pressures are called 'root causes', and relate to social, political and economic structures; at an intermediate level they are called: 'dynamic pressures', and include population growth, urban development, increase in population density, environmental degradation, the absence of ethics, etc; and at a local level they are called: 'unsafe conditions', typified by social fragility, potential harm, poverty, among other things. In this approach prevention-mitigation should be conceived of as 'releasing' the pressure from the macro to the local levels. According to this line of thought, risk reduction requires intervention at all levels: conditions of insecurity, the dynamic pressures and the root causes (Wisner 1993; Cannon 1994; Blaikie Cannon, Davis, Wisner 1994).

Other authors, looking at the issue from the social communications viewpoint, adopted a critical position with reference to the different approaches considered earlier. They point out in general that there exists a positivist and performative character in the different conceptual proposals, given that concepts come from experts and are subject to subjective alteration or manipulation. Most of these ideas emphasize the active role that persons play in constructing the meaning of risk and the role of communication as a transforming power, indicating the need to consider risk as an 'imaginary' and not as something external to the people who experience it. The basic message here is that is important to consider perceptions, attitudes and motivations both individually and collectively (individual perception and social representation). These may vary drastically from one context to another (Johnson and Covello (1987); Slovic 1992; Luhmann 1993; Maskrey 1994; Adams 1995; Muñoz-Carmona 1997).

5.4 Limitations of the different approaches

The foregoing discussion shows that risk terminologies have not only varied through time, but have also changed from a disciplinary perspective. This means that in spite of disciplinary

refinement, there is in reality no single conception that unifies the different approximations or that is able to bring these together in a consistent and coherent manner. Psychologists, sociologists and historians generally draw on what may be termed 'constructivist' postulates, considering risk to be a 'social construction'. From this perspective the risk notion is only understandable of one takes into account the analysis of individual and collective perceptions and representations, and interactions between social actors. On the other hand, engineers, geologists, geographers, economists and epidemiologists generally adopt an approach that could be described as 'realist', based on the hypothesis that risk can be quantified or objectively assessed. Appendix I, offers a brief description of the theories on risk and the main differences among the conceptual approaches.

As already argued, the natural science approach offers a partial view –a view which, however, has undoubtedly contributed to knowledge of one main component of risk: the hazard. However, many still confuse risk and hazard and fail to distinguish between an intense natural event and a disaster. Risk, cannot be understood exclusively as the possible occurrence of a natural phenomenon. This confusion has contributed to the misunderstanding of risk and disaster by the exposed population and has sometimes been used by political authorities and other decision makers in order to avoid blame.

The socio-technical vision takes a different perspective and focuses on the effects of the event and not on the event itself. There is no doubt whatsoever that the contribution of engineering in analyzing the resistance capacity of structures signified an important change of paradigm with respect to risk. However, although a more complete definition of risk was provided, the approach remained partial and too based too much on the physical effects. Curiously the methodologies developed through this approach offer real risk estimations only in a few cases. In practice, the evaluation of physical vulnerability tended to replace risk evaluation, which was left as a secondary result. Through these techniques risk is evaluated in economic terms by estimating the replacement cost of the damaged vulnerable system. It is even common to find, in the case of future loss scenarios, that the term 'social impact' refers to the number of victims - the dead and injured. Despite the fact that this information is important, for emergency preparedness and response, it remains a restricted vision, concentrating on applied sciences and disregarding social, cultural, economic and political aspects.

It is important to point out here that, except in the case of seismic hazards, the vulnerability referred to in this approach has normally been considered a constant when used for territorial planning purposes. This is based on the notion that the elements are located in hazard-exposed zones and thus vulnerable. Many hazard maps have unconsciously been converted into and referred to as risk maps, and vulnerability is taken as a constant and a mere function of the exposition of the elements. Thus, this approach continues to give over-riding importance to the hazard and the hazard is considered the sole cause of disaster. The use of geographical information systems, GIS, has reinforced the view that risk is something 'photographic' or 'frozen'. In the best of cases, the concept of vulnerability proposed by this approach is merely used to explain physical damage and other direct side effects. Risk, seen from this perspective, has been interpreted in general as a potential loss, taking into account possible damage. The

disaster, defined as the materialization of risk, has been restricted to a consideration of the loss represented in physical damage and not, in a more comprehensive fashion, as the overall consequences for society. Without doubt, this approach has been fostered by the notion that vulnerability can be conceived as exposure, or in the best of cases as the susceptibility to suffer damage, without really making any reference to resilience; i.e. the capacity for recovery or to absorb the impact.

The contribution of the so-called socio-cultural approach was initially low-key due to the predominant tendency to study the behavior of the population in situations of emergency or imminent emergency. In the developed world, social scientists have given considerable emphasis to the study of risk from day to day life and human security perspectives, with regard to technological incidents that could affect the populations' health. In a few cases there has been a special interest in the perception of individuals or collective social units as, but less interest has been shown when it comes to the implications of these or to the processes that contribute to the social gestation of disaster. However, some studies have placed emphasis on the capacity of communities to absorb the impact or to recover after an event. These works have questioned the restricted vision of the applied sciences school of thought, indicating that vulnerability should not be considered exclusively as the possibility of physical damage.

Towards the end of the twentieth century theoretical work on the topic of risk started to place more emphasis on social, economic and political processes. At times, however, the emphasis on the social aspects of vulnerability has been overemphasized, ignored the fact that environmental impact and potential physical damage are very important when it comes to conceiving and estimating risk. Vulnerability has tended to be interpreted as a 'characteristic' or as a 'feature' and not as a condition, circumstance or predisposition to damage, where this is the result of susceptibility, frailties and a lack of resilience or capacity for recovery. Some authors forget completely about the hazard and the fact that this has to be taken into account in order to establish the notion of risk.

It is also important to remember that the concept of risk is linked to decision-making, and therefore it has a time dimension, relating to the feasibility and convenience of taking action. But, without hazard, without a trigger phenomenon, there would be no risk and no possible future disaster. Some social scientists tend to see poverty as a synonym to vulnerability and not as a factor contributing to vulnerability. In general terms, few studies refer to risk as such and limit themselves to dealing with vulnerability as if it were a synonym for risk and not a factor of risk. But, perhaps the greatest defect is the fact that with the argument that risk is something subjective, no attempt is made to estimate it, or the techniques that are used for estimation are not very consistent.

Although the 'objectivist' and 'constructivist' paradigms are therefore inadequate, since they are too one-sided, they both contain useful elements for the understanding and measuring risk. It is therefore important to transcend the antagonism between the two schools of thought, assigning importance to qualitative as well as to quantitative methods. Action and decision, implicit in the definition of risk, require taking into consideration subjective risk perception and the scientific

need for objective measurement. Due to the fact that different disciplines are involved in the various aspects of risk a common language and holistic theory of risk is called for. Conceptually and pragmatically it is very unsatisfactory to maintain a situation where each individual subjectively defines and assumes risk in their own particular way. This position is totally inoperable when intervention in risk becomes indispensable from the public policy angle.

