Natural Hazards

# Understanding and Managing Risk Associated with Natural Hazards: An Integrated Scientific Approach in Latin America and the Caribbean

ICSU
International Council for Science
Regional Office for
Latin America and the Caribbean

# Understanding and Managing Risk Associated with Natural Hazards: An Integrated Scientific Approach in Latin America and the Caribbean

ICSU
International Council for Science
Regional Office for
Latin America and the Caribbean

**March, 2009**

CREDITS:
Graphic Project: Sandra Frias
Eletronic Edition: Sandra Frias and Sandra Santos
Collaborators: Sergio Gil Silva and Sybelle M. M. de Jongh
Images: Stijn Bossink (Heavy lightning)






# Foreword

Founded in 1931, the International Council for Science (ICSU) is a non-governmental organization that plans and coordinates interdisciplinary research to address major issues of relevance to both science and society. Over the years the geographical breadth of ICSU activities has changed. Increasingly a major emphasis for ICSU has been the development of scientific capacity in developing countries and the integration of these scientists in international research initiatives.

The creation of three ICSU Regional Offices, established in Africa, Asia and the Pacific, and Latin America and the Caribbean also marks a fundamental change in ICSU structure, the aim of which is two-fold. Firstly, it should enhance the participation of scientists and regional organizations from developing countries in the programs and activities of the ICSU community. Secondly, it will allow ICSU to play a more active role in strengthening science within the context of regional priorities through scientific collaboration.

Especially in regards to Latin America and the Caribbean, this is an important step in bridging the 'islands of competence' that exist in every country and that together will be able to advance significantly the scientific research agenda in the region. The first step towards the establishment of a Regional Office was the appointment in 2006 of the Regional Committee for Latin America and the Caribbean, integrated by renowned scientists of the region.

The Regional Office for Latin America and the Caribbean was the third to be established and was inaugurated in April 2007. It is hosted by the Brazilian Academy of Sciences, in Rio de Janeiro, Brazil, and supported by the Brazilian Ministry of Science and Technology, ICSU and CONACYT Mexico.

Based on the ICSU Strategic Plan 2006-2011, the Regional Committee has selected four priority areas to be developed:

Mathematics Education;

- Biodiversity: knowledge, preservation and utilization of biodiversity of all countries of the Latin American and Caribbean region, and to ensure that the scientific community of the smaller countries of the region are fully integrated in DIVERSITAS;
- Natural Hazards and Disasters: prevention and mitigation of risks specially of hydrometeorologic origin with special attention to the necessary social science research;
- Sustainable Energy: assessment of the existing capacities in the LAC region and the social impact of the use and development of new energy resources.

Four Scientific Planning Groups were appointed to develop proposals that reviewed the current status of the priority area on the region and to formulate a set of detailed objectives and targeted areas of research to be developed in the next few years.

Engaging highly qualified scientists from Latin America and the Caribbean, the Scientific Planning Groups did an outstanding work within a restricted time limit. We thank each and every one of the participants for their enthusiasm and dedication.

This document is the final report of the Scientific Planning Group in Natural Hazards and Disasters, which is being submitted to the scientific community in the expectation of effectively influencing the development of scientific research in this area in the years to come.

*Alice Abreu*
Director of ICSU-LAC

*José Antonio de la Peña*
Chair of the Regional Committee for LAC

# Contents

## Scientific Planning Group and Regional Committee

### Scientific Planning Group in Natural Hazards and Disasters

- Omar Dario Cardona (Colombia) - Chair
- Allan Lavell (Costa Rica/UK)
- Michel Hermelin (Colombia)
- Juan Carlos Bertoni (Argentina)
- Tony Gibbs (Barbados)

- Carmen Samayoa (Guatemala) - Liaison RCLAC

### ICSU Regional Committee for Latin America and the Caribbean

- José Antonio de la Peña( México) - Chair
- Juan A. Asenjo (Chile)
- Tara Dasgupta ( Jamaica)
- Sandra Díaz (Argentina)
- Mahabir Gupta (Panama)
- Maria del Carmen Samayoa (Guatemala)
- Enrique Lessa (Uruguay)
- Elena Vigil (Cuba)

#### Ex officio

- Jerson Lima Silva (ABC)
- Sergio Pastrana (ICSU Executive Board)
- Patricia Ocampo-Thomason (ICSU Secretariat)
- Alice Abreu (ICSU Regional Office)

# Executive Summary

Disasters associated with environmental hazards reflect and signify unmanaged risk and may also be seen as representing unresolved development problems. Disaster risk is defined as the probability of future damage and loss associated with the occurrence of environmental hazards, where levels and types of loss are determined by the levels of exposure and vulnerability of society. Disaster is a social condition whereby the normal functioning of society has been severely interrupted by the levels of loss, damage and impact suffered

Disaster risk and disaster originate in socio-environmental processes. The notion of the "social construction" of risk is now widely used to capture the idea that society, in its interaction with the physical world, constructs disaster risk by transforming physical events into hazards through social processes that increase the exposure and vulnerability of population groups, their livelihoods, production, support infrastructure and services. Disaster risk and disaster have been constantly on the rise over the last five decades and with Climate Change processes can be expected to increase further in the future if concerted action in favour of risk reduction is not enacted. Such disaster risk reduction requires the implementation of Disaster Risk Management principles and practices that allow the reduction of existing risk (corrective management) and controls over the creation of new risk in the future (prospective management).

**The Research Context**

Understanding risk, the processes that lead to its construction or development and the development of adequate risk reduction and control mechanisms requires an improved and increased research endeavour. Given the multi dimensional nature of risk and the multiple natural and social factors that intervene in its development and in the ways society understands and reacts to it, this research must be minimally based on multidisciplinary formats and optimally on those that promote interdisciplinary and trans-disciplinary research. Although disciplinary oriented research has much to offer in understanding particular facets of the problem, a real understanding of risk and disaster, the ways society understands and reacts to it and the opportunities for risk reduction can only be achieved with more complex formats, that require greater levels of conceptual development, agreement and homogeneity and the promotion of methodological frameworks that encourage and make possible interaction between the natural, applied and social sciences and which promote wide level stakeholder participation.

To date, although progress has been made in bringing social and natural sciences together in the study of risk and disaster this has not in general gone much beyond broad based multidisciplinary efforts. Research efforts are still more likely to be disciplinary based, and whilst the basic, natural and applied sciences continue to provide valuable information for understanding and decision, the social sciences, after two decades of development in the topic, tend to have stagnated due to lack of research impetus and support on an organized, collective basis. The present ICSU programme will attempt to advance in the promotion of multi and interdisciplinary research on the risk and disaster topic providing new insights to risk management decision making, implementation and action.

**Programme Objectives**

The particular objectives of this programme will be:

a. To promote interdisciplinary research on the risk and disaster problematic that includes: a more thorough knowledge of significant hazard events and patterns, a better understanding of risk construction processes; the promotion of risk measurement, evaluation and analysis; the understanding and promotion of more adequate and comprehensive decision making processes; and, the introduction of more permanent and consequent risk management schemes and principles.

b. The promotion of research that draws together Climate Change Adaptation and Disaster Risk Reduction research, discussion and practice.

c. The development and promotion of methodologies for integrating social and natural science in interdisciplinary research formats. And, those that promote the transition between research and action, using participatory methods and consideration of stakeholder roles.

d. To promote better relations and understanding between the scientific and government policy communities, developing methods for better transmitting and relaying information and knowledge to the latter.

e. To promote better relations and understandings between the scientific and civil society and private sector beneficiary communities, developing methods for better transmitting and relaying information and knowledge to these.

f. Support and promote research and capacity building efforts from a holistic perspective, stimulating the creation of relevant institutional frameworks to achieve this. Strengthen the research capabilities in social, natural and applied sciences and their capacities to interconnect on common conceptual and methodological bases.

g. Promote the creation of a post impact multidisciplinary analysis and review board and research capability capable of rapidly producing post mortem or forensic type analysis of disaster causation and impacts that are able to fuel public debate and lead to review of existing practices and failings. Based on this, support and promote the establishment of an independent review body on risk, disaster and research in the region.

**Research Themes and Methodology**

In order to promote these objectives the programme has identified four major research themes that may be promoted through the development of individual or collective research projects and programmes:

**Firstly**, the identification of significant, as yet uncharted and un-mapped natural hazard processes and patterns, that could and may be associated with present or future risk patterns and disaster.

**Secondly**, the understanding of the factors and processes (social and physical) that contribute to the social construction of risk and to the ways in which risk is distributed socially, territorially and temporally.

**Thirdly**, with regard to the ways risk may be evaluated, measured or dimensioned objectively (actuarially). And, as to the ways risk is analysed socially. That is to say, the way risk is given real social meaning and a basis is established for decision making, in favour of, or against risk reduction and control.

**Fourthly**, the understanding of decision making processes and the real enactment or rejection of risk reduction and control, disaster preparedness, response and recovery actions.

Although these four aspects or themes and their subdivisions are different, they can also be seen to be concatenated and final outputs in terms of risk management will be influenced by the inputs garnered from each type of process and its contribution to the understanding and measurement of risk. The more definitive or conclusive of these themes, when seen from the angle of disaster risk and disaster as such, obviously relates to the decision to act, to reduce or control risk. That is to say, the structure and configuration of research undertaken on causal factors, evaluation and assessment should optimally be directed by an interest in the promotion of adequate decision making and the identification of risk management needs and options. This does not of course mean that basic science is not to be encouraged with its latent positive effects on understanding and decision making. The three "knowledge" demands or contexts (new natural hazard identification and patterns, risk construction processes, evaluation and assessment) are absolutely fundamental in achieving decision making and must be seen as an integrated part of this.

Whilst recognizing the importance of maintaining an open approach to project postulation and development under the above mentioned themes, the ICSU scientific planning group that developed the present proposal have identified six particular priority areas for further consideration and development: the development of methodologies for supporting risk analysis in small and medium towns; research on risk reduction amongst population occupying slope areas in cities in the LAC region; the development of risk modelling and data platforms for countries in the region; the development of risk and risk management indicator schemes and practices; research on real decision making processes at the national, regional and local levels; and, research that provides a better basis for the promotion

of climate change adaptation based on the experience generated in the risk management field.

In the development of the four identified themes and in the development of the particular projects, attention must be placed on the development of research formats and methodologies that encourage interdisciplinary work, adequate processes of social communication that permit natural and applied science findings to be incorporated in risk reduction activities and the encouragement of wide scale stake holder participation.

**Programme Organization and Promotion**

The programme would attempt to promote and finance research endeavours under any one of these themes. This would be done through the establishment of a formally enacted research programme linked to an established research and training facility, endowed with financial support from different supporting agencies. At the same time individual and collective research projects that wish to be seen to be part of the ICSU promoted collective effort could "inscribe" projects under the programme to the extent they are in line with objectives, conditions and methodological requirements as set out in the present document.

**Support Activities**

In addition to the research programme as such, the scientific planning group has indicated two types of support activity necessary to advance programme objectives:

### Research Training and Support

Multi, inter- and trans-disciplinary research should be the objective of support through the present programme. In this sense, the programme and the financing mechanisms it may develop should be instrumental in the establishment and promotion of educational and training modalities and mechanisms that promote holistic, integrated, inter- and trans-disciplinary approaches to research and problem formulation.

This may be achieved in a number of ways.

