



ENSO WHAT?

LA RED GUIDE TO GETTING RADICAL
WITH ENSO RISKS

Based on the results of a LA RED-IAI
promoted research project

GUSTAVO WILCHES-CHAUX

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Foreword

With the major climatic events of 1997-98, ENSO once more came on the world scene, this time as never before in history. This is in many ways related to the spatial technology available and also internet which allowed us to follow events in real time. Such circumstances signify a new epoque for science and society in terms of the ways of perceiving the ENSO phenomenon.

From a scientific perspective there could have been no better opportunity for understanding the ENSO phenomenon. Thus, at the same time that we had satellite images of the surface sea temperature, we also had good estimates of sub surface temperatures, atmospheric winds and unprecedented measurement of sea level changes facilitated by outer space located technology. What was learnt about the 1997-1998 ENSO led to a change in paradigmatic parameters and the generation of new ideas, abundant scientific knowledge, the improvement of climate prediction models, recognition of the need to invest in ocean and atmospheric observational systems. And, it clearly demonstrated how scientific and technological development is critical for society.

However, the 1997-98 ENSO was singularly paradoxical. At the same time that it was the most predicted event ever and an early warning was given six months previous to its full development, using almost homogenous or

unanimous criteria, and covering governments, response organizations and society in general, the event led to massive impacts and losses of economy and human life. In the Andean countries economic losses were in the billions and economic growth indicators were negatively affected.

ENSO What? How could such a significant contradiction occur (greater warning and greater loss at the same time). The present book contextualizes the problem with precision. This relates to the lack of a real change of attitude despite the lessons learnt over the last years in terms of increased impacts of climate on society. Today, ten years after the publication of LA RED's first guide to local risk management, Gustavo Wilches-Chaux, with his usual brilliance and clarity, and at a time when significant changes are called for in public risk and disaster policies, puts the present book in our hands. This is the fruit of an invaluable creative, collective effort that brings together and molds in an imaginative fashion, research results from LA RED members. This is a conceptual guide that allows us to understand the real fissures in the ways we see, visualize, perceive and confront climate-society relations

For the scientific world, planners, decision makers, and all other actors affected by climate change "ENSO What" takes us on a journey of discovery along with the author where we are confronted with the relations between the

dynamics of communities and nature and the complexity of the relationship between culture and the socio political and economic construction of territory. This book provides a solid conceptual base for understanding climate risk management and needs from an as yet not widely dispersed holistic and integral method.

In an elegant, creative, and accessible to all manner (not just to scientific elites), this book closely examines the notion of territorial security and its bases and how these may collapse when faced with events like ENSO or global climatic change in the medium and long terms. The conceptualization of vulnerability offered in this book represents a synthesis of ongoing intense debates between students of this notion and reality in the study and reality of risk when faced with natural events. And, it offers value added in that it adjusts the conceptual and methodological framework to our Andean reality.

After providing us with a magnificent collection of evidence as regards ENSO impacts in Latin America, the author provides us with a precise and amicable approximation as to what public policy and management should be when faced with natural events and changing climate; as to the relationships between risk management and sustainability, something seemingly obvious but which at the same time is complex, of significant importance and a challenge for national and local governments, planners and development actors

Holistic, pragmatic, real and useful approaches to climate, its manifestations, impacts and the strategies needed are here presented in this brilliant compilation. I invite readers to assimilate its lessons whilst these are applied in reality.

RODNEY MARTÍNEZ GÜINGLA
Scientific Coordinator

CIIFEN
International Centre for Research
on the Niño Phenomenon

Presentation

Between 2000 and 2005 a research project on **Disaster Risk Management and ENOS in Latin America** was undertaken in the framework of the Comparative Research Network created by the Interamerican Institute for Global Change Research (IAI) and financed with funds from the National Science Foundation of the United States of America. Eight national research teams participated from Florida (USA), Mexico, Costa Rica, Colombia, Ecuador, Peru, Argentina and Brasil, within an overall framework provided by the Latin American Network for the Social Study of Disaster Prevention – LA RED.