6. Intervention in risk and disaster

Traditionally intervention in the disaster problematic has been considered in terms of the so called "disaster cycle or continuum" which identifies different stages or phases which require different types of intervention. The terms prevention and mitigation have been used to identify activities that attempt to reduce hazards and vulnerabilities or risk, and thus avoid or reduce future disasters and loss. Preparedness activities provide better options for disaster response prior to and during disaster, and are put in place prior to the impact of dangerous physical events. Emergency or humanitarian response attempts to guarantee human security and welfare immediately following the impact of different physical phenomenon. Rehabilitation and reconstruction activities on the other hand attempt to optimally restore, transform and improve the economic, social, infrastructural and life style conditions in the affected zone, granting higher future levels of security through the implementation of activities and actions that control future risk. In this sense, the notion of recovery (rehabilitation and reconstruction) has been imbued with the idea of future disaster prevention and mitigation. The Appendix II presents a glossary of terms that include the different concepts used in this work. Such terms are the result of depuration and conceptual adjustment that herein are not considered trivial; by contrary, they are considered the fundamentals of the coherence and consistency of risk management.

6.1 Risk management for sustainable development

Up to the beginning of the 1990s, disaster preparedness and humanitarian response dominated disaster practice. Risk reduction (corrective and prospective) was not a priority for public policy or in terms of social action in general. However, in the face of growing evidence as to significant increases in disaster losses and the inevitable increase in financial and human resources dedicated to disaster response and recovery, increased recognition of the need to promote prevention and mitigation activities, or risk reduction, occurred. Unfortunately, on many occasions since the early 90s these terms have been distorted due to resistance and bias on the part of some traditional response agencies. Thus, it is not uncommon even today to find the terms prevention and mitigation used to refer to response and preparedness activities. This ambiguity may be partly due to the preponderance still given to the notion of disaster prevention and mitigation and not to risk prevention and mitigation, or risk reduction. For some, there can be no disaster mitigation unless a disaster already exists. As a matter of fact, the prevention of disasters is a contradictory term or even pretentious pursuit. It is for this reason, among others, that it is important to refer to risk, rather than to a disaster since this leads to a clearer understanding of what it is we wish to prevent and mitigate.

There is now an increasing awareness regarding the fact that risk is the essential problem and disaster a derived or associated problem. Risk and risk factors have become central notions and concepts in the study and practice associated with disaster. This paradigmatic transformation has been accompanied by an increasing emphasis on the relationship between risks and disaster, and development planning and, consequently, with the environmental problem and sustainability. Risks and disaster are now increasingly seen as components or dimensions of development concerns and not as autonomous conditions generated by forces external to society (Lavell 2000).

Given this change in conceptual emphasis and the growing importance accorded to risk as opposed to disaster (i.e. to the process and not to the product) the topic of intervention has been subject to changing emphases and terminologies. Thus, during the 90s the terms Disaster Administration, Civil Protection and Disaster Prevention and Reduction were common, whilst today at the beginning of the 21st century this terminology has gradually been replaced, in Latin America at least, by such ideas as risk management and risk and vulnerability reduction. This new approach and terminology does not exclude disaster response, but rather, positions it more comprehensively in the idea of integral risk management

Even where disaster has not yet materialized, risk and risk factors are always present and may be the subject of conscious human modification, reduction or control. This is what prevention and mitigation is essentially all about. Moreover, even where structural risk exists and this cannot be reduced, the magnitude and impact of future disasters can be reduced by adequate anticipatory preparedness activities, including the design of disaster response plans and mechanisms that allow society to more adequately absorb the shocks associated with disaster. This is a form of risk management that differs from anticipatory risk prevention and mitigation.

In the case of disasters associated with rapid onset events, there will be pre-existing risk conditions, albeit presuming a rapid transformation. Humanitarian or emergency response comprise a further dimension of risk management where the central objective is the control of new risk factors that threaten the lives, health, security and welfare of affected populations. Finally, with disaster reconstruction, risk management takes the form of activities and procedures that search to control future risk factors guaranteeing an increase in the security of economic structures, infrastructure and population. In this sense reconstruction should incorporate risk control and environmental management similar to those involved in the planning of new development projects (Lavell 2000)

Because risk management is a complex and dynamic social process, it is based on the idea that risk, as any social construction and process, is ever changing. A change in societal risk, or in risk in determined social contexts, is the product of both gradual and more abrupt changes in social, economic and environmental processes (Lavell 2000). Given the existence of dynamic risk conditions, society requires differentiated mechanisms in order to manage the different risk conditions that exist or could exist. Risk and environmental impact evaluation are very similar as far as planning is concerned, given both are related to the consequences of environmental change (Clarke and Herington 1989)

Risk management may be understood as a series of elements, measures and tools directed towards intervention in hazards and vulnerabilities with the objective of reducing existing or controlling future possible risks. This concept of prevention and mitigation can be differentiated from another group of tools whose objective has been the improvement of intervention in disasters once these occur preparedness activities, response and reconstruction. Risk management aims to articulate different types of actions, assigning a central role for prevention and mitigation, but without abandoning disaster response, in an attempt to develop preventive policies that significantly reduce the need for intervening in disasters once these occur. This type of management should not be seen as a purely government-led process, but a participatory exercise, involving governmental and non governmental actors with the idea of dealing with risk and disaster. In this sense, risk management policy must be based on the involvement of the diverse social, institutional, public, and private forces and groups that exist, on a broad and inclusive territorial basis.

It is pertinent here to discuss the concept of sustainable development in the context of risk management. The notion of "development" transmits the idea that the human and physical environment can be more productive and healthy, taking into consideration ecological, political, cultural and technological factors. The concept of "sustainability" refers to the maintenance and prolongation of development over time. Apparently, the words development and sustainable seem to be contradictory. However, we don't have to be very optimistic in order to believe that development can be sustainable with the application of technological innovations and the application of management strategies such as prevention. A part of the improvement in human living conditions consists in the achievement of greater levels of security and survival in relation to the actions and reactions of the environment. This calls for a better understanding of the forms of interaction between our immediate social environment and the natural environment (Duque 1990). It follows, therefore, that risk management is a fundamental strategy for sustainable human development given that it attempts to establish an equilibrium between natural ecosystems and the societies which occupy and utilize them, guiding human actions and activities that affect the environment and vice versa.

It should be realized that disasters are to a great extent an expression of an inadequate relationship between the development model and the environment within which the model is supposed to operate. Conflicts between economic, social, political and cultural objectives and mores may lead to inconsistencies in this regard, possibly ending up in a disaster. Because of this, risk management should be an explicit objective and component of development planning where development is understood not only as an improvement in living conditions but also in the quality of life and welfare. Independently of ideological discussions, development should guarantee the needs of humans and their environment and promote quality growth. Security is in general a fundamental component of sustainable human development and for this reason risk reduction is also a fundamental strategy in the search for equilibrium between human settlements and nature. Indicators such as the Human Development Index used by the United Nations Development Program (UNDP 1991; Sen 2000) permit a more sophisticated evaluation of development than the conventional indicators of economic growth, such as GDP per capita, which tend to consider short term changes, do not take into account of prevention and mitigation concerns.