Firstly, research projects supported by the present programme should be required to incorporate on the ground mechanisms for supporting and strengthening capabilities for cross disciplinary collaboration and work, which could have a spin off effect in teaching programmes led by project researchers. Incorporation of young researchers in projects and their exposure to interdisciplinary formats would be another spin off effect.

A second, more formal and institutionalised approach would be in the promotion and support given to the establishment of one or more interdisciplinary research and teaching facilities in the LAC region, linked to existing national or regional institutions. An ideal mechanism could be the promotion of holistic educational opportunities through the involvement of students in research projects that are complimentary to any formal educational opportunities offered.

A third complimentary mechanism would be through the support and incentives given for postgraduate courses in holistic and comprehensive risk management principles given in established, existing institutions.

### Post mortem or Forensic Studies of Disaster in the Region

The most valuable laboratory for the study risk and disaster are the impacts of real events. To learn effectively from these events research teams, protocols and logistics must be developed well in advance and necessary institutional arrangements must be negotiated and in place. Although post-event diagnostic surveys are carried out in the region, these are done in an uncoordinated way and the lessons learnt are insufficiently disseminated and only rarely peer reviewed.

There is the need to establish the mechanism for post-event diagnostic surveys that allow an understanding of fundamental physical and social processes that led to risk and disaster; on key issues of structural performance during earthquakes and hurricanes which have implications for public health and social and economic impacts; on social responses to disaster and on processes leading to recovery plans and processes. Post-event diagnostic surveys should be multi-disciplinary and should support analysis for the improvement of mitigation planning, regulation and investment. Results of the diagnostic surveys should be disseminated to the professional and educational communities, and wider a field by means of the most appropriate and efficient information technology.

Such a facility and the information it affords would be the basis for the establishment of a permanent evaluating committee on risk and disaster in the region that through its work and results could serve as a pressure element for change in practice and policy in the region.

Understanding and Managing Risk Associated with Natural Hazards: An Integrated Scientific Approach in Latin America and the Caribbean

# 1. Introduction: Establishing the Research Theme and the Conceptual and Methodological Approach

## 1.1 Disaster Risk and Disaster Risk Management

Risk, as seen in the context of disaster, may be defined as the potential, probable damage and loss associated with the occurrence of diverse types, intensities and magnitudes of physical phenomena (single, multiple or concatenated), affecting exposed and vulnerable populations, their livelihoods, support mechanisms and infrastructure. This damage and loss may, under certain circumstances, reach such levels and consequences that we talk of large scale "disaster" or "catastrophe". At other times, when faced with lower levels of loss and damage, it is now common to talk of small and medium scale disasters.

As such, risk is the result of the interaction in time and space of probable physical events with exposed vulnerable elements of the social and environmental systems. On such interaction, these physical events are transformed into hazards with the real potential for contributing to future loss and damage. It is in the latency of risk that the opportunity for risk reduction and prevention exist, employing diverse disaster risk management principles, strategies and instruments. These may be developed in the context of existing risk ("corrective management") or for avoiding future risk ("prospective management"). Disaster risk management may be defined as a social process that searches to reduce, predict and control disaster risk factors in a development framework, by means of the design and implementation of appropriate policies, strategies, instruments and mechanisms. (Figure 1, below, provides a summary of the causal and intervention aspects associated with this vision of risk).

Disaster may be seen as the actualization or materialization of existing disaster risk. That is to say, latent risk conditions are transformed into real damage and loss when a detonating physical event actually occurs. The existence of risk is a *sine qua non*, a prerequisite for future disaster. Disaster is the product of a complex relationship between the physical world, the natural and built environment, and society, its behaviour, functioning, organization and development. As such it is a product and consummated reality, but, at the same time, the existence of

disaster conditions leads to new social processes and new or transformed risk conditions. Risk is a continuum, and disaster one of its many "moments" or "manifestations".

The principle objective of the present ICSU sponsored research programme is to contribute to better and more effective understanding of disaster risk and disaster risk management in the Latin American and Caribbean regions, promoting research in an integrated interdisciplinary framework.

Whilst most concerned with the disaster risk reduction (mitigation) and prevention, including recovery aspects, research will also contribute to a better understanding and intervention in the disaster preparedness and response aspects of the risk management formula. On the other hand, whilst most concerned with natural hazards and their impacts, this must be accompanied by a concern for what have come to be known as socio-natural hazards. That is to say, physical phenomenon and associated hazards that are the product of human intervention in the natural environment and which range in their scale and importance from the impacts of global climatic change (related to land use changes and carbon emissions) through to small scale flooding or land-sliding related to local processes of deforestation and slope destabilisation. Technological hazards will only be considered to the extent they concatenate with natural and socio natural hazards to increase impacts and effects. Biological hazards will also only be considered to the extent that they are a sub product of given disaster conditions.

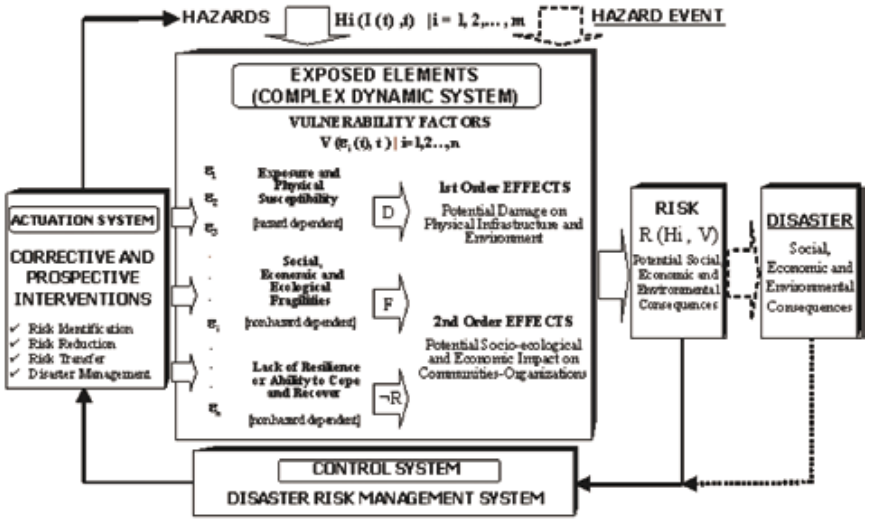


**Figure 1:** Theoretical Framework and Model for a Holistic Approach to Disaster Risk Assessment and Management.
**Source:** Adapted from Cardona (1999: 65), Cardona and Barbat (2000), IDEA (2005a/b) and Carreño, Cardona and Barbat (2007).

## 1.2. An Integrated Scientific Approach.

As disaster risk is not an autonomous or externally generated circumstance (as is the case with natural phenomena or events per se) to which society reacts, adapts or responds, but rather, the result of the interaction of society and the natural or built environment, it is in the knowledge of this relationship and the factors influencing it that an adequate understanding of risk may be achieved.

And, with this understanding, the options for social intervention and control of disaster risk (and risk in general) become more possible and probable.

The complex relationship between society and environment, which explains the existence of disaster risk, also signifies that the options for understanding and successfully intervening in risk requires the harmonious and integrated presence and application of relevant social, natural, basic and applied science knowledge and methods. Risk is the product of the interface of the inert, dynamic, physical, and the living social worlds, such that understanding of it can only be forthcoming where an understanding of these different contexts and relationships is achieved.

Syncretism, whereby social science factors or conditions are introduced on top of, or in parallel to physical factors and knowledge, will not lead to the needed understanding of risk. Knowledge of each of the factors that contribute to risk (physical events transformed into hazard, vulnerability and exposure) may be undertaken by the physical and social sciences apart (using multidisciplinary formats), but an understanding of the dialectical relation and the final product to which society responds or does not respond and the profiling of relevant and feasible intervention, also requires more integrative, interdisciplinary or trans-disciplinary models.

Given the as yet still unsatisfactory situation as regards integrated research, ICSU has a significant role to play in "centring" analysis and discussion, in moving to promote integrative approaches, in developing ideas as to interdisciplinary methods of achieving greater knowledge and more pertinent guidelines for decision making in the risk mitigation and prevention areas. A basic starting point for this is the acceptance that although the physical world, the processes it encloses and displays, and the potential hazards it convenes are a *sine qua non*, a requisite and prerequisite for talking of and understanding disaster risk, risk is, in the final equation **socio-ecological** and it is in the ways society measures, understands, perceives, relates and assigns importance to risk (and risk factors) that the bases for intervention may be laid down and developed. Reverting the historical and current trend in favour of increased disaster loss will require such integration and the results it may bring in terms of increased relevance and application of scientific knowledge. It is in the lack of integration and communication, amongst other things, that we can find an explanation for the observed non linear or causal relationship between an ever increasing knowledge base on multiple aspects and factors of risk and disaster, but, at the same time, ever increasing disaster losses.

Assigning importance to and taking conscious decisions based on information and knowledge relating to the reduction or control of risk is an indispensable factor in establishing an area of concern, study and intervention where risk constitutes a socially and politically constructed problem that demands a solution; where risk assumes levels of relevance that demand intervention and control.

# 2. Rationale for the Research Programme

## 2.1 The Disaster Risk and Disaster Problematic

The establishment of the UN International Decade for Natural Disaster Reduction-IDNDR in 1990 and the creation of the International Strategy for Disaster Reduction-ISDR- in 2000, accompanied by the successive declarations emanating from the World Disaster Conferences held in Yokohama and Hyogo in 1994 and 2005 respectively, are clear signals and indicators of the increased interest and concern for disaster risk and disaster related issues at a world level. The 1994, Cartagena, and 2004, Manizales, Inter-American Disaster Conferences held in Latin America and the Caribbean are parallel instances that echo such concerns at the regional levels.

Relatively recent events such as the Niño of 1997-98; Hurricane George and Mitch in 1998, Jeanne and Ivan in 2004 and Wilma in 2005 and Tropical Storm Stan in 2005; the debris flows of Vargas in 1999; the earthquakes of El Salvador in 2001, in the coffee-growing area of Colombia in 1999 and in the Pisco region in Peru in 2007;, the serious flooding in Bolivia in 2006 and 2007 and in Tapasco in Mexico in 2007, and the eruptions of Tungurahua in Ecuador in 2006 and Cheiten in Chile in 2008 are but the more dramatic cases of a serious and permanent problem that effects millions of persons every year in the region. And, behind these events and the disasters they help conform, there is a permanent and changing process of risk construction associated with in-operational development models, increased exposure in coastal, river side, lake, volcanic slope and seismic areas and ever increasing vulnerability levels associated, amongst other things, with increased poverty and, now, increased food security problems.

The human, economic, material cultural, psychological and historical loss and damage associated with successive events has constantly increased over the last four decades, with preponderance for those associated with hydro-meteorological events. Such losses have increased dramatically over the last ten years. One of the possible explanations for this is the increased effect of global climate change. Whether this is the explanation or not for trends over the last 15 years, most certainly we can expect very much increased impacts over the next years related to changes in rainfall, storm and related hydro-meteorological parameters. When combined with the probable increase in exposure and vulnerability, the panorama is very serious and the need for evidence based, research supported intervention even more critical. There is a growing body of evidence and argument that experience with the mitigation and prevention of ongoing, every day, historical disaster risk is amongst the most efficient and efficacious ways of establishing options and incentives that reduce the risk associated with Climate Change (called adaptation, by climate change specialists). Due to this there is a need and demand to better coordinate and integrate disaster risk and climate change management

issues. Research can help substantiate such a view and contribute to a closing of the distance between the practitioners and institutions in each of these two complimentary areas of enquiry and practice.