The national teams were coordinated by Anthony Oliver Smith from the University of Florida, Gainesville; Virginia Garcia Acosta from the Centre for Study and Research on Social Anthropology-CIESAS, Mexico; Allan Lavell and Adriana Bonilla from the Secretariat General of the Latin American Social Science Faculty in Costa Rica; Andres Velazquez from the Seismological Observatory for the South West of Colombia-OSSO- University of Valle; Othon Zevallos Moreno from the National Polytechnic School, Quito; Eduardo Franco Temple and Lenkiza Angulo from ITDG, Peru; Hilda Herzer from CENTRO, Buenos Aires, Argentina; and Marx Prestes Barboza of the University of Paraiba, Campina Grande, Brasil

For the first three years the Project was coordinated globally by Eduardo Franco, friend

and colleague of outstanding human and academic merits, who sadly passed away prematurely in 2003. Since then the project was coordinated by the author of this short prologue. The present book is a tribute to the memory and life of Eduardo who was one of the prime movers in the elaboration and financing of this project.

The project included the following activities: research on ENOS and risk patterns in the region; the building up of a data base on disasters associated with climatic events between 1970 and 2003, using the DESINVENTAR soft ware and methodology developed by LA RED; the creation and administration of a computer based information and documentation system; the organization of academic meetings and training activities; and project dissemination activities, articles and other printed pieces.

Almost unique amongst the first round of IAI funded projects, the Project concentrated on the human dimensions of the risk problem examining the ways society contributes to risk construction. Hazards were looked at from society and not the other way around.

Project results are directed to different “markets”: academics and students of the problem seen from a scientific angle; and, what are collectively known as decision makers, including politicians, management sectors, and, perhaps most importantly, the population and its organised sectors.

Due to this rather coarse grained way of looking at potential readers and users of research results, the need to produce two types of publication arose. On the one hand an “academic” book which summarises the principle project results and methodology; and on the other hand, a publication which makes the results and their context more accessible to the lay reader and those interested in decision making and training. The latter audience is the principle market for the present book

The book has been written, compiled and illustrated by Gustavo Wilches-Chaux, lawyer, writer, social communicator, photographer, humanist and intellectual of outstanding experience and reputation and amongst the 14 founding members of LA RED and is based on project results and his own reflections and experience with risk and environmental management concerns for more than 25 years

The more conventionally academic results of the project will be published later under the title ENOS and Disaster Risk in the Americas: Process, Patterns and Management, compiled by the author of this note.

ENSO What? follows a tradition set by LA RED in 1998 with the publication of Rise, Fall and Recovery of Felipe Pinillo, Mechanic and Solder (The RED Guide to local risk management), also written by Wilches-Chaux, and based on the research and experience of many RED members. This research and experience had been previously systematized by Elizabeth Mansilla in an internally circulated document amongst RED members.

Those who work in the local risk management and disaster areas are well cognizant of the impact and importance this first book had and continues to have on thinking as regards the topic in Latin America. It is perhaps with this book that the notion of risk management and local risk management take off in Latin America, rapidly substituting the notions of disaster management and administration which dominated up to that moment.

Our respect and thanks to the researchers on this project for their dedication, patience and achievements. To IAI and the National Science Foundation for their generous support for the research and publications. To the Bureau for Crisis Prevention and recovery of UNDP for its support for the final project meeting held in Guayaquil and Las Crucitas, Ecuador, en April 2006. To the International Centre for Research on ENOS- CIIFEN- for hosting and supporting this last meeting. And, to OXFAM Great Britain for its support for the Project publications. Finally to Gustavo himself for his imagination and commitment.

Needless to say, project results and publications are the sole responsibility of the authors and LA RED.

For me as project coordinator it is a great pleasure to present this publication in the hope its contents may contribute to managing the problems associated with climatic related disaster risk.

ALLAN LAVELL
Principal Researcher
ENOS Risk Project
Latin American Social Science Faculty-FLACSO

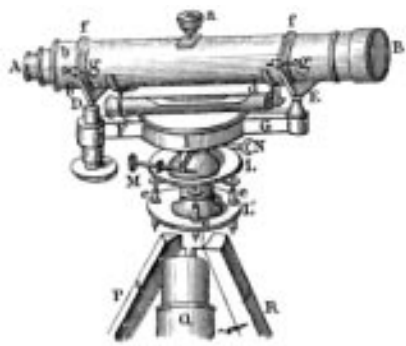
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Author's note



The concept “**Climate Variability**” has been adopted conventionally to refer to the combination of natural and permanent changes proper to the Earth’s climate. The concept “**Climate Change**”, on the other hand, is limited to the differences between the planet’s present climate and what its climate will be in the future due to the influence of anthropogenically induced factors; that is to say, due to the impact of human activity. And, the concept “**Global Change**” denotes the combination of ecological and social consequences associated with climate change. Among these consequences we include the impact of Climate Change on the manifestations of Climate Variability.