APPENDIX I: THEORIES OF RISK

Theoretical contributions on risk may be classified in various categories including

a) process, analogue or systemic models;
b) structural and cognitive explanations;
c) interpretative representations;
d) quantitative methods; and
e) taxonomic frameworks.

An example of a process model is that proposed by Rowe (1977), which is widely used in the field of technological risk and toxicology. This approach suggests the existence of four stages: hazard identification, risk estimation, risk evaluation and risk management. An example of an analogue model is provided by Covello, von Winterfeldt and Slovic (1987) in an attempt to explain risk communication using signal theory. Palmlund (1992) proposed an analogue model with the classic structure of a Greek tragedy (with actors, scenario, drama, and roles) in order to explain the environmental tragedy from a political and social perspective. An example of a systemic model is provided by Kates (1971) from the human ecology school of thought. He describes the notion of "adjustment" to natural hazards considering the interactions between nature, humans and technology. This model attempts to explain the dynamics of the interaction between the components, but does not necessarily provide information on the underlying causes of the process.

A classic contextual or structural explanation, where risk is seen as an attribute of social structures, is that proposed by Douglas and Wildavsky (1982). A cultural theory of risk is proposed by Rayner (1992). In this category, we may also include those approaches proposed by the Political Economy school, which may be considered constructivist. This is the case of the work of Westgate and O'Keefe (1976), Wijkman and Timberlake (1984), Susman *et al*, (1984) and Chambers (1989). These socio-economic approaches defend the idea that risk is socially constructed. The contributions of Wisner (1993), Cannon (1994), Blaikie *et al* (1996) and those of different members of the Network for the Social Study of Disaster Prevention in Latin America (Maskrey 1994; Lavell 1996; Cardona 1996; Mansilla 1996) may also be considered constructivist, taking a neo Marxist approach and emphasizing the social construction of vulnerability and, therefore, risk.

A cognitive explanation which has been called "psychometric theory of risk" is provided by Fischhoff, Slovic and Lichtenstein (1979) and Slovic (1992). This theory proposes the existence of "mental models" and "cognitive architecture". A case of quantitative laws is provided by Starr (1969), who uses three quantitative laws to explain behavior when faced with risk. His ideas were not well accepted by social scientists but continue to be a necessary point of reference when one talks of the acceptability of risk and of security norms and codes.

Systematic classifications (taxonomies) have also been used to provide order and structure for a range of phenomenon and circumstances. Examples may be found in the classification of natural hazards proposed by Burton and Kates (1964), the classification of dangerous materials proposed

by Slovic et al (1985) and the vulnerability classifications developed by Wilches-Chaux (1989) and Aysan (1993). Many of these conceptual proposals have been published in the *Journal of the Society of Risk Analysis*, founded in 1980. This journal was inspired by concerns for technological risk in particular. However, many of the ideas put forward may be extrapolated to the field of risk associated with natural and socio-natural phenomenon. Finally, mention must be made of the postmodernist ideas put forward towards the end of the 20th century by social scientists such as Ulrich Beck, Niklas Luhmann and Anthony Giddens. For these authors, risk is intimately linked to societal development and is influenced by the decision-making and communication processes that occur under the influence of current power relations (Muñoz-Carmona, 1997). A theoretical proposal that attempts to integrate all of these categories can be found, for example, in the theory of the social amplification of risk proposed by Kasperson et al (1988). This attempts to lay out a causal process integrating the technical, social, cultural and psychological dimensions of risk.

On a historical note, the first specialized research center to be established on the topic of disaster was *the Disaster Research Centre* at Ohio State University, which built on the pioneering geographical research of Gilbert White and his collaborators at the University of Chicago. This center was founded by sociologists, Enrico Quarantelli and Russell Dynes in 1963, and was later moved to the University of Delaware in 1985. Research here was concentrated on the social response to disaster and on post disaster recovery, following, in the first instance, analogies with response in case of nuclear attacks. However, the first center to really study risk was the Center for Technology, Environment, and Development-CENTED- at Clarke University. This center was established by geographers Robert Kates and Roger Kasperson, and physicist, Christopher Hohenemser, in 1972. The center concentrates on both natural and nuclear risks. Since then, at least six research centers were established in the US in the 70s, and at least seven more during the 80s. During the 90s, stimulated by the IDNDR, innumerable centers and programs dealing with risks and disasters were founded around the world. The topic has gained popularity since then and it being increasingly recognized that the terms hazard, vulnerability and risk have different meanings and implications from both the methodological and practical angles.

Conceptual approaches

The different approaches to risk concepts and evaluation are based, in general, on different disciplinary foundations. One can distinguish between two major approaches, namely the socio-technical approach which may be considered as having been derived from the applied sciences and economics and the socio-cultural approaches derived from sociology, psychology, anthropology and culture studies.

The socio-technical approach includes contributions by the natural and engineering sciences and is based on probabilistic estimation of risk. This approach is adopted in toxicology and epidemiology, the actuarial sciences and economics where cost-benefit comparisons are made. All of these approaches are based on statistical prediction and probability analysis. With reference to the socio-cultural vision, diverse social theories of risk may be identified and, as Ortwin Renn (1992) points out, there may be as many perspectives in sociology as there are

sociologists! Renn classifies the theories in two categories, namely objectivist and constructivist. Moreover, the socio-cultural vision also includes psychological approaches which include psychometric analysis and the cultural school that bases its work on the analysis of groups and organizations. Unlike the socio-technical methods, socio-cultural approaches do not offer a common denominator for measuring the social and cultural acceptability of risk (Douglas 1985).

Objectivism and Constructivism

Probabilistic estimations of risk attempt to predict failures in the security of complicated technology systems, even where insufficient data is available on the system being analyzed. Failure and event trees are used for the analysis, and the probability of failure of each component of the system is evaluated in systematic fashion linking these to the structure of the system. This type of approach is useful for detecting deficiencies and for improving security levels in complex systems. The actuarial approach represents a classic example of "objectivist" approaches to the analysis of risk, where the base unit is an expected value that corresponds to the relative frequency of an average event in time. Undesirable events are understood in terms of physical damage to persons and ecosystems. This may be observed and objectively measured with appropriate scientific methods. An application of this approach can be found in the case of predictions of road accidents for some future year. Results may be extrapolated from data on fatal accidents in previous years. The estimation of risk is reduced to a single dimension and is represented by an average in time, space and context. Estimations of health and environmental risks basically use the same types of method.