## 2.2. Natural and Social Science Relations in Risk Research: the Challenge of Integrated, Interdisciplinary Research

Despite the many calls for interdisciplinary and trans-disciplinary methods and research over the last two to three decades, the disaster risk theme is still dominated today by partial approaches whereby the different sciences and disciplines contribute their specialized knowledge to the understanding of diverse facets of the problem. All of these are of undoubted importance for risk and disaster studies and intervention, but do not define or delimit the topic as such, on their own account. This is why some authors suggest that as yet we still do not have an integrated conceptual framework, a common theory, for studying disaster risk and disaster, which is jointly adopted or understood by the specialised sciences or disciplines. Thus, a geoscientist studying and contributing to the understanding of seismic activity, patterns and processes is not **per se** a disaster risk or disaster specialist, but rather a specialist in seismic activity, a legitimate area of enterprise **with** or **without** any direct interest in disaster. Similarly, an engineer or sociologist can study built structures or social behaviour that are of relevance to risk and disaster but this does not make them per se experts in disaster risk or disaster.

The transition from disciplinary specialisation on aspects pertinent to understanding risk to becoming a disaster risk (problem area) specialist requires other ingredients, amongst which a common analytical and conceptual framework for approaching and understanding risk is but one. The challenge for disaster risk studies is to build a central notion or concept and to articulate our research processes and research actors about this in an integrative fashion, always taking into account that research and its results should optimally be informed by a demand and need for policy and action related information and analysis. The present research initiative will promote an integrated research method and will hopefully contribute to advances in interdisciplinary methods and results.

The disciplinary history of research on risk and disaster in Latin America, seen from the scientific and inter-scientific perspective may be typified or caricatured in the following brief way (see section 4 for a more detailed analysis).

An early dominance of natural and applied science research on physical and hazard phenomenon and structural responses (earthquake, volcanoes, geo-dynamic, meteorological and hydrological) led to the growth, consolidation and dominance of the physical sciences in the risk problematic between the 1950s and 1970s. And, despite efforts to increase the salience and relevance, presence and impact of social science aspects, the physical and applied sciences continue to dominate both research and teaching on the topic in the region. The increased demand from disaster agencies and international financing organizations for social science aspects and measurement and consideration of social causes and impacts has led to an increase in the integration of social science aspects in

physical science stimulated and promoted research but this is more likely to be a tag on thing rather than something fully integrated and methodologically sound from an interdisciplinary perspective. Multidisciplinary work is far more prevalent than efforts at inter o trans-disciplinary science.

Social science has not, in general, managed to establish and foment specialised disaster risk research institutions at the university level in Latin America and the Caribbean, as has been achieved in Northern continents. Much less has it been possible to promote and sustain interdisciplinary research facilities. Risk and disaster research is more likely to be promoted on an individual or group basis than on an institutional basis. In consequence, little research is promoted on an integrated science basis.

One of the principle value added aspects of the present programme can be seen to be the manner in which it could promote research themes and formats where the confluence of social, natural and applied sciences in the definition of objects of study and methods is demanded from the outset. It is to be hoped that one of the outcomes of such a scheme could be the creation of one or more Latin American and Caribbean based integrated research institutions on the topic of risk and disaster, as exist in Northern continents, with a commensurate interest in the promotion of more integrated teaching programmes.

## 3. The Specific Objectives of the Research Programme

a. To promote interdisciplinary research on the risk and disaster problematic that includes: a more thorough knowledge of significant hazard events and patterns, a better understanding of risk construction processes; the promotion of risk measurement, evaluation and analysis; the understanding and promotion of more adequate and comprehensive decision making processes; and, the introduction of more permanent and consequent risk management schemes and principles.

b. The promotion of research that draws together Climate Change Adaptation and Disaster Risk Reduction research, discussion and practice.

c. The development and promotion of methodologies for integrating social and natural science in interdisciplinary research formats. And, those that promote the transition between research and action, using participatory methods and consideration of stakeholder roles.

d. To promote better relations and understanding between the scientific and government policy communities, developing methods for better transmitting and relaying information and knowledge to the latter.

e. To promote better relations and understandings between the scientific and civil society and private sector beneficiary communities, developing methods for better transmitting and relaying information and knowledge to these.

f. Support and promote research and capacity building efforts from a holistic perspective, stimulating the creation of relevant institutional frameworks to achieve this. Strengthen the research capabilities in social, natural and applied sciences and their capacities to interconnect on common conceptual and methodological bases.

g. Promote the creation of a post impact multidisciplinary analysis and review board and research capability capable of rapidly producing post mortem or forensic type analysis of disaster causation and impacts that are able to fuel public debate and lead to review of existing practices and failings. Based on this, support and promote the establishment of an independent review body on risk, disaster and research in the region.

# 4. The Current State of the Game as regards Risk and Disaster Research in the LAC Area

## 4.1. Natural and applied sciences: Emphasizing the hazard and the technical approach

The term "natural disaster" has been very frequently used in Latin America and the Caribbean (LAC) to refer to the occurrence of severe natural phenomena. Events such as earthquakes, tsunamis, volcanic eruptions, hurricanes, floods, landslides, among others, have been considered synonyms of disaster. Unfortunately, this interpretation has favoured the belief that there is nothing to be done when faced with disasters, other than improved response and reconstruction. This interpretation also led to disasters being considered events of destiny or bad luck or even the result of supernatural or divine causes, when seen from the community level. In the same way, vestiges of this kind of interpretation can be found in the legislation of most countries of the region, 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.

In LAC, similar to other regions, geophysicists, seismologists, meteorologists, geologists, among others, have tended to promote or support the idea that disasters are a topic principally if not exclusively associated with the physical phenomena that generate the natural events that contribute to disaster. In addition, despite technological advances in the prediction or prognosis of a future event, in most countries of LAC, budget decision-makers very often justify the lack of action and investment in seismological, geophysical, hydrological and meteorological instrumentation, arguing that damage and loss are unavoidable. A low level of investment in research and in monitoring networks has been the common rule in most countries; notwithstanding the efforts of regional institutions such as The Regional Seismology Centre for Latin America (CERESIS), The Pan American Institute for Geography and History (IPGH), and the Inter-American Institute for Global Change Research (IAI), among others, in commenting on and promoting the need to have better monitoring not just for prediction but also for generating better scientific knowledge. Only recently, with the development of environment and science and technology ministries and with the establishment of new inter-institutional organisations (such as disaster prevention/civil protection structures, emergency commissions) some governmental scientific institutions, related to hydrometeorology, geosciences and environment have been strengthened and their instrumentation potential updated. Due to this, fully fledged and comprehensive early warning systems have not yet been developed, as they should be implemented using real time geospatial and information technology. On-line shake maps and rapid damage assessments, for example, have only been developed for two cities in the region.

During the second half of the twentieth century, when technological advances contributed enormously to the knowledge of natural phenomena, it was commonplace in LAC to define risk as the estimation of the possible occurrence of a physical or social phenomenon. This definition of risk is still commonplace among specialists that study phenomena such as earthquakes, landslides, and storms. In the 1970s, and even in the 1980s, the probability of an earthquake was usually considered to be synonymous with estimating seismic risk. In other words, many still confused risk and hazard and failed 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 declaration of the 1990s as the International Decade for Natural Disaster Reduction (IDNDR) by the United Nations General Assembly was, without doubt, directly influenced by the natural sciences and in LAC led to the beginnings of a change in terminology. Towards the end of the 1980s and particularly in the 1990s the concepts of seismic hazard and threat started to be more frequently used, to refer to what was previously termed seismic risk. Indeed, the majority of seismic building codes in the region, for example, changed their terminology only in the last 15 years.

In LAC, as in other regions, the concept of risk in the applied and physical sciences commenced with the use of probabilistic models. One of the main worldwide contributions to hazard and risk, from a probabilistic perspective, was made in LAC prior to in other regions. Theory of probabilistic seismic hazard analysis was partially developed in Mexico and the first published seismic zone map that included levels of ground motion and associated return periods using attenuation relations were made by engineering researchers from the Universidad Nacional Autónoma de México (UNAM) at the beginning of the 1960s. Based on this approach probabilistic hazard analysis was used to establish building code design requirements in Mexico from 1970 onwards. This was later introduced in California and in other places of the world.

This seismic approach was adapted for other natural hazard evaluations but the building codes in most countries were only established with seismic requirements, with the exception of the Caribbean where tropical storms are very frequent and wind load standards (codes) for structural design were issued from the start of the 1970s. The implementation and updating of building codes in the region, on the whole, has been slow and delayed due to the lack of political will to adopt them as law. Since the 1980s countries such as Mexico, Chile, Peru, Venezuela, Colombia and in the Caribbean have codes, norms or regulations for building construction but their main problem has been enforcement. Outstanding contributions to the region and to the world were made by Colombian engineers from the 1980's onwards. These contributions were with regard to the development of simplified earthquake resistant construction guidelines for dwellings, middle-rise reinforced concrete buildings as well as to vulnerability evaluation and retrofitting of essential existing buildings, following technical recommendations made in the United States. Now, these types of requirements have been included in most international standards and building codes worldwide.

Using the same approach of the rates of exceedance proposed for hazard analysis, some probabilistic models were developed in Mexico and Colombia during the 1990s to reflect consistent annual probabilities of exceedance (or equivalent return periods of specific levels of loss); i.e. these techniques were adapted for risk evaluation evolving vulnerability functions. Using this approach risk calculations resulted from the probabilistic modelling of hazard in order to determine the estimate of 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 was that the results may be easily translated into potential losses and might be then applicable, in terms of the cost/benefit ratio, in the development of security standards, retrofitting programs, urban planning and investment projects. The influence of the Pan-American Health Organization (PAHO), the Organization of American States (OAS), the United Nations Development Program (UNDP), the Inter-American Development Bank (IADB), and the World Bank, among others, improved risk awareness and the level of intervention in the vulnerability levels of hospitals, schools, lifelines, bridges and other infrastructure. Unfortunately, the rate of growth of the problem is faster than the solutions offered and not only is good practice necessary, but also an immense increase in the level of intervention.

The employment of damage matrixes, loss functions, fragility curves or vulnerability indices, including those relating the intensity of a hazard event to the degree of harm or damage to buildings, have allowed the estimation of scenarios of potential loss in case of future events such as floods, volcanic eruptions, landslides, tsunami, earthquakes in a number of places in different countries. This type of analysis of risk has increasingly been useful in the countries of LAC for contributing data on hazards or risks to land use or physical and territorial planning specialists, as an ingredient for the decision-making process.

The old 'risk transfer' approach employed by the insurance/reinsurance industry favoured the post 2000 consolidation of a new paradigm as regards risk analysis of public assets, security and trustworthiness of systems in some countries. This contribution of engineering and the hard sciences to the study of vulnerability, promoted the concept of vulnerability using probabilistic and actuarial methods. Risk modelling to develop strategies of risk retention and transfer and for the design of financial instruments such as reserve funds, contingency credits, cat bonds, are beeing explored in Mexico, Colombia and in the Caribbean, where an insurance captive facility has been created among the countries. Recently multi hazard risk evaluations and disaster risk indicators projects have been supported by the World Bank and the IADB-Inter-American Development Bank- in Central America and for all countries of the region, respectively. These projects are state-of-the-art and they are multipurpose, because their objectives are risk understanding, risk communication, risk reduction and risk financing.