These terms will be used throughout the text. However, when we speak of “changes of climate”, we are referring to manifestations of every kind of change.



Introduction

As I begin to write this book...

As I begin to write this book (January to April, 2006), reports come in that both the river Elbe and the Danube have burst their banks after water levels rose to heights not experienced (in the case of the Danube, at least) for more than a century. Thousands of people are victims of floods which have left hundreds of homes and over two thousand hectares of crops under water. At the same time, the press reports flash flooding caused by unusually heavy rainfall along the Uaso Nyiro (Kenya) river basin. As a result, over three thousand farmers have been obliged to abandon their lands in an area still suffering the consequences of a prolonged drought that has affected three-and-a-half million inhabitants and has decimated thousands of herds of cattle in the north and northeast of the country.

In other latitudes, a hail storm and a tornado leave over seventy-five wounded and destroy harvests, homes, vehicles and infrastructure in Israel, where these phenomena are uncommon. And, eight states in the South and Midwest of USA, where they are frequent, have experienced three hundred and fifty one tornadoes so far in 2006. That's four times the norm for these months of the year.

During these first four months of the year floods and other related phenomena, such as landslides, affected numerous regions of Colombia, Ecuador, Peru, Brazil and Bolivia, and the high-

way that connects Colombia's interior regions to Buenaventura, the country's main Pacific port, is still being cleared after a number of landslides completely isolated the port for days on end. Dozens were buried alive under the rubble, and economic losses were enormous.

In its first April issue, Time Magazine featured a cover story on global warming scarily titled - "BE WORRIED. BE **VERY** WORRIED".

People are currently speculating as to the 2006 hurricane season in the Caribbean. The 2004 and 2005 seasons registered the highest number and greatest intensity of storms since official records began.

What is happening to Planet Earth? And what is happening to us human beings and the territories we are part of?

It is a well-known fact that globally, disasters associated with hydro-meteorological factors¹ are far more numerous and cause far greater damage than disasters due to other natural phenomena, such as earthquakes or volcanic eruptions.

In the following pages we will examine the nature of disaster risk linked to hydro-meteorological phenomena and, in particular, those that are expressions of so-called "climatic variability", with emphasis on the process known as ENSO (El Niño Southern Oscillation).

¹ DesInventar Methodological Guide (in Spanish), OSSO, La Red (Cali, 2003)

But, we will not do this exclusively from the viewpoint of hazards, that is to say, the *hydrological* or climatic phenomena which, under certain conditions, may turn out to be dangerous and threatening. Rather, we will analyze disaster risk from the point of view of ecosystems and those human communities that have been incapable of living harmoniously and in a “sustainable” way with such phenomena. In other words, we will look at risk from the perspective of ecosystem and community *vulnerability* and the loss of *resistance* and *resilience* in those territories where risks are real and disasters finally occur.

With regard to the Danube disaster quoted above, Gabriel Partos, an analyst with the BBC, points out that rising water levels on the Danube – a perfectly normal phenomenon for this river and others – spelt disaster for three main reasons.

First, because of changes in land use, whereby increasing use of the flood plains for agriculture and human settlements has led to lower water levels in the river. Secondly, because of the progressive destruction of the watersheds forest cover and a loss of its environmental function in controlling stream flows. And third, due to the fact that artificial channels have been built to divert (or “straighten”) the river’s course, thus totally altering its dynamics².

Partos’ analysis, undertaken in a completely different cultural and geographical context to that of Latin America, is, however, a good example of the type of approach used by researchers of the ENSO-IAI-LA RED project. For various years these researchers dedicated their efforts to ascertaining why ENSO, with its hazard characteristics and “patterns”, helps construct risks and generate disasters in the countries studied. Some of the principle results of that project are summarized in the second part of this book, which is in itself mainly based on their research.

The subject dealt with in these pages is a fascinating one because day by day, close to home and in more remote places, events occur that confirm our basic understanding of the problem and corroborate our presuppositions – or, to the contrary, force us to adjust our hypotheses.