The approach taken by economics transforms physical damage or other undesirable effects into subjective benefits. The base unit of these benefits describes the level of satisfaction associated with a possible action or transaction. An attempt is made to compare risks with benefits (Camerer and Kunreuther 1989). Since risks represent possible and not real costs it is necessary to relate them to the probability of occurrence of an event. Ultimately, what is sought is the use of resources in order to maximize benefits for society. Economic risk comprises a logical and coherent framework for situations where decisions have to be made by individuals and where decisions on loss are confined to the decision maker's immediate environment. Although the economic perspective permits a uni-dimensional measure of risk that supposes that the benefits and risks are commensurable, there are many factors that impede its use in risk management policies. These include: the problem of aggregating individual gains, the existence of variations between individual preferences, the problem of taking appropriate action to reduce future negative consequences, the impacts on third parties, and the notions of rationality and ethical considerations that the model is based on.

In general, such technical analysis provides society with a limited and narrow definition of desirable effects, reducing the possibilities to numeric probabilities based on relative frequencies. Unfortunately, the objectivity that is associated with such calculations, which may be seen as a virtue, can also lead to the serious problem of oversimplifying a complex phenomenon.

On the other hand, the psychological approach suggests that individuals respond according to their perception of risk and not according to objective risk levels and scientific evaluations of this. Such estimations are only taken into account by individuals to the extent they are considered in the light of individual perceptions. This approach assigns importance to the beliefs people have regarding the possibility of occurrence of an undesirable event. In this regard, the question arises as to whether perceptions are based on adequate information or rather, on biases and ignorance, which would make them very inadequate if they are to be used as criteria for decisions on risk reduction. From the point of view of many anthropologists and cultural sociologists, social responses to risk are determined by prototypes and cultural mores i.e. clusters of convictions related to different perceptions of reality. Seen from this perspective, environmental risks are considered to be purely social constructions.

Individualism and Structuralism

Individual and contextual models have been proposed by social scientists to explain social responses to risk. The individual model is largely based on psychology, whereas the contextual one is sociologically oriented. In the case of the individualist paradigm an attempt to understand group behaviour is made by studying individuals. An example of such models can be found in the "theory of knowledge and personality" (Wildavsky and Dake 1990). This offers an explanation of the cognitive response to risk, which is based on the knowledge, information, aversion or tolerance of risk that is characteristic of different personality types. Psychometric and risk perception theories are based on this type of paradigm as are some economic models of risk based on the theory of expected gains to which Camerer and Kunreuther make reference (1989).

Theoretical development of risk perception commenced with the research of Tversky and Kahneman (1973; 1974). These authors were interested in the identification of factors that influence the probability estimations of persons. They concluded that when people face complex problems that involve probability and event frequency they apply certain rules of judgment and heuristics in order to simplify the problem. These often lead to biases and value judgments. Later contributions by Slovic, Fischhoff and Lichtenstein (1981) led to the psychometric and cognitive theory of risk perception, based on prediction of individual responses to certain activities, particularly those of a technological nature.

Through the contributions of cultural theory and structuralism an attempt has been made to advance the understanding of the ontological aspects of risk and of the connection between sociological variables and individual attitudes to risk. The ontology of risk refers to its metaphysical status as a property and quality of the physical world. This is a common supposition amongst those who promote the technical evaluation of risk. In the case of contextual approaches, the context is taken as a starting point. These models take into account the social structure, institutional forms and culture. This approach has many variations, including those proposed by Rayner, Renn, Palmlund, Wynne, and Kasperson, although the latter author avoids providing social factors with an ontological character (Krimsky and Golding 1992).

Structuralists and contextualists defend the position that risk is subjective and varies according to the context, criticizing attempts to give it an objective and measurable character. Cultural theorists have even gone as far as to criticize the psychometric paradigm indicating that risk is inevitably the result of social process, even though it has some roots in nature. That is to say, they defend the position that the most appropriate approach to risk analysis is sociological and not psychological, given that risk is a social product (Thompson and Wildavsky 1982). The debate between individualism and contextualism can only be resolved if we find a reply to the difficult question as to whether personality precedes context or vice versa.

All concepts of risk have a common element: a distinction between reality and possibility. If the future were predetermined or independent of present human activities, the term risk would have no significance. If the distinction between reality and possibility is accepted, then the term risk could be defined as "the possibility that an undesirable state of reality (adverse effects) will occur as a result of natural events or human activities" (Luhman 1990). This definition means that humans can and do make causal connections between actions (or events) and effects, and that undesirable effects can be avoided or reduced if the causal events or actions are avoided or modified. According to this definition, risk is a descriptive concept (a representation) and, at the same time, takes a normative dimension. The definition of risk involves three elements: undesirable results, the possibility of occurrence and a state of reality. All approaches to risk provide different conceptualizations of these three elements. These may be paraphrased in the following three questions: How may we specify and measure uncertainty? What are the undesirable results? What is the concept of reality we hold to? This helps us to distinguish between the different perspectives (Renn 1992).

The distinction between risk evaluation and risk reduction is of interest in this regard, since it has implications regarding the distinctions between science and political decision-making. If risk is seen as being objectively associated with an activity or a phenomenon and as something measurable in probabilistic terms in order to identify well-defined adverse effects, one can order the risks according to "objective" measures of the probability and magnitude of damage, and resources would be allocated in order to deal with the greatest risks. However, if risk is seen as a social or cultural construction, then intervention would have to be based on different criteria and priorities and should reflect social values and preferences for different life styles. These two positions represent the extremes of a spectrum of different positions regarding risk, and both could possibly be biased versions of reality (Renn 1992). Experience shows us that risk is multidimensional and that differences in culture and social values call for different approaches. Experience shows us that there is no society in which a single criterion has been held to as regards all types of risk. However, the relativist position derived from social constructivism is difficult to justify in terms of its practical consequences when we observe that in many countries similar reduction standards and priorities have been established, despite notable differences in culture and society.

APPENDIX II: GLOSSARY

ACCEPTABLE RISK: The possible social, economic, and environmental consequences that a society or segment of society implicitly or explicitly assumes and tolerates because it considers it unnecessary, inopportune or impossible to take reduction measures given the existing economic, social, political, cultural or technical context. It represents the probability of a determined consequence occurring within a specified time period that is considered admissible in the determination of minimum-security demands and needs. This level of risk may be used as parameter in deciding protection levels and planning mechanisms when faced with possible dangerous physical phenomena.

ADAPTABILITY: The capacity or ability of an individual or group to adjust to changes in the natural and built environment in order to survive in sustainable conditions.

ANTHROPOGENIC: Of human origin, or related to human activities and technologies.

ANTHROPOGENIC (OR HUMANLY INDUCED) HAZARD: A latent threat associated with agricultural and industrial production, the transport and consumption of goods and services, and the construction and use of buildings and infrastructure. This category of hazard includes a large number of different cases, including contamination of air, land and water; urban and rural fires or conflagrations; spills of toxic substances; rupture of dams and dykes etc.

CAPACITY: The sum of the attributes and resources of a community or organization that may be used positively for carrying out an activity, including risk management.