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 rather too much based on the physical and economic 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 substitute real risk evaluation, which was remained 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 only 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. 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 of 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.

On the other hand, from the beginning of the 1990s, disciplines such as geography, urban and territorial planning, economics and environmental management have helped to strengthen the contribution of the applied science approach to disasters in the region. 'Maps' are more and more common due to the ever greater participation of geologists, geotechnical engineers and hydrologists who contributed raw materials for the adequate identification of the danger or hazard zones, in line with their areas of interest in natural phenomena Computer tools such as geographic information systems, (GIS), have facilitated this type of identification and analysis in urban centres and hydrographic basins in most countries of LAC. However, 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, automatically 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 most important, if not 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.

Finally, from the 1990s onwards, climate variability and change have been of special interest to meteorologists and researchers due to the effects of the El Niño Southern Oscillation (ENSO) phenomenon in most countries and due to the potential exacerbation of hazards such as hurricanes, floods, droughts, landslides, cold waves, etc with climate change. Unfortunately, over the last years these concerns have been translated into a research emphasis again on hazards and less on vulnerability and adaptation. For this reason it is necessary to advocate an interdisciplinary effort to address vulnerability reduction from

a comprehensive or integrated scientific approach with the participation of researchers from natural, applied and social sciences in the region.

## Social Science Research: A Balance of the Historical Development and Current Status

Latin America and the Caribbean has had a chequered and changing history as regards social science inspired research (within or not a multidisciplinary or interdisciplinary framework).

Pre 1990 research efforts can be divided into two types, with two major influences. Firstly that research promoted and developed principally by North American scientists in the wake of major disasters in the region from 1960 onwards and which analysed response and reconstruction strategies and goals ( in particular, associated with the 1970 Peruvian, 1972 Nicaraguan, 1976 Guatemalan and 1986 Mexican earthquakes; the 1982-83 Niño; and the 1964 Fifi and 1988 Joan hurricanes). Examining the failings of a good part of these initiatives this type of research certainly contributed to the search for innovation and improvement in response and reconstruction in the region. Little research was undertaken however on more fundamental social risk construction and reduction aspects.

The second source of inspiration came from Latin American or Latin American based researchers or writers, from 1981 onwards. The 1980 failed Brady Prediction in Peru, the 1983 Popayán earthquake, the 1985 Mexico earthquake and the 1986 Nevado de Ruiz lahar helped stimulate this research. Two themes dominated the limited research or reflection and writings undertaken. Firstly, the topic of vulnerability would be developed, which would have such an important effect on the utilized risk paradigm and the ending of the formerly dominant physical science paradigm for interpreting disaster. And, secondly, a number of studies would be produced as regards the relations between disaster and development and development and disaster. These would bring forth the importance of environment and territory in conditioning risk and disaster, related particularly to hydro-meteorological hazards. The incipient concern for vulnerability and development would be of critical importance in the later development of modern risk and disaster research and paradigms in the region. At the same time that this incipient social science research was achieved, the natural sciences were in full swing, well financed and increasingly geared up to disaster oriented initiatives. The Brady prediction and other disasters had led to an increase in financing and in the attempts to predict and prognosticate events, both geological and meteorological. Moreover, new natural science research and monitoring centres were established in various countries in the region in the 1980s. Little effort was made in the pre 1990s years to bring together social and natural scientists in a common research endeavour related to reducing risk or disaster.

The commencement of the UN International Decade for Natural Disaster Reduction in 1990 undoubtedly served to stimulate research and technological development world wide and social scientists were not slow to push for and undertake more research, particularly in Northern countries where an already

well developed research capacity existed. In Latin America, this event, plus a concern for the direction the Decade would take and the role attributed to social aspects and local inputs in its formulation, led to the creation of the Latin American Network for the Social Study of Disaster Prevention-LA RED- in 1992. Bringing together a mere 15 persons interested in a social approach, this network would grow significantly over the next ten years and have a major impact on thought on the topic and on the development of conceptual and methodological frameworks for research. Moreover, it promoted more than 10 multinational, comparative research projects over the period 1993 to 2005 that brought to light many interesting and innovative theoretical, empirical and practical aspects. The development of notions on vulnerability and the social construction of risk; on the risk-environment-development relationship; small and medium disasters; socio natural hazards; corrective and prospective risk management; and the very idea and concept of risk management and local risk management in particular can be fundamentally attributed to the RED as it developed new ideas and channelled and modified appropriate "Northern" thought southwards.

In the concepts, method and thought of LA RED members, which included from the beginning engineers, geologists and ecologists with interest in social science ideas and methods, multidisciplinary and interdisciplinary principles, have been present since the beginning. The notion of the "social construction of risk" that has informed a good part of social science research and discussion rests on the idea that risk is constructed on the basis of physical events where society through different social processes (including exposure, vulnerability, capacity building, resilience, coping capacities and perception), determine the final levels of risk and the nature of the intervention undertaken in terms of reduction, mitigation and prevention. The natural-social interface is a determining fact in examining, understanding and intervening risk.

During the 2000's, in the post Mitch, Vargas and 1997-98 Niño era, and at a time when Climate Change issues and the call for adaptation strategies has increased substantially, the rate of social science research promoted on an organic basis on risk and disaster has in fact dropped, although at a university level and amongst post graduate and undergraduate students, a very much larger number of theses are now being produced. This tendency may be explained by the impact of the demands for consultancy work amongst different international and national agencies and the impact this has had in siphoning off some of the more well tried researchers in the region, the lack of institutionalised research facilities for promoting social science based research ( no specialised research facility has been established in the region over the last 20 years to take up on research challenges from an integrated angle), the lack of finance for research, and the increased pragmatic, and maybe opportunistic access to finance for climate change adaptation work, which is seen by some to compete with more traditional disaster risk management issues.

This tendency to a decrease in organically promoted and supported risk and disaster research comes at a time when the problematic is of ever increasing importance and the need for integrated research more and more evident as the patterns of the physical and social aspects influencing risk are under transition and change associated with global change in general.

With regard to Climate Change Adaptation concerns, whilst most research is directed to understanding changes in climatic parameters and modelling of climatic systems is prevalent and increasingly funded, little has been done as regards the analysis of changing vulnerability and exposure patterns and what this signifies for adaptation. Moreover, due to the way in which Climate Change came onto the scientific and social scene, with its early concentration on understanding the process by which change is brought about ( carbon emissions, land use changes and urban heat island effects etc), climate change work and research has tended to be separate from disaster risk concerns. Institutionally,they are also dealt with by different instances. This is not at all convenient as it is clear to many that climate change adaptation is in many aspects the continuity of risk mitigation and prevention as considered by risk management specialists working on risk associated with normal climate variability. Much can be gained from integrating climate change and risk management issues, including the fact that much may be learned about adaptation and the challenges it provides, by examining human responses and adjustments to ongoing climate variability including to such phenomenon as the El Niño and La Niña.

## 5. Research Programme

With regard to disaster risk, four different research and action themes have been identified for this programme that require the differential participation or interaction of natural, basic, applied and social sciences in the understanding, design and increased effectiveness of prevention, mitigation or response based interventions.

**Firstly**, the identification of significant, as yet uncharted and un-mapped natural hazard processes and patterns, that could and may be associated with present or future risk patterns and disaster.

**Secondly**, in the understanding of the factors and processes (social and physical) that contribute to the social construction of risk and to the ways in which risk is distributed socially, territorially and temporally.

**Thirdly**, with regard to the ways risk may be evaluated, measured or dimensioned objectively (actuarially). And, as to the ways risk is analysed socially. That is to say, the way risk is given real social meaning and a basis is established for decision making, in favour of, or against risk reduction and control. Very high risk levels seen from the actuarial (statistical and mathematical) perspective may be given low priority ratings by different social groups due to the influence of social, cultural, economic or political factors. The reverse may also be true under determined conditions.

**Fourthly**, with regards to the understanding of decision making processes and the real enactment or rejection of risk reduction and control, disaster preparedness, response and recovery actions.

Although these four aspects or themes and their subdivisions are different, they can also be seen to be concatenated and final outputs in terms of risk management will be influenced by the inputs garnered from each type of process and its contribution to the understanding and measurement of risk. The more definitive or conclusive of these themes, when seen from the angle of disaster risk and disaster as such, obviously relates to the decision to act, to reduce or control risk. That is to say, the structure and configuration of research undertaken on causal factors, evaluation and assessment should optimally be directed by an interest in the promotion of adequate decision making and the identification of risk management needs and options. This does not of course mean that basic science is not to be encouraged with its latent positive effects on understanding and decision making.

The three "knowledge" demands or contexts (new natural hazard identification and patterns, risk construction processes, evaluation and assessment)

are absolutely fundamental in achieving decision making and must be seen as an integrated part of this.

The present research programme uses the four fold division of research needs established above as a basis. Some of the challenges and limits and methodological and research questions related to each of these are presented below. These should serve to guide project formulation in the future under the auspices of this present research programme initiative At the same time, in the following section, a short series of generic research topics compatible with the four research areas identified are presented. At the same time these are seen to be of priority status by this ICSU committee, they are not meant to be limiting but rather indicative of a series of areas of preoccupation for future research that should be facilitated by the present research programme initiative.

## 5.1 Unknown, ignored or forgotten natural hazards and their patterns

Research and monitoring undertaken by geo-science establishments over the last 50 years in particular have helped to notably increase our understanding of the natural processes and events that may be associated with, or a factor in the risk and disaster equation. However, past disasters have constantly reminded us that there are many significant potential hazard contexts that are not known or mapped or simply have been wiped out of human memory due to time and social processes. Examples may be taken from the 1983 San Isidro and the 1991 Limon quake in Costa Rica, the 1993 tsunami in Nicaragua; Hurricane Mitch and it effect and route in Central America; the Vargas mudslides in Venezuela, the Cheiten eruption in Chile, where such events were either simply uncharted, unexpected or erased from human memory and consideration due to time and inaction. This indicates that there is still a real and significant need to promote new studies of natural processes and events and their patterns that serve as important inputs for planning and management. One major challenge given the size and extent of the continent and the number of possible uncharted physical processes and occurrences is how to determine need and priority in research such that this is significant for the risk and disaster problem and not just to science in general. A further problem in relationship to hazard patterns relates to the need to down scale much existing hazard information to the local or micro levels. Much work is required in this sense in the region, oriented to the use of hazard information in local planning and community based schemes.

Uncharted events are one significant aspect. But, another problem exists with those events that have at some time been charted but which for some social or political reason have been forgotten or mis-represented. Research must contribute to our understanding of such processes. The recent Chinese earthquake has revealed that the area affected was not on any map of high risk areas; the Limon earthquake was not on risk maps despite the fact that later analysis showed that the area had been affected by a similar level event earlier in the 20$^{th}$ and in the 19$^{th}$ centuries. Antecedents of such events as the Vargas mudslides have also subsequently been traced

## 5.2 Understanding the Social Construction of Risk

Risk is the product of the interaction in time and space of exposed and vulnerable persons, their livelihoods and support infrastructures, and potentially damaging physical events. Therefore, besides a thorough understanding of the diverse natural processes that generate potentially damaging physical events (which is the topic of diverse natural and applied sciences-seismology, vulcanology, hydrology, meteorology, civil engineering etc), an understanding of risk minimally requires:

- knowledge of the processes by which human intervention in the natural environment leads to the creation of new physical phenomena or events and potential hazards (socio natural);

- knowledge of the processes by which persons, property, infrastructure and goods are exposed to potentially damaging events—i.e. understanding location.