But, above all, it is fascinating because the debate on climate change, and in particular the debate on the impact of human activities on global warming, has achieved such political relevance and been the cause of such conflict (in the best possible sense of the word), that it seems to me comparable in its implications to the first half of the XV century debate over the position of the earth in the solar system.

The effects of climate change, which among other things determines that phenomena once thought to be completely natural, such as El Niño and hurricanes, are now starting to be considered in part to be a result of human activity (so-called socio-natural phenomena) shakes the foundations of the dominant existing development model and its implications at the economic, ecological, social, institutional, political and ideological levels. It may be compared to the way the findings of Galileo Galilei overturned Aristotelian-Thomistic rationality and questioned the authority of the Roman Catholic Church. A major difference may of course be found in the fact that the heliocentric theories didn’t imply assigning blame or responsibility for what went round what, while the theories of Global Warming and its possible hazard implications clearly place the finger on human activity and demonstrate that nature is not the only one to blame.

The IAI-LA RED project explains why the growing disaster impact of El Niño and La Niña owes less to the intrinsic physical characteristics of ENSO and associated hazard events than to the loss of “territorial security” amongst the affected communities. This “territorial security”, to which we will dedicate a complete chapter, is the result of the dynamic interaction between various factors. These allow communities and ecosystems to resist the effects of certain natural, socio-natural or anthropogenically-induced phenomena without trauma.

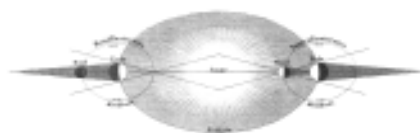
To understand territorial security, community and ecosystem resistance and resilience, and in order to better promote risk management and disaster prevention, we have to recognize and explore the roots of those processes which bring about a loss of “territorial security”. Of course, this can only be achieved when we commit to taking more than merely remedial or cosmetic measures. We must Get Radical with Risk (GRR).

Rather than providing a definitive statement, the contents of the following pages attempt to offer an “interpretation matrix”, a guide to the reading and understanding of those everyday, more frequently occurring and growing in intensity phenomena that alter our daily routines, our “normality”. We feel these sensorially and discover them through direct experience, or via the TV, radio, Internet, newspapers and so forth. These phenomena involve us all, since the world is getting smaller and the problems that affect it are no longer somebody else’s problem, but also our own.

GUSTAVO WILCHES-CHAUX
Bogotá, april 2006

² BBC News – <http://news.bbc.co.uk/>_19 April 2006

POSTSCRIPT TO THE INTRODUCTION



During the long year that has passed since we completed a first version of this book (including the introduction) and now, as we go to press, climate and weather dynamics have continued to do their own thing. This has included intense periods of heat followed by intense periods of cold (or vice versa) in Europe and North America; a relatively easy hurricane period in the Caribbean during 2006 (related to the presence of El Niño in the Pacific), but with very strong hurricanes in other regions, including the Mexican Pacific coast; dramatic effects of El Niño in Bolivia and Peru well into 2007; an increase in tornado incidence in the United States; and new incidents of flooding, landslides and other disasters of hydro-meteorological origins which are repetitive around the world but increasingly abundant and with greater and more complex impacts on society and environment.

During this same period climate change has received unprecedented attention in the media and at the political level. Al Gore's documentary "An uncomfortable truth" received an Oscar and brought about a new type of political discourse; the topic gets on the agenda of the UN Security Council for the first time and climate hazards are considered along with other hazards in relationship to the "stability" of our planet; the leaders of the world's richest nations grouped in G8 (including the United States, a country traditionally adverse to commitments to the topic of climate change) come to an agreement to limit "Climate Change" and reduce carbon emissions by 100% by mid century and also to compare the environmental agendas with those of the G5 countries (China, Mexico, India, Brasil and South Africa); the last Inter Governmental Panel on Climate Change-IPCC- report (February 2007) seems to leave no doubt as to the responsibility we humans have in terms of the actual state of our climate and in the imminence and seriousness of its effects.

* * *

Towards the end of September 2006 six caimans died in a National University of Colombia research centre in the city of Villavivencio in the countries Eastern Plains region. The press reported these deaths as the first victims of the 2006-7 Niño in Colombia. They spoke of temperatures of 7 degrees celsius or more above local averages and decreases in humidity from 95 to 79 percent. This was completely true.

However, when one delved deeper one discovered that the animal keeper had reported that "when we started to run water in order to fill the tanks we realised the