CONCATENATED OR COMPLEX HAZARDS: The possible occurrence of a series or sequence of two or more threatening physical phenomenon where the first triggers the second and so on. An example is an earthquake that leads to the rupture of a dam, then flash flooding and the destruction of pipelines transporting dangerous substances which in turn lead to loss of flora and fauna and contamination of water and soil resources with consequent negative effect on humans.

CONTINGENCY PLAN: Specific pre-established operational procedures for coordination, warning, mobilization and response when a dangerous phenomenon is imminent or present, and for which scenarios are available

CORRECTIVE INTERVENTION: A process that attempts to reduce existing levels of risk in society or in a component of society, product of the historical patterns of territorial occupation, production, construction of infrastructure, amongst other things. It reacts to and compensates for risk that already exists in society. Examples of corrective risk management methods or instruments are the construction of dams and dykes to protect population already located in the flood plains of rivers, the retrofitting of buildings against earthquakes and hurricanes, changes in cropping patterns in order to adjust to adverse environmental conditions, reforestation of river basins in order to diminish existing processes of erosion, landslides and flooding.

CRISIS: An unstable condition involving abrupt or decisive changes. Corresponds a process of liberation of submerged and repressed elements of a system resulting from an exogenous or endogenous perturbation that leads to paralysis of the protecting and moderating elements, the extension of disorder, the appearance of all types of uncertainty, and chain reactions that finally lead to mutation or disappearance of the system. Crisis may result from a disaster or be the disaster itself. Crises usually have negative consequences but they may also offer opportunities for positive changes.

CRITICAL LIFELINES (NETWORKS): Basic or essential infrastructure, relating to energy (dams, electric sub stations, electricity cables, fuel storage facilities, gas ducts and oil pipelines), transport (road systems, bridges, transport terminals, airports, river and maritime ports), water (treatment plants, aqueducts, drainage systems, irrigation channels and water ducts) and communications (telephone exchanges, radio and television stations, post office and public information offices).

DANGEROUS PHENOMENON (EVENT): A physical occurrence of natural, socio-natural or anthropogenic origin described in terms of its characteristics, severity, location and area of occurrence. It represents the materialization in time and space of a hazard. (note: it is important to distinguish between a potential or latent phenomenon, a hazard, and the real phenomenon once this occurs).

DIRECT EFFECTS: Impact directly related to the occurrence of a physical phenomenon, including the adverse damage on persons, infrastructure, productive systems, goods, reserves, services and environment, and immediate impact on social and economic activities.

DISASTER: A social process triggered by a natural, socio-natural or humanly induced phenomenon which, due to vulnerability conditions in the population, infrastructure and economic systems, causes intense, serious and extended alterations in the normal functioning of the affected country, region, zone or community to the extent that these are unable to autonomously respond to and resolve the problems using their own resources. The alterations may be diverse and differentiated, including the loss of life, health problems amongst the population, damage, loss or destruction of collective and individual goods and damage to the environment. These require immediate response by the authorities and the population in order to attend to the needs of the affected population and restore acceptable levels of welfare and life opportunities.

ECOSYSTEM: A spatial unit defined in terms of a complex of physical and biotic components and processes that interact in an interdependent manner and create characteristic flows of energy, and cycles or movement of materials.

ELEMENTS AT RISK (EXPOSED): The social and material context represented by persons, resources, infrastructure, production, goods, services and ecosystems that may be affected by a physical phenomenon.

EMERGENCY: A situation, directly related to the imminence or occurrence of a physical phenomenon. When the event is imminent, confusion, disorder, uncertainty and consternation may occur in exposed areas. Once the event occurs the emergency is characterized by an intense alteration or interruption of the normal functioning of the community, zone or region, and the minimum conditions necessary for the survival and functioning of the affected social unit may be absent. Both contexts require immediate attention by government agencies and organizations, the press and the community in general. A state of emergency comprises a phase or stage of disaster but does not as such substitute the notion of disaster. An emergency may exist without a disaster.

EMERGENCY PLAN: The definition of general functions, responsibilities, and procedures that govern institutional response and warning, resource inventories, coordination of operational activities, and training through simulation exercises and revision of procedures, with the objective of saving lives, protecting goods and achieving an adequate state of normalcy as quickly as possible following the impact of a dangerous phenomenon.

ENVIRONMENTAL DEGRADATION: A process that damage the natural resource base or adversely affect natural processes and ecosystem, thus reducing their quality and productivity. Potential effects vary and include the transformation of resources into hazards. (see "Socio natural hazards", below)

EVALUATION OF HAZARDS: The process by which the probable future occurrence of a dangerous physical phenomenon, of determined intensity, in a particular place and within a defined time period, is determined. It provides information on the estimated period of return and the geographical location of probable events.

EVALUATION OF VULNERABILITY: A process used for estimating the susceptibility or predisposition of the population, production, infrastructure, goods, services and environment to suffer damage or loss when affected by a specific type of physical phenomenon. This includes an analysis of the factors that impede or increase the difficulties of recovery, rehabilitation and reconstruction, using available community resources.

GOODS AND SERVICES: Tangible and intangible products that have an economic value, benefit those who own or use them, and permit individual and community life. Both private and public goods can be owned individually or collectively, whilst services can only be consumed.

HAZARD: A latent threat associated with the possible occurrence of a physical phenomenon of natural, socio-natural (see definition below) or anthropogenic origin. The phenomenon is anticipated to cause adverse effects to exposed persons, production, infrastructure, goods, services and environment. A hazard comprises an external risk factor and is expressed as the probability that an event of determined intensity will occur in a specific place within a defined period of time.

INDIRECT EFFECTS: Those impacts that are causally related to the direct effects and losses. These are usually associated with concatenated or consequent impacts on the population, social and economic activities and the environment. Examples include the loss of production opportunities

and future income, increases in poverty levels, and increased costs of transport due to the loss of roads and bridges.

INTEGRATED INFORMATION SYSTEM: When applied to risk management, this refers to the knowledge base on hazards, vulnerabilities and risks, vigilance and warnings, and response capacity and management processes available to institutions and the population, and fundamental for risk management decision-making and prioritization of activities and projects.

INTENSITY: A quantitative and qualitative measure of the severity of a phenomenon in a specific place

LOSS: An adverse economic, social or environmental cost during a specific period of exposure.

NATURAL HAZARD: A latent threat associated with the possible occurrence of a physical phenomenon originating in the natural processes of environmental transformation and modification. Natural hazards are normally classified according to their particular origins, distinguishing between: Geodynamic hazards (endogenous or tectonic, such as earthquakes and volcanic eruptions; or exogenous, such as landslides, avalanches and subsidence); Hydrological (such as slow and rapid onset floods, sedimentation, erosion and desertification); Atmospheric (storms and other meteorological or oceanographic phenomenon such as hurricanes and the Niño); and Biological (such as disease vectors and plagues or pests).