- knowledge of the processes that contribute to the multi-dimensional vulnerability of persons and their livelihoods and increases or decreases in this social condition- i.e. understanding the allocation and distribution of social and economic resources in favour of, or against the achievement of resistance, resilience and security.

### 5.2.1 New Hazards

In the case of new events and hazards associated with human intervention in the environment (e.g. where deforestation leads to greater landslide and flood potential; where emission of carbon gases leads to changes in climate and an increase in climate related hazards; where destruction of mangroves leads to greater exposure to wave action and coastal erosion with negative impacts on humans), research must elucidate as regards the rationale for the type of human intervention undertaken, the limits and opportunities the environment presents when faced with such interventions and as to the options or alternatives that may exist for achieving similar, if legitimate, social or economic goals, but without the generation of such adverse environmental impacts and results. Knowledge must be increased as regards the existence, locus, intensities and patterns of such events, from those locally generated through to climate change related events. This means a new map of hazards that goes beyond the normally considered "natural" events or hazards

From the research perspective, natural sciences can provide a basic platform and understanding of intrinsically delicate and "quasi-stable" physical processes (in terms of geomorphology, ecology, etc.), whereas social science can provide an understanding of the social, economic, cultural and political rationale for the types of intervention experienced. With this a basis can be established for alternative forms of intervention that maximize social and economic welfare without leading to a loss in the productivity and stability of the supporting environment.

From the information and management angle, a major challenge for the natural sciences is in making relevant and politically expedient information and knowledge on physical processes available to individual and collective decision makers such that the consequences are transparent and alternatives may be recommended. This undoubtedly requires the active and coordinated participation of the social sciences in aspects related to the overall social communication of knowledge and the design of politically expedient strategies for the dissemination of information and knowledge amongst decision makers.

As may be easily appreciated, the types of relationship and needed coordination between social and basic, natural or applied sciences vary when dealing with the research or information management perspectives.

In the first case, although the types of research fostered by natural and social scientists are clearly aimed in the same direction (understanding the factors that contribute to risk and the generation of risk factors), the object of research can be seen as essentially "autonomous" and information and knowledge generated through the development of natural-basic and social science research does not require major collaboration or interaction, beyond that which is required amongst the natural and social sciences themselves (for instance, understanding land slide and flood mechanisms generated by human intervention in the environment will probably require the collaboration of meteorologists, hydrologists and other earth scientists; and, understanding of patterns of forest exploitation on slopes will require the collaboration of economists, geographers, sociologists and anthropologists).

However, this conclusion as regards interaction and collaboration between disciplines should be reconsidered if we widen our perspective to also deal with research methods and not just objectives and goals. Thus, where participatory research methods and stakeholder involvement are considered as necessary options with regard to the study of environmental change processes, the need for closer relations and understanding between social and natural, basic and applied science practitioners becomes obvious.

In the case of information and knowledge dissemination amongst decision makers, the above mentioned stakeholder principle holds firm as a principle, but must be complimented with the collaboration of social sciences in the development of information strategies that make hard scientific information available to decision makers and the public in general in accessible, easily understandable and politically and socially expeditious ways.

### 5.2.2 Understanding Location and Exposure to Damaging Physical Events

If population and economic resources were not placed in potentially dangerous locations, no problem of disaster risk would exist. In fact land use and territorial planning are key factors in risk control and prevention.

However, due to the intrinsic and fluctuating hazardous nature of the environment, increasing population growth, diverse demands for location and

the gradual decrease in availability of safer lands, amongst other factors, it is almost inevitable that humans and human endeavour are many times located in potentially dangerous places. In fact, given that the same places are many times endowed with natural resources and also, at the same time, periodically exposed to hazard (volcano slopes, river flood plains etc), location in hazardous areas is, in general, all but inevitable. The art of land use and territorial planning, or other forms of rationalizing location is, therefore, to reduce to a minimum unnecessary exposure and vulnerability to damaging events. Where exposure to probable future events is impossible to avoid completely, land-use planning and location decisions must be accompanied by other structural or non structural methods for preventing or mitigating risk. Land use plans must be based on location and vulnerability reduction strategies and methods.

Clearly the starting point for land use and territorial planning is knowledge of the natural environment, its resource and hazard base, the carrying capacity and limits to human usage, amongst other factors. At the same time, natural and basic sciences may provide information and knowledge as to the limits of the natural environment when faced with diverse land use options and processes and the potential for new humanly induced hazards- e.g. the degradation of aquifers due to urban development; increases in run off rates due to use of asphalt and concrete, and needed urban flood controls; possible local climate changes due to urban growth and the heat island effect.

From the perspective of the social sciences, location is the product of differing economic, social, cultural and political rationales where information on the physical composure of the land, carrying capacity, limits to growth etc are "data" or information filtered by social lenses and considered expeditiously or not according to convenience and social, economic and political calculation and needs, amongst other factors. The diversity of contexts to be found may be illustrated at an individual or family level, examining two extremes.

Firstly, the economically well-off who may consciously locate in areas known to be exposed to potentially very damaging events such as earthquakes and forest fires, due to the amenity value of these locations and where they "reduce" or "transfer" risk through the use of safer building techniques, social protection mechanisms, including preparedness and emergency plans and insurance, for example.

And, at the other extreme, very poor families that locate in highly hazardous areas, due to the lack of access to the formal land market and more secure land, and where the risk of disaster is constantly traded off against the risks associated with every day life. This many times means that even when they are offered the option of relocation they refuse to move due to their access to other survival resources *in locus* and due to cultural or historical ties to the land. Other sectors of society are located between these extremes and manage other location rationales.

From a governmental angle, although control of hazard factors should be an intrinsic part of governance, it is well known that the local and national levels in fact contribute enormously to unsafe location and increases in vulnerability. The granting of building permits in prohibited areas and the provision of basic

urban services in areas highly exposed to hazards both serve to "institutionalize risk" and, in the last instance, form part of what may be called "implicit" urban policy. Under other circumstances and in other places governments strictly adhere to land use planning and hazard control location principles. Understanding this diversity of contexts and decisions is an intrinsic challenge for social science research.

As in the case of the study of processes leading to the generation of socio-natural hazards, the relations between natural, basic and social sciences in gaining an understanding of location and exposure may at times be one of sequenced inputs whereby the social interpretation of location and the search for control are based on a knowledge of the "natural" limits to location and the ways in which human intervention can change the nature of the environment and the hazards it presents. What is extremely problematic is when location is not based on any real knowledge of environment and its limits to occupation and use. Under some circumstances this is due to the lack of information and knowledge as to a particular environment, but in other cases it is the result of the lack of adequate dissemination of information amongst family or collective decision makers. One of the major new problems for risk and disaster control in our future globalized and highly mobile world, will be the location of new enterprise and human activity in unfamiliar environments. All of these topics are worthy of more research involving social and natural and basic sciences.

Seen from a more interactive stance it is once more with regard to research method, stakeholder participation and mechanisms for information and knowledge dissemination that more interaction between the sciences may be foreseen and planned for in the understanding and intervention of location decisions. And, a lot of what information access is all about will inevitably pass through the filter of legal requisites and demands. Thus, one critical aspect of information generation and use is the way in which this is made available to collective or institutional primary decision makers (government and private sector, in particular). Another matter is with regard to the information afforded or accessible to secondary, civil society and family level decision makers. When one shops at a certain shopping centre how much information is available directly to consumers as regards hazard factors inside or in the vicinity? When one studies at a certain university or your children in a certain school, how much is known by the educational "consumers" as regards the hazardousness of the installations we occupy? Or, when going out to purchase a house how much do potential buyers know as to the hazards involved in place and the levels of structural security of the houses on sale? Clearly the relations between social and natural and basic science are fundamental in such circumstances where social communication and democratic access to information are critical factors in helping reducing risk.

### 5.2.3 Understanding vulnerability

"Vulnerability", seen from a social or anthropocentric viewpoint, essentially refers to the propensity of human beings and their livelihoods (these may be analysed from an individual, family, group, area, regional, national or international perspective) to suffer damage and loss when impacted by single or diverse physical events, and to confront problems in reconstruction and recovery.

Understanding vulnerability requires an analysis of the contexts (physical, institutional, social, economic, etc.), characteristics and structure of human beings and their livelihoods which predispose them to such damage, loss and difficulties in recovery. Explanation of vulnerability constitutes a fundamental part of the definition of the notion and in such explanation varied aspects of a physical, technical, social, economic, institutional and organizational nature intervene, which require the presence and interaction of diverse natural, applied and social sciences.

Although one can accept that there are intrinsic or innate levels of vulnerability associated with life in general, as far as risk and disaster studies are concerned, vulnerability, its facets, factors and levels should be seen as a result of defined social processes. That is to say, vulnerability is the most palpable manifestation of the social construction of risk. Only by dealing with the socially constructed elements of vulnerability may we broach aspects that are subject to social intervention and change. Intrinsic or innate factors that contribute to vulnerability are by definition inherent and in most cases unchangeable and therefore not subject to risk management mechanisms, beyond those associated with increases in consciousness, education and knowledge as to the limits to security when faced with certain physical conditions (a meteor of a few kilometres diameter impacting the earth, a paroxysmal volcanic eruption or an upper scale earthquake would be examples of exceptional events to which all life would be highly "vulnerable" irrelevant of what risk reduction practice is in place or could be imagined).

Vulnerability is the result of different social and environmental processes and the characteristics and conditions they give rise to. It is a condition that exists with reference to a concrete hazard context and is, therefore "determined", delimited or contextualised with reference to defined and delimited physical events. That is to say, one is not vulnerable in general (although there are what could be called "general vulnerability factors"), but rather, vulnerable when faced with determined hazard conditions. Thus, vulnerability in relation to earthquakes is not necessarily the same as in relation to hurricanes, drought, or forest fires. Or, vulnerability used in reference to multi hazard contexts is not the same as in mono hazard exposure. This simple affirmation signifies that all vulnerability analyses or studies and all interventions to reduce or control vulnerability must be informed by a thorough understanding of the nature of the different potentially damaging physical events that threaten different zones and populations.

Here one of the outstanding questions relates to the types, levels of sophistication, forms of expression and delimitation of the physical factors required for different types of vulnerability analysis and the methods used to get to this information, which can range from community based hazard and vulnerability analysis through to more formal, sophisticated and modern scientific research. Once again this signifies that the methods of generating and disseminating information amongst interest groups and stakeholders are as relevant a question and practice as is the generation of scientific information in itself. Information without communication is of little use where the final objective of research is social improvement and change.

Whilst accepting this general principle as to the hazard specific nature of vulnerability, it is also clear that certain factors, such as poverty, the lack of social networks, capital and support mechanisms, will affect vulnerability levels irrespective of the type of hazard context- i.e. they are non hazard dependent. Clearly this type of generic factor is different to the hazard specific factors and assumes a different position in the intervention equation and the nature of risk management processes. The existence of such factors clearly can be related to what have been called "deficits in development" and clearly show us that research on vulnerability and risk can not be separated from a consideration of the development patterns and models employed in different contexts and historical moments.

## 5.3 The Measurement of Risk: Risk Analysis and Indicators

Disaster Risk is manifested in the probability of loss and damage in the future. Risk is manifest, latent and evident and may be subjected to measurement to the extent knowledge exists or can be generated on the presence and magnitude of the diverse risk factors. To the extent such information exists, an objective, actuarial type of measurement-evaluation- may be attempted, equivalent to that which insurance companies exercise when deciding on catastrophic risk or health insurance rates for individuals or collectivities. Subsequently, for informing decision making processes, objective, actuarial risk must be subjected to considerations on perception, social, cultural and economic valorisation—that is to say, assessment.

Such actuarial measurement and the subsequent construction of risk indicators must be based on an understanding of the mechanisms by which risk are constructed ( see previous section) and on the existence of adequate, objectively verifiable and measurable "hard" core, physical, and "soft" core, social, information. That is to say, information on physical events and hazard contexts, on factors contributing to vulnerability and on aspects relevant to location and exposure, are requisites for risk evaluation. Risk evaluation can not take place without this diverse information base deriving from natural, basic, applied and social science sources working in an integrated fashion, from a common understanding of risk and its components.

"Hard" attributes or factors include information on such aspects as: potential physical phenomena, their magnitude, intensity and return periods; the physical characteristics of places; the characteristics of building materials and techniques; the value of installed infrastructure and production. "Soft" attributes or factors include information on social, economic and political variables affecting location and vulnerability; information on attitudes, beliefs and perceptions; information on levels of preparedness and on human resource capabilities in general.

Whilst much information may exist for many places world wide, in general we are still lacking much basic information at a large scale of resolution both on hazard and vulnerability factors. This is particularly true as regards developing and emerging economies. The challenges for social and natural science are still enormous as regards basic research and information gathering. Given the large

numbers of communities at risk in any hazard prone area, a challenge exists not only with regard to information as such but also as regards the methods by which such information is and may be compiled. This inevitably gives sway to discussions and consideration of participatory, artisan or traditional knowledge bases as fundamental, complimentary measures to formal scientific research.

The development of easily accessible and understandable indicator systems is also a challenge where dealing with local or family decision makers as opposed to national government and the private sector. Understanding information is a first indispensable step in fomenting adequate risk reduction and control decision making at different levels. Thus, for example, the type and level of information relevant for a national governmental sectoral agency will be different to that required for local mayors, planning offices or construction companies. Dealing with these different needs and levels requires differing integration of natural and social science aptitudes and methods.

## Assessing Risk: An Immediate Prelude to Decision Making

Although clearly related, evaluation and assessment of risk are two different, if sequential and related aspects of importance for disaster risk management. Whereas evaluation signifies the maximum objectification of risk in terms of probable losses and damage, assessment requires the placing in perspective of such losses with reference to the general life system and goals of the affected or interested parties. This placing in perspective can be seen from an economic, social, cultural, historical, life style or political angle. Significant risk (that is to say, that for which a solution must and will be sought) will differ as a notion according to the different social and psychological variables that operate in different societal settings. An understanding of these factors is critical for understanding risk construction and also as regards the opportunities and options that exist for risk management mechanisms.

Mechanisms for risk assessment vary from the strictly formal to the informal and subjective (but not because of that, unscientific). Thus, whilst a government or private company may engage in cost benefit analysis in order to substantiate decision making, studies also show such organizations employing less "formal" measures and subjecting decision and non decision to assessment processes based on strictly political or "emotional" characteristics (the notion of blame reducing policies fits here). Individuals and families will probably assess risk in varying different ways according to circumstances, income, social class etc.

Assessment criteria will vary from group to group, individual to individual. Poor and very poor families and communities will always go way beyond "assessment" methods and processes that take disaster risk factors as their point of departure. Therefore, for instance, where poor communities reject relocation to "safer" areas when offered this option by local government, NGOs etc., such rejection is many times not based on strict evaluation of disaster risk but rather on the comparison between gains accruing to changed location and the advantages of staying put—economic, cultural, social, historical. That is to say, disaster risk is compared to every day risk aspects in order to substantiate decisions.

With regard to risk assessment it is clear that many of the techniques are firmly based in social science methods and practices—they imply social and economic assessment in some way or another, whether formal or informal, objective or perceptive. However, whatever the technique or social criteria used as a base for assessment, this is always undertaken in a framework typified by an existing, objectively identifiable hazard context. The nature of the information available on these contexts, the availability of easily accessible and understandable information, the accuracy with which information is seen to be produced and the accuracy of risk predictions associated with this are all fundamental assessment parameters and inputs. Thus, assessment inevitably signifies a consideration of information, data, the ways these are generated, the means by which information is more easily accepted and confided in by users, mechanisms for user appropriation of information and the mechanisms for its generation, amongst others.

Thus, even where assessment is a social technique, inputs for it and methods of achieving it are inevitably interdisciplinary. Active participation in the process of assessment and understanding of this by natural, basic and applied science practitioners can only lead to a more ample understanding of how such processes are enacted and, therefore, as regards the variables taken into consideration in decision making when these go beyond simple scientific "fact". With this, improvements in methods of data collection and data dissemination may or could accrue.

## 5.4 Decision Making for Risk Management

Previously, we have suggested that the overall primary objective of research, analysis, understanding, evaluation and assessment should be the provision of information and knowledge that facilitates and promotes decision making in favour of risk reduction and control. In this sense the three previously discussed aspects can be seen to be part of the needs and process of decision making. However, decision making seen as a theoretical process, and decision making seen in terms of real life and decisions may be two different things. And, unfortunately, we know very little as regards the real processes that have informed many significant decisions as regards risk management practice. Moreover, we also lack much in terms of understanding the process of "no decision". That is to say, the process by which actions were ignored or rejected by decision makers is not very often well known. Rather, they are more likely to be the subject of criticism and superficial comment in terms of such things as the lack of political will, the ignorance of science by decision makers, etc.

Decision making as an object of scientific enquiry may serve as a means for putting in perspective the three formerly discussed areas for research and interdisciplinary collaboration. The study of the decision making process, in both successful and unsuccessful cases, at different societal levels and in different societies, synchronically and diachronically, could, amongst other things, help enormously in fostering a better understanding of the socio-natural interface and the ways in which knowledge construction is better fostered by closer conceptual and practical relations between the disciplines and in their relationship to the users of information and the direct stakeholders in the decision making process.

## 6. Some Priority Themes for the Research Programme.

In this section, and in accord with priorities established by the ICSU planning committee, we identify a series of themes that could or should be promoted as projects in a first stage of the programme. As commented at the beginning of the previous section these are indicative not exclusive, and it is hoped that projects be promoted in the full range of options and needs identified in the previous section.

### 6.1 Methodology for Natural and Socio Natural Hazard Mapping and Integration in Planning Processes in Small Towns and Villages in Latin America (theme 5.1)

The environmental knowledge necessary for natural and socio-natural hazard mapping in Latin America is generally not affordable for villages and small towns. Research is required for designing methodologies for evaluating available cartography and information and to implement the steps required in order to reach a base level which will permit an acceptable appreciation of natural and growing socio natural hazards and to recommend further actions.

The product of such efforts should be applicable in convincing local inhabitants and authorities that natural and socio natural hazards must be considered as an important aspect of local planning and that further improvements of hazard and vulnerability determination are investments for the future well-being of the population. A by-product of the development of projects within this thematic area could be related to water availability, building materials access and localisation of adequate sites for garbage disposal, actions which may be considered as health protection for inhabitants.

### 6.2 Towards Better Hillside Construction (theme 5.2)

There are many urban areas in Latin America with significant settlements on steep ground. All but a handful of the Caribbean islands are mountainous. For instance, over 60% of Jamaica is mountainous. In Grenada, 45 percent of the island's surface has a slope between 21% and 30%, 25 percent of surface has a slope in excess of 30%.

Steep slopes are inherently hazardous areas for human settlements. There is also the question of aesthetics. Current hillside low-income developments in urban areas are unbelievably ugly. Another sore point is the unhealthy living conditions.

Although much work has been done by several agencies on specific aspects of the problem, there is a need for the consolidation of expert guidance on safe construction on steep slopes in one document or set of documents. This requires a multi-disciplinary approach involving (in no particular order) anthropology, sociology, land use planning, forestry, geology, seismology, geotechnics, environmental impact assessment, hydrology, infrastructural engineering, architecture, structural engineering, earthquake-resistant design, wind-resistant design, public health.

The theme should be developed based on a presentation of fundamental scientific issues as background for specific and practical guidance for all aspects of hillside development. The end is to provide all stakeholders with detailed tools for the safe, healthy and pleasing development of hillside communities.

## 6.3. Data Collection for Natural Hazards (theme 5.1)

The engineering and planning community requires more and better information for the rational design of drainage systems, wind and earthquake resistant structures. Rainfall information was routinely collected by agriculturalists in many parts of Latin America and the Caribbean in past centuries. This data collection activity is now not so prevalent. Meteorology is driven in many countries by the needs of civil aviation. Extreme wind events are infrequently and not adequately measured and recorded at ground level. There are insufficient anemometers installed in the region. The recording of accelerations, velocities and displacements caused by strong earthquakes is rarely achieved. There are very few strong motion accelerographs installed and maintained in the region.

This thematic area must project and promote the establishment of data recording infrastructure and conclude long-tern commitments from research institutions and other agencies for the maintenance and monitoring of the recording instruments. The obtaining and archiving of previously collected data on rainfall, wind speeds and ground motions from the LAC region must also be a central objective of this thematic area.

## 6.4 Disaster Risk Modelling Platforms (theme 5.3)

Disaster risk modelling platforms are modular systems of models to consistently evaluate hazard, vulnerability and risk at local, regional and national levels using appropriate levels of resolution and according to well defined purposes (land-use, cost-benefit, preparedness, mitigation investment and financial protection). The core of the platforms should allow us to select the type of hazard (earthquakes, hurricanes: wind/surge, floods, landslides, volcano, tsunami), scale and resolution according to the quality of information available, and the purpose of evaluation. A major objective of these platforms is to develop a risk evaluation and communication tool to assist in socializing risk assessment at the local, regional, national, and international levels and to make policy makers aware about the country's exposure levels and provide them with open source tools to help them design risk management strategies. The multi risk modelling platforms should have an open architecture and be dynamic allowing

for wide distribution and future updating and improvement by the users through an Application Programming Interface (API). The software platforms should be hosted in a manner that are widely accessible, including web sites for countries and/or regions; i.e. Central America, South America and the Caribbean. These platforms should be compatible to use Google Earth, Microsoft Geo, NASA World Wind or similar tools available for geospatial data visualization free of charge. The idea is to allow anyone online (communities of shared interests) to enter information about visible structures on high resolution maps using GIS. This platform would permit the development of an Atlas of hazards and risks (using probabilistic metrics; e.g. probable maximum loss, average annual loss, based on the loss exceedance probability curve of exposed sets of assets) at any scale in the countries according to the information available, with warnings of potential suitable use and assumptions, and will be similar to the Wiki approach to facilitate the use and contributions of scientists by open architecture and source models.

## 6.5 Indicators of Disaster Risk and Risk Management at sub-national level (theme 5.3)

Systems of indicators are proposed to measure risk and vulnerability using relative indices at the sub-national level. From the interdisciplinary perspective this means it is necessary to consider "hard" and "soft" variables related to both the impact of the events, the capacity of society to sustain and cope with the impact and the implications of these effects. The aim would be to provide regional and urban center decision-makers with access to the information that they need to identify risk and propose adequate disaster risk management policies and actions. Systems of indicators should allow for the identification of economic and social factors that affect risk and risk management, as well as the comparison of these factors among the units of analysis (provinces, departments, urban districts, and so on). The goal of this research would be to design methodologies of risk understanding and communication, and apply them to a wide range of sub-national areas in order to identify analytical factors (economic, social, resilience, etc.) to carry out an analysis of the risk and risk management conditions in the countries. The systems of indicators must allow a holistic, relative and comparative analysis of risk and risk management allowing the creation of risk management performance benchmarks in order to establish performance targets for improving management effectiveness. The systems' main advantages should lie in their ability to disaggregate results and identify factors that should take priority in risk management actions, while measuring the effectiveness of those actions. The main objective is to facilitate risk understanding and the decision-making process (risk reduction and risk financing). In other words, these systems will allow using a common "rule" of measurement to compare and benchmark the results. The goal of the models are not only to "reveal a truth", but rather to provide information and analyses that can "improve decisions". In addition, the systems of indicators should help fill an important information gap for subnational decision-makers in the financial, economic, environmental, public health, territorial ordering, and housing and infrastructure sectors. The methodologies should provide tools for monitoring and promoting the development of risk management capacities. Because the data would be comparable across units of analysis, this should make it possible for

policymakers to gauge their area's relative position and compare their evolution over time.

## 6.6 Decision Making and Risk Mitigation and Prevention (theme 5.4)

Risk mitigation (corrective) and risk prevention (prospective) measures are achieved where decisions are taken to implement different schemes and practices. These decisions may be taken by organizations, governments, groups or individuals. Coming to a decision requires information and must be made in the context that encompasses the actors taking the decisions. Our knowledge of decision making associated with disaster risk mitigation and prevention is scarce in Latin America. Why, under what circumstances, due to what motivations, using what information and what parameters are often time unknown factors. This relates to national government with regard to national policy, to local governments with regard to local plans and as regards particular acts such as retrofitting, dyke building, putting risk considerations in project planning processes etc.

An understanding of the complexities of decision making on various different levels in various countries, related to both prospective and corrective mechanisms and interventions would greatly help actors understand how things get done and on how to get things done. Understanding the relationships and roles of natural and technical sciences as compared to policy makers, economists and other social science based actors, would also help both sets of actors comprehend how they have and could collaborate in getting decisions taken. Our understanding of decision is many times incorrect and we assume that certain processes such as cost benefit analysis are significant in all decisions taken by government or private sector. This is not necessarily true.

This thematic area will promote studies of decision-making processes in a series of different risk contexts. Both successful implementation and non successful proposals will be analyzed. The areas for research will vary from city governments who incorporate risk management tools through to local governments that take the decision to build dykes to protect communities; from decisions to retrofit buildings to decisions to introduce risk analysis in public investment plans. Selection of case studies will cover a range of countries, contexts, situations and sectors.

## 6.7 Climate Change Adaptation and Disaster Risk Management: Understanding, Joining and Learning (theme 5.2)

Disaster Risk Management concepts and experience have been developed in the light of historical and projected future contexts of hazard and vulnerability. When dealing with climate related aspects this can be seen in the light of hazards associated with what may be referred to as "normal climate variability". Adaptation to climate change, on the other hand, has been developed as a notion and sought practice through other professional and institutional modalities as

if it were a separate and discrete area of knowledge, directed to future climate conditions influenced by human intervention, using scenarios which go up to 50 or 100 years ahead.

This "false" separation of two clearly related topics is the product of historical and institutional reasons and must be dissolved in the interest of advances on both risk fronts—now and then. It is clear that the central problem for both communities is risk in society associated with physical, hydro-meteorological, hazards, the ways new hazards, or extremer versions of ongoing hazards, interact with exposure and vulnerability conditions to produce greater risk in society, and with regard to ways of reducing or controlling this risk.

Disaster risk management has developed principally with regards to existing risk—corrective risk management. However, the line of thought developed more recently with regard to prospective risk management (i.e. anticipating and controlling future risk) is clearly of absolute relevance to the so called adaptation to climate change problematic and can be used a s a bridging concept between the two areas of reflection and enquiry.

Research must be stimulated which, on the one hand, clearly identifies changes in the semantic, spatial and temporal patterns of hydro-meteorological hazards and accompanying exposure and vulnerability factors, including, very importantly, evidence of such changes associated with climate variability and climate change during recent periods ( under the notion that climate change is now under way). And, as regards the ongoing processes by which populations in areas where climate can be seen to be changing today and which have traditionally been required to deal with climate variability extremes, have dealt with such contexts through historical or ongoing prevention, mitigation, risk reduction or adaptation schemes. Knowledge of ongoing processes of risk reduction and control will help enormously in understanding and promoting "adaptation" in the more distant future, within the overall context of more wide-ranging global change. The options for such adjustment in the future rests on our ability to deal with today's problems and significantly control existing exposure and vulnerability



trends, many, but not all, associated with poverty.

## 7.1. Capacity Building.

Experience in the region and support for training and education has concentrated principally on disciplinary fronts where the physical and applied sciences lead the way and social sciences have made important gains and advances over the last 15 years. Seen from the disciplinary perspective and the role this plays in education and training for risk and disaster work, the region has a fundamental basis of well trained persons, if insufficient in numbers in many countries. Clearly there is a need to further promote and enhance existing capacities at the disciplinary level and further promote the widened incorporation of risk related aspects in a wide range of disciplines at undergraduate and postgraduate levels. This is not necessarily something that should be a priority concern of this ICSU programme given existing mechanisms and support and promotion for disciplinary advances.

Rather, it is the multi, inter and trans disciplinary research challenge that should be the objective of support through the present programme, in search of offering mechanisms for promoting the type of research method indicated in the present report. In this sense, the programme and the financing mechanisms it may develop should be instrumental in the establishment and promotion of educational and training modalities and mechanisms that promote holistic, integral, inter and trans-disciplinary approaches to research and problem formulation.

This may be achieved in a number of ways.

Firstly, research projects supported by the present programme should be required to incorporate on the ground mechanisms for supporting and strengthening capabilities for cross disciplinary collaboration and work, which could have a spin off effect in teaching programmes led by project researchers. Incorporation of young researchers in projects and their exposure to interdisciplinary formats would be another spin off effect.

A second, more formal and institutionalised approach would be in the promotion and support given to the establishment of one or more interdisciplinary research and teaching facilities in the LAC region, linked to existing national or regional institutions. An ideal mechanism could be the promotion of holistic educational opportunities through the involvement of students in research projects that are complimentary to any formal educational opportunities offered.

A third complimentary mechanism would be through the support and incentives given for postgraduate courses in holistic and integral risk management principles given in established, existing institutions.

The present programme, backed by the status of ICSU should search to support such initiatives both financially and in terms of human resources.

## 7.2. Post mortem or Forensic Studies of Disaster in the Region.

The most valuable laboratory for the study risk and disaster are the impacts of real events. To learn effectively from these events research teams, protocols and logistics must be developed well in advance and necessary institutional arrangements must be negotiated and in place. Although post-event diagnostic surveys are carried out in the region, these are done in an uncoordinated way and the lessons learnt are insufficiently disseminated and only rarely peer reviewed.

There is the need to establish the mechanism for post-event diagnostic surveys that allow an understanding of fundamental physical and social processes that led to risk and disaster; on key issues of structural performance during earthquakes and hurricanes which have implications for public health and social and economic impacts; on social responses to disaster and on processes leading to recovery plans and processes. Post-event diagnostic surveys should be multi-disciplinary and should support analysis for the improvement of mitigation planning, regulation and investment. Results of the diagnostic surveys should be disseminated to the professional and educational communities, and wider afield by means of the most appropriate and efficient information technology.

Such a facility and the information it affords would be the basis for the establishment of a permanent evaluating committee on risk and disaster in the region that through its work and results could serve as a pressure element for change in practice and policy in the region.

## 8. Recommendations on Financing of the Research Programme and Associated Support Activities

The idea of forensic studies is complementary to that recommended in ICSU's global programme elaborated at a world level from its Paris office and headquarters and now awaiting final approval by the ICSU hierarchy at the next conference ein Mozambique.

Two basic modes may be suggested.

Firstly, on the basis of the approved content of the present programme, block financial support for the programme may be sought for from existing international organizations that support research and training. Multi institutional support for the programme should be sought from research promotion organizations and from international development agencies interested in the risk and disaster topic. Minimally in a first phase a sum around 10 million dollars should be sought for research and a complimentary amount to promote capacity building in the region. A separate fund should be sought for the post mortem-forensic studies aspect and the establishment of an ICSU promoted permanent evaluation committee on risk and disaster in the region.

Secondly, ICSU with its contacts and presence in national research support committees and institutions—CONACYTS for example, in various countries-, should search to achieve an annual allocation of financing for the research aims and training goals at a national level that would complement the regional, comparative and integral goals at the global level.

## 9. Mechanisms for Guidance and Oversight of the Programme

The Programme must have a coordinating and support office located in a renowned academic institution or within the ICSU structure as such. Regional support facilities could be an option also.

A working team consisting of programme coordinator and a maximum of two support officers from social and physical sciences, along with necessary admin and secretarial support would promote, monitor, control and evaluate programme operations and advances. Research projects should not exceed three years. Where support should be available for the educational and training aspects and for the forensic studies component, additional staff would be needed.

# Glossary

**ANTHROPOGENIC OR ANTHROPIC HAZARD**
A latent threat associated with economic production, commerce, transport, and consumption of goods and services and the construction and use of infrastructure and buildings. These comprise a wide range of threats including different types of water, air and land pollution, fires, explosions, spills of toxic substances, accidents in transport systems, the rupture of dams, building collapse, etc.

**CORRECTIVE RISK MANAGEMENT**
A process aimed at reducing existing levels of risk within society. Examples of corrective management activities or instruments include the construction of dykes to protect population located in hazard prone zones, the seismic retrofitting of buildings, changes in cropping patterns to adapt to adverse environmental conditions, reforestation of river basins in order to diminish existing processes of erosion, landslides and flooding.

**DANGEROUS PHENOMENON (EVENT)**
A natural, socio-natural (see definition below) or humanly generated phenomenon which may cause damage to society. It is the materialization in time and space of a hazard. It is important to distinguish between a potential or latent phenomenon represented by the notion of hazard, and the phenomenon itself, once it occurs.

**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.

**DISASTER RISK**
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.

**DISASTER 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.

**ECOSYSTEM**
Spatial unit comprising a group of physical and biotic components and processes which interact in an interdependent manner and which have created characteristic energy flows and cycles or movement of materials.

**ENVIRONMENTAL DEGRADATION (DETERIORATION)**
Processes induced by human actions and activities which damage the natural resource base or which adversely affect natural processes and ecosystems, thus reducing their quality and productivity. Potential effects are numerous and include the transformation of resources into socio-natural hazards. Environmental deterioration can be the cause of a loss in the ecosystems' capacity to recuperate following external impacts. This loss of recover capacity can in turn generate new hazards of a socio-natural type.