PREPARATION (PREPAREDNESS ACTIVITIES): Measures taken to organize and facilitate operations for the effective and opportune provision of early warnings, search and rescue activities and rehabilitation of the population and the economy in case of disaster. Preparation is achieved through the organization and planning of warnings, evacuation, search and rescue, and emergency and rehabilitation aid and assistance.

PROGNOSIS: When applied to physical phenomena, prognosis refers to the calculation of the probability that the phenomenon will occur. This may be based on the study of the physical generating mechanisms, the monitoring of the perturbing system and/or information on the period of return and existence of past events. A prognosis may be of short term character, generally based on the search for and interpretation of signals or precursor events; medium term, based on statistical information relating to parameters that indicate the potential appearance of the phenomenon; and long term, based on the determination of the maximum probable or credible event that could occur in a determined time period and that can be used as data for planning purposes in the affected area.

PROSPECTIVE INTERVENTION: The anticipation or prevision of risk that may be generated with future development projects and investments. It comprises measures taken to guarantee that new risk factors do not appear with new initiatives in construction, production, infrastructure, transport and commercialization. Prospective intervention must be seen as an integral part of development and project planning, whether these are developed by government, private sector or civil society. The final objective of this type of intervention is to avoid new unnecessary risks

guaranteeing adequate levels of sustainability for new investments and thus avoiding the need for more costly corrective intervention later.

RECOVERY: A process by means of which adequate and sustainable living conditions are restored in the affected area or communities. This may be achieved by means of rehabilitation, repair, reconstruction or replacement of destroyed, interrupted or deteriorated infrastructure, goods and services and through the reactivation and promotion of economic and social development in the affected communities.

RESILIENCE: The capacity of a damaged ecosystem or community to absorb negative impacts and recover from these.

RESPONSE: Actions, anticipated in the preparedness or planning stages implemented immediately following the impact of a dangerous phenomenon. In some cases these are preceded by readiness and mobilization activities, as a reaction to warnings. Response comprises an immediate reaction geared up to guarantee opportune attention for the affected population.

RISK (COLLECTIVE): The possibility or danger of suffering damage or loss. It is the probability that a determined level of adverse economic, social or environmental consequences occur in a particular time and place, and that these are of such magnitude and severity that the community would be affected as a whole. This is derived from examining and factoring-in the hazards and vulnerabilities of exposed elements.

RISK ANALYSIS: When applied to disasters, risk analysis relates to the idea that risk is the result of the interaction of hazards and vulnerabilities which lead to potential loss and damage to exposed elements. Such analysis is based on social, economic and environmental impacts and consequences for particular social and economic groups or units arising from the occurrence of a dangerous phenomenon in a particular place. Changes in hazards and vulnerabilities modify risk levels. Analysis of hazards and vulnerabilities are facets of risk analysis and must be considered together, not as independent and separate factors. An analysis of vulnerability is impossible without an analysis of hazard, and vice versa.

RISK MANAGEMENT: A social process leading to the planning and application of policies, strategies, instruments and more concrete intervention measures that favor the reduction, prevision and control of the possible adverse effects of a dangerous physical phenomenon on the population, production systems, infrastructure, goods, services and environment. Integrated actions that favor risk reduction, prevision and control using prevention, mitigation, preparedness, rehabilitation, reconstruction and recovery activities.

RISK MANAGEMENT PLAN: A risk management plan consists of an ordered and coherent set of strategies, programs and projects that orient activities favoring the reduction, prevision and control of risk and emergency preparedness and post impact disaster recovery. The achievement of appropriate levels of security when faced with a range of risks, and reduction of the material

losses and social consequences associated with disasters, leads to improvements in the quality of life and sustainability of the population.

RISK MANAGEMENT SYSTEM: An open, dynamic and functional institutional and organizational structure created with the objective of promoting and facilitating the incorporation of risk management practices and processes in the culture and social and economic development of the community, with the full participation of the population and its organizations. This should be accompanied by adequate orientations, norms, resources, programs, technical and scientific activities and planning mechanisms.

RISK MITIGATION: The planning and execution of intervention measures aimed at reducing existing risk. Mitigation assumes that in many circumstances it is neither possible nor feasible to control risk completely but it can be reduced to levels that are acceptable or feasible. The mitigation of risks may operate in the context of reducing or eliminating existing risks, or it may accept those risks and through the use of preparedness activities, including early warning systems, to reduce the damage and loss once the dangerous event occurs.

RISK PREVENTION: Measures and actions that attempt to predict new risks and prevent their occurrence. The prevention of risk refers to prospective risk management, whilst mitigation refers to corrective actions. Given that total prevention is rarely feasible the notion has a semi utopian and impractical character, and has to be considered in the light of acceptable risk. (see above)

RISK REDUCTION: Corrective and prospective intervention measures that change or reduce existing or possible future risk conditions These comprise prevention-mitigation and preparedness measures adopted prior to the appearance of a threatening phenomenon with the aim of: a) avoiding the presence of the dangerous phenomenon, reducing its threat level or reducing the levels of exposure of the different social elements; b) reduce its effects on the population, infrastructure, goods, services and the environment, by reducing their vulnerability.

RISK SCENARIOS: An analysis of the conditions, causes and dimensions of risk affecting specific territories and social groups, presented in written, cartographic or diagrammed form, using quantitative and qualitative techniques and based on participative methods of enquiry. This implies a detailed consideration of hazards and vulnerabilities, of the causal processes and of the social actors that contribute to risk. As a methodology it offers a basis for decision-making on intervention, which overcomes the limitations associated with the simple estimation of different scenarios of potential consequences or effects in a particular geographical area.

SOCIO-NATURAL HAZARDS: A latent threat associated with the possible occurrence of a physical phenomenon whose existence, intensity or recurrence is related to processes of environmental degradation and human intervention in natural ecosystems. Amongst the many examples of this type of phenomenon, cases may be found in floods and landslides that result, in different degrees, from such processes as deforestation and destruction of river basins; reduction of coastal protection due to logging of mangroves, and the lack of sufficient or adequate storm drainage systems in urban areas. Socio-natural hazards are created where human activity intersects

with natural ecosystems and may be seen as a process by which resources are transformed into hazards. Changes in the environment and new hazards associated with Global Climate Change will probably comprise the most dramatic and notable examples of socio-natural phenomenon. Similar types of phenomenon to those classified as socio-natural may also be the product of totally natural processes. In this case they would simply be natural hazards.

SUSTAINABLE DEVELOPMENT: Environmental, economic, social, cultural and institutional transformations that seek to provide a durable improvement in the quantity and quality of goods, services and resources. The term also refers to social change that promotes the security and quality of human life and an improvement in living conditions on an equitable basis, without deteriorating the natural environment or compromising the opportunities for similar levels of development for future generations.

VULNERABILITY: In the context of risk management, vulnerability refers to an internal risk factor for an element or group of elements that are exposed to a hazard. Vulnerability reflects the intrinsic physical, economic, social and political predisposition or susceptibility of a community to be affected by or suffer adverse effects when impacted by a dangerous physical phenomenon of natural, socio natural or anthropogenic origin. It also signifies a lack of resilience limiting the capacity to recover. The differences in vulnerability of given social and material contexts determine the severity of the effects of dangerous phenomenon.

WARNING (EARLY): A declaration emitted by responsible and accountable institutions, organizations or individuals. Such warning implies adequate, precise and effective information provided prior to the occurrence of a dangerous phenomenon. This information should lead emergency organizations to activate previously established mechanisms, and the population to take specific precautions. Besides warning the population as to the imminent danger, warnings are declared in order that the population and the relevant institutions may adopt specific actions when faced with the threatening situation.

REFERENCES

Adams, J. (1995). *Risk*, London, UCL Press.

Anderson M. B. and Woodrow P. J. (1989). *Rising from the Ashes: Development strategies in times of disaster*, Boulder, Westview Press.

Aysan,Y. (1993). "Vulnerability Assessment", *Natural Disasters: Protecting vulnerable communities*, Ed. Marriman P.A., Browitt, C.W, IDNDR, Thomas Telford, London.

Blaikie, P., Cannon, T., Davis, I. and Wisner, B. (1996). *Vulnerabilidad, el entorno social de los desastres*, La Red de Estudios Sociales en Prevención de Desastres en América Latina, La RED/ITDG, Bogotá. In English: *At Risk* (1994).

Blockley, D. (Ed.) (1992). *Engineering Safety*, MacGraw-Hill International Series in Civil Engineering, London.

Burton, I. (1962) Types of agricultural occupance of flood plains in the United States, University of Chicago, Department of Geography Research Paper **121**.

Burton, I. and R..W. Kates, (1964) "The perception of natural hazards in resource management" *Natural Resources Journal* 3(3) 412-441.

Burton, I., Kates, R. W. and White, G. F. (1968) The human ecology of extreme geophysical events; *Natural Hazard Research*, Working Paper **1**, Department of Geography, University of Toronto.

Burton, I., Kates, R. W. and White, G. F. (1978) *The Environment as Hazard*, New York, Oxford University Press.

Camerer, C.F. and H. Kunreuther (1989)."Decision process for low probability events: Policy implications" *Journal of Policy Analysis and Management*, **8**, 565-592.

Cannon, T. (1994) "Vulnerability analysis and the explanation of natural hazards, en Varley, Ann, *Disasters Development and Environment*, Wiley, Chichester.

Cardona, O.D. (1985). Hazard, Vulnerability and Risk Assessment, unedited working paper, Institute of Earthquake Engineering and Engineering Seismology IZIIS, Skopje, Yugoslavia.

Cardona, O.D. (1986). "Estudios de Vulnerabilidad y Evaluación del Riesgo Sísmico: Planificación Física y Urbana en Áreas Propensas", Asociación Colombiana de Ingeniería Sísmica, *Boletín Técnico AIS* No. 33, Bogotá.

Cardona O.D. (1996). "Manejo ambiental y prevención de desastres: dos temas asociados", *Ciudades en Riesgo*, M. A. Fernández (Ed.), La RED, USAID, reimpresión como *Cities at Risk*, 1999.

Cardona, O.D. (2001)."*Estimación Holística del Riesgo Sísmico utilizando Sistemas Dinámicos Complejos"* http://www.desenredando.org/public/varios/2001/ehrisusd/index.html, Universidad Politécnica de Cataluña, Barcelona.

Cardona, O. D. and Barbat, A. H. (2000). *El Riesgo Sísmico y su Prevención*, Cuaderno Técnico 5, Calidad Siderúrgica, Madrid.

Cardona, O.D. and Hurtado J.E. (2000): "Modelación Numérica para la Estimación Holística del Riesgo Sísmico Urbano, Considerando Variables Técnicas, Sociales y Económicas" *1er Congreso de Métodos Numéricos en Ciencias Sociales*, CIMNE-UPC, Noviembre 2000, Barcelona.

Chambers, R. (1989) *Vulnerability, Coping and Policy*, IDS Bulletin No. **20**, Institute of Development Studies, Sussex

Clark, M., Herington J. (1989): *The Role of Environmental Impact Assessment in the Planning Process*, London, New York: Mansell Publishing Limited.

Coburn, A. and Spence, R. (1992). *Earthquake Protection*, John Wiley & Sons, New York.

Covello, V.T., von Winterfeldt, and P. Slovic (1987). "Communicating scientific information about health and environmental risks: Problems and opportunities from a social and behavioral perspective" In *Uncertainty in Risk Asessment, Risk Management and Decisionmaking*. L. Covello, V. L. Lave, A. Moghissi, and V. Uppuluri, (Eds.) New York, Plenum Press.

Cutter, S. L. (Ed.) (1994). *Enviromental Risks and Hazards*, Prentice Hall, New Jersey.

Douglas, M. (1985) *Risk Acceptability According to the Social Sciences*. New York, Russell Sage Foundation.

Douglas, M. and A. Wildavsky (1982) Risk and Culture: An Essay on the Selection of Technological and Environmental Dangers. Berkeley, University of California Press.

Drabek, T. E. (1986). *Human Systems Response to Disasters*, New York, Springer Verlag.

Duque, G. (1990): *Desarrollo Sostenido en la Prospectiva de la Problemática Ambiental y la Supervivencia*, Sociedad de Mejoras Públicas de Manizales, Colombia.

Elms, D. G. (1992). "Risk Assessment", *Engineering Safety*, D. Blockley, (Ed.), MacGraw-Hill International Series in Civil Engineering, 28-46, London.

Fischhoff, B. Slovic, P. and Lichtenstein, S. (1979) "Weighing the risks" *Environment*, 21(4), 17-38.

Fournier d'Albe, M. (1985) "The quantification of seismic hazard for the purposes of risk assessment", *International Conference on Reconstruction, Restauration and Urban Planning of Towns and Regions in Seismic Prone Areas*, Skopje, Yugoslavia.

Johnson, B. B. and Covello, V. T. (1987). *The social and cultural construction of risk.* Dordrecht, D. Reidel Publishing Company.

Kates, R. W. (1971). "Natural hazard in human ecological perspective: hypotheses and models", *Economic Geography*, **47(3)**, 438-451, Clark University.

Kates, R. W. (1978). *Risk Assessment of Environment Hazard*", John Wiley & Sons, New York.

Kasperson, R.E., O. Renn, P. Slovic, H.S. Brown, J.Emel,R.Goble, J.X. Kasperson, and S. Ratick (1988). "The social amplification of risk: a conceptual framework". *Risk Analysis* **8(2)**:177-187.

Krimsky S. and Golding, D. Eds.(1992). *Social Theories of Risk*, Praeger, West Port, CT.

Lavell, A. (1992): "Ciencias Sociales y Desastres Naturales en América Latina: Un Encuentro Inconcluso" *Desastres Naturales, Sociedad y Protección Civil*, COMECSO, México.