### EVERY DAY OR CHRONIC RISK

A series of living conditions which characterize (although not exclusively) poverty, under-development and structural human insecurity and which restrict or endanger sustainable human development. Examples of this can be found in poor health conditions, low life expectancy, malnutrition, lack of employment and income, lack of access to potable water, social and family violence, drug addiction/substance abuse, alcoholism and overcrowding of residential areas and individual housing.

### EXPOSED ELEMENTS (ELEMENTS AT RISK)

The social and material context represented by persons, resources, infrastructure, production, goods, services and ecosystems that may be affected by a physical phenomenon due to their location in its area of influence.

### HAZARD

A latent threat associated with the probable occurrence of a physical phenomenon of natural, socio-natural or anthropogenic origin that may be expected to have adverse effects on people, production, infrastructure, goods, services and environment. Hazards are risk factors that are external to the exposed social elements and represent the probability that a phenomenon of determined intensity will occur at a specific location and within a defined period of time.

### HAZARD ANALYSIS OR EVALUATION

The process by which the possible occurrence, magnitude, location and temporality of a damaging physical event is ascertained.

### NATURAL HAZARD

A latent threat associated with the possible occurrence of a physical phenomenon of natural origin –for example, an earthquake, a volcanic eruption, a tsunami or a hurricane. 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).

### PROSPECTIVE RISK MANAGEMENT

A process by which future risk is foreseen and intervened or controlled. Prospective management should be seen as an integral component of development planning and the planning cycle of new projects, whether these are promoted by the government, the private sector or civil society. The final aim of this type of management is to avoid new risks, guarantee adequate levels of sustainability of investments, and avoid having to take expensive corrective management measures in the future. (See Risk Prevention, below.)

### RESILIENCE

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

### RISK ANALYSIS

A projection of the probable social, economic and environmental impacts of future physical phenomenon on particular social and economic groups, areas or territories. This is achieved through an analysis of the hazards and vulnerabilities of exposed social and economic units. Changes in one or more of these parameters modify the levels of risk, the total expected losses and the consequences for a given area.

### 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 PREVENTION

Anticipatory measures and actions which seek to avoid future risks. This means working with probable future hazards and vulnerabilities. Seen from this perspective, risk prevention is a facet of Prospective Risk Management, while risk mitigation or reduction relates to Corrective Management. Given that total prevention is rarely possible, prevention has a semi-utopian connotation and should be seen in the light of considerations as regards socially determined acceptable risk levels.

### RISK SCENARIOS

An analysis of the dimensions and types of risk that affect defined territories or social groups and presented in written, mapped or other graphic forms using quantitative and qualitative techniques and based on participatory methods. This implies a detailed analysis of hazards and vulnerabilities. Risk scenarios

provide a basis for decision making on risk reduction, preparedness and control. Recent developments of the notion of risk scenarios include a parallel understanding of causal social processes and of the social actors that contribute to existing risk conditions. A risk scenario is the result of an integrated risk analysis process.

**SOCIAL PARTICIPATION**

The process by which the subjects of development and risk take an active and decisive part in decision making and activities designed to improve their living conditions and reduce or prevent risk. Participation is the basis of empowerment and the development of social capital.

**SOCIO-NATURAL HAZARD**

Latent threat associated with the probable occurrence of physical phenomena, the existence and intensity of which is related to processes of environmental deterioration or human intervention in natural ecosystems. Examples of these can be found in floods and landslides related to deforestation and the degradation or deterioration of watersheds; coastal erosion due to mangrove logging; urban flooding due to the lack of adequate fluvial drainage systems. Socio-natural hazards are generated at the interface between nature and human activity and are the product of a process by which natural resources are converted into hazards. The new hazards associated with Global Climate Change represent the most extreme example of socio-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**

The propensity of human beings and their livelihoods to suffer damage and loss when impacted by external physical phenomenon. Distinct levels of human and livelihood vulnerability may be explained by the incidence of diverse processes and conditions relating, amongst others, to the presence of insecure buildings and infrastructure, limited economic resources and incomes, lack of social protection, insecure livelihoods, poverty, inadequate educational, organizational and institutional arrangements and lack of well developed social and political capital.

**VULNERABILITY EVALUATION**

The process by which the susceptibility and predisposition to damage or loss is determined when faced with the possible occurrence of a dangerous physical phenomenon. This also includes an analysis of the factors and contexts which can substantially impede or render difficult the subsequent recovery, rehabilitation and reconstruction of the affected social unit using the resources autonomously available to it.

**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


BECK, Ulrich, 2000: "Risk Society Revisited: Theory, Politics and Research Programmes", in: Adam, Barbara; Beck, Ulrich; Van Loon, Joost (Eds.): *The Risk Society and Beyond*, (London: SAGE Publications): 211-229.

BIRKMANN, Jörn, (Ed.), 2006: *Measuring Vulnerability to Hazards of Natural Origin: Towards Disaster Resilient Societies* (Tokyo: UNU Press).

CANNON, Terry, 1994: "Vulnerability analysis and the explanation of natural hazards", in: Varley, Ann (Ed.): *Disasters Development and Environment* (Chichester: Wiley).

CARDONA, Omar D., 1999: *Diagnóstico local de riesgos naturales en Santa Fe de Bogotá para la planificción y medidas de mitigación*, (Bogotá, D.C.: Panamericana-Secretaría de Salud).

CARDONA, Omar D., 2004: "The Need for Rethinking the Concepts of Vulnerability and Risk from a Holistic Perspective: A Necessary Review and Criticism for Effective Risk Management", in: Bankoff, Greg; Frerks, Georg; Hilhorst, Dorothea (Eds.): *Mapping Vulnerability: Disasters, Development and People* (London: Earthscan Publishers): 37-51.

CARDONA, Omar D. (2009). "Disaster Risk and Vulnerability: Notions and Measurement of Human and Environmental Insecurity" in *Coping with Global Environmental Change, Disasters and Security - Threats, Challenges, Vulnerabilities and Risks*, Editors: H.G. Brauch, U. Oswald Spring, C. Mesjasz, J. Grin, P. Kameri-Mbote, B. Chourou, P. Dunay, J. Birkmann: Springer-Verlag (in press), New York.

CARDONA, Omar D.; Barbat, Alex H., 2000: *El Riesgo Sísmico y su Prevención* (Madrid: Calidad Siderúrgica).

CARREÑO, Martha-Liliana; Cardona, Omar D.; Barbat, Alex H., 2007: "Urban Seismic Risk Evaluation: A Holistic Approach", in: *Journal of Natural Hazards*, 40,1 (January): 137-172.

ESTEVA, Luis, Rosenblueth Emilio, 1964: "Espectros de temblores a distancias moderadas y grandes" Sociedad Mexicana de Ingenieria Sismica, Publ. 1, 2 (March), 1–18.

ESTEVA, Luis, 1967: "Criterios para la Construcción de Espectros para Diseño Sísmico", *Memorias de las XII Jornadas Sudamericanas de Ingeniería Estructural y III Simposio Panamericano de Estructuras*, Caracas.

ESTEVA, Luis, 1970: *Regionalización sísmica para fines de ingeniería*; serie azul, Instituto de Ingeniería, UNAM.

FEMA (1999) *Earthquake Loss Estimation Methodology, HAZUS*, National Institute of Building Science for Federal Emergency Management Agency, Washington.

FUNTOWICZ, Silvio O.; Ravetz, Jerome R., 1990: *Uncertaintv and Qualitv in Science for Policv*, (Dordrecht: Kluwer Academic Publishers).

FUNTOWICZ, Silvio O.; Ravetz, Jerome R., 1992: "The Role of Science in Risk Assessment", in: Krimsky, Sheldon; Golding, Dominic (Eds.): *Social Theories of Risk* (Westport, CT: Praeger): 59-88.

GOLDING, Dominic, 1992: "A Social and Pragmatic History of Risk Research", in: Krimsky, Sheldon; Golding, Dominic (Eds.): *Social Theories of Risk* (Westport, CT: Praeger): 23-52.

HARDING, Timothy W.; Romerio, Franco; Rossiaud, Jean; Wagner, Jean-Jacques; Bertrand, Sébastien; Frischknecht, Corine; Laporte, Jean-Dominique, 2001: *Management des risques majeurs: des*

*disciplines à l'interdisciplinarité*. Document de travail No 1 du Groupe de recherche Management des risques majeurs (Geneva: Université de Genève, Programme plurifacultaire du Rectorat)

IDEA, 2005a: *Sistema de indicadores para la gestión del riesgo de desastre: Informe técnico principal.* Programa BID/IDEA de Indicadores para la Gestión de Riesgos (Manizales: Universidad Nacional de Colombia).

IDEA, 2005b: *System of indicators for disaster risk management: Main technical report.* IDB/IDEA Programme of Indicators for Disaster Risk Management (Manizales: UNC).

JRC-EC, 2002. *State-of-the-art Report on Current Methodologies and Practices for Composite Indicator Development.* Applied Statistics Group, Joint Research Centre, European Commission, Institute for Protection and Security of the Citizen Technological and Economic Risk Management, Ispra, Italy.

KRIMSKY SHELDON; Golding, Dominic (Eds.), 1992: *Social Theories of Risk* (Westport, CT: Praeger).

LAVELL, Allan, 1999: "Environmental Degradation, Risks and Urban Disasters. Issues and Concepts: Towards the Definition of a Research Agenda", in: Fernandez, Maria A. (Ed.): *Cities at Risk: Environmental Degradation, Urban Risks and Disasters in Latin America*: (Quito: A/H Editorial, La RED, US AID): 19-58.

LAVELL, Allan, 2000: "Draft Annotated Guidelines for Inter-Agency Collaboration in Programming for Disaster Reduction", unpublished (Geneva: Emergency Response Division at UNDP).

LUHMANN, Niklas, 1990: "Technology, Environment, and Social Risk: A System Perspective", in: *Industrial Crisis Quaterly*, 4,S: 223-31.

ORDAZ, Mario; Miranda, Eduardo; Reinoso, Eduardo and Pérez-Rocha, L.E. 1998: *Seismic Loss Estimation Model for México City*, Universidad Nacional Autónoma de México, México DF.

PREVENZIONE LOMBARDIA, 2007: *Sintesi degli studi finalizzati alla gestione integrata dei rischi*, (Milano: Istituto Regionale de Ricerca della Lombardia).

RENN, Ortwin, 1992: "Concepts of risk: A classification", in: Krimsky, Sheldon; Golding, Dominic (Eds.): *Social Theories of Risk* (Westport, CT: Praeger): 53-79.

ROSENBLUETH, Emilio, 1976: Optimum Design for Infrequent Disturbances, *Journal of the Structural Division*, ASCE, **102:9**, 1807-1825.

UNDRO, 1980: *Natural Disasters and Vulnerability Analysis,* Report of Experts Group Meeting of 9-12 July 1979 (Geneva: UNDRO).

WHITE, Gilbert F., 1973: "Natural hazards research", in: Chorley, Richard J. (Ed.): *Directions in Geography* (London: Methuen and Co. Ltd.): 193-216.

WISNER, Ben; Blaikie, Piers; Cannon, Terry; Davis, Ian; 1994, [2]2004: *At Risk, Natural Hazards, People's Vulnerability and Disasters* (London and New York: Routledge).

ICSU
International Council for Science

ACADEMIA BRASILEIRA DE CIÊNCIAS

FINEP

FAPERJ
Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro

Ministério da Ciência e Tecnologia

BRASIL
UM PAÍS DE TODOS
GOVERNO FEDERAL

CONACYT