Lavell, A. (1996). "Degradación ambiental, riesgo y desastre urbano. Problemas y conceptos: hacia la definición de una agenda de investigación", *Ciudades en Riesgo*, M. A. Fernández (Ed.), La RED, USAID.

Lavell, A. (2000): "Draft Annotated Guidelines for Inter-Agency Collaboration in Programming for Disaster Reduction.", unprinted for Emergency Response División at UNDP, Geneva.

Liverman D.M. (1990) Vulnerability to global environmental change, *Understanding Global Environmental Change: the contributions of risk analysis and management*, R.E. Kasperson, K. Dow, D. Golding, and J.X. Kasperson (Eds.),Worcester, MA, Clark University.

Luhmann, L. (1990). "Technology, Environment, and Social Risk: A System Perspective", *Industrial Crisis Quaterly*, **4**, 223-231.

Luhmann, L. (1993). *Risk: A sociological theory*, New York: Aldine de Gruyter.

Mansilla, E. (Ed.) (1996) *Desastres: modelo para armar*, La RED, Lima.

Maskrey, A. (1994). "Comunidad y desastres en América Latina: estrategias de intervención", *Viviendo en riesgo: comunidades vulnerables y prevención de desastres en América Latina*, Allan Lavell (Ed.), LA RED, Tercer Mundo Editores, Bogotá.

Mileti, D. S. (1996) Psicología social de las alertas públicas efectivas de desastres, Especial: Predicciones, Pronósticos, Alertas y Respuestas Sociales, Revista *Desastres & Sociedad No.* **6**. LA RED, Tarea Gráfica, Lima.

Milutinoviç, Z., and Petrovski J. (1985): "Earthquake Vulnerability and Loss Assessment for Physical and Urban Planning", *International Conference on Reconstruction, Restoration and Urban Planning of Towns and Regions in Seismic Prone Areas*, IZIIS, Skopje, Yugoslavia.

Muñoz-Carmona, F. A. (1997). "Notes on Communication and Volcanic Risk", In B. M. Drottz Sjoberg (Ed.). *New risk frontiers.* 10th Anniversary. The society for risk Analysis-Europe. Stockholm. 1997. (pp.123-128). Stockholm: Center for Risk.

Palmlund, I. (1989) "The case of estrogens: An inquiry into social risk evaluation" Unpublished doctoral

dissertation, Clark University.

Quarantelli, E.L., (1988): "Disaster Studies: An Analysis of the Social Historical Factor Affecting the Development of Research in the Area", *International Journal of Mass Emergencies,* Vol. **5(3)** pp. 285-310.

Rayner, S. (1992). "Cultural theory and risk analysis", in *Social Theories of Risk*, S. Krimsky and D. Golding, (Eds.), Praeger, West Port, CT.

Renn,O. (1992) "Concepts of risk: A classification", in Social Theories of Risk, S. Krimsky and D. Golding, (Eds.), Praeger, West Port, CT.

Rowe, W.D. (1977) *An Anatomy of Risk*, New York, Wiley.

Sen, A.K., (2000): *Development as Freedom*. New York: Alfred A. Knopf.

Slovic, P. (1992). "Perceptions of Risk: Reflections on the Psychometric paradigm". *Social Theories of Risk*, S. Krimsky and Golding (Eds.), pp.117-152, Wesport, Connecticut, Praeger.

Slovic, P., Fischhoff, B. and S. Lichtenstein (1981). "Perceived risk: Psychological factors and social implications" *Proceedings of the Royal Society of London.* A 376, 17-34.

Slovic, P., Fischhoff, B. and S. Lichtenstein (1985). "Characterized perceived risk" In Perilous Progress: Managing the Hazards of Technology". R. W. Kates, C. Hohenemser, and J.X. Kasperson (Eds.), Boulder, CO, Westview Press.

Starr C. (1969). "Social Benefit vs. Technological Risk: What is our Society Willing to Pay for Safety" *Science*, American Association for the advancement of Science, **165**, 1232-1238.

Susman, P., O'Keefe, P., and Wisner, B. (1984) Global disasters: A radical interpretation, pp. 264-83 in Hewitt 1984.

Taylor C., Vanmarcke E., and Davis J. (1998): "Evaluating Models of Risk from Natural Hazards" *Paying the Price*, Kunreuther H., and Roth R.J., (Eds.) Joseph Henry Press, Washington.

Thompson, M. and A. Wildavsky (1982). "A proposal to create a cultural theory of risk", In *The Risk Analysis Controversy: An Institutional Perspective*, H. C. Kunreuther and E.V. Ley (Eds.), New York, Springer-Verlag, 145-161.

Timmerman, P. (1981) *Vulnerability, Resilience and the Collapse of Society*. Environmental Monograph No. **1**, Institute for Environmental Studies, University of Toronto.

Tversky, A. and D. Kahneman (1973), "Availability: A heuristic for judging frequency and probability" *Cognitive Psychology*, **4**, 207-232.

Tversky, A. and D. Kahneman (1974), "Judgment under uncertainty: Heuristics and biases" *Science* 185, 1124-1131.

UNDP (1991) *Human Development Report*. Oxford University Press. New York.

UNDP (2000) *Expert Meeting on Risk and Vulnerability Analysis and Indexing*, Bases for the World Vulnerability Report WVR and Disaster Risk Index, DRI. (Aysan, Y., Maskrey, A. and Cardona, O.D.) UNDP/DRRP, September 11 and 12,Geneva.

UNDRO (1980): *Natural Disasters and Vulnerability Analysis*, Report of Experts Group Meeting, Geneva.

Wesgate, K.N. and O'Keefe, P. (1976) *Some definitions of disaster*, occasional paper No. 4, Disaster Research Unit, University of Bradford.

White, G. F. (1942). "Human adjustment to floods: A geographical approach to the flood problem in the U.S", Research Paper **29**, Department of Geography, University of Chicago.

White, G. F. (1964) "Choice of Adjustment of Floods", Research Paper **93,** Department of Geography, University of Chicago.

White, G. F. (1973). "Natural hazards research", *Directions in Geography*, R. Chorley (Ed.), 193-216, London.

Whitman R., Reed J. W. and Hong, S. T. (1973). "Earthquake damage probability matrices", *Proceedings of the Fifth World Conference on Earthquake Engineering*, Roma.

Wijkman, A. and Timberlake, L. (1984). *Natural Disasters: Act of God or Acts of Man*, Earthscan, Washington.

Wilches-Chaux G. (1989). *Desastres, ecologismo y formación profesional*, SENA, Popayán, Colombia.
Wildavsky, A. and K. Dake (1990). "Theories of risk perception: Who fears what and why?"*Daedalous* 119(4), 41-60.
Wisner, B. (1993) “Disaster Vulnerability: Scale, Power and Daily Life”. *GeoJournal* 30(2):127-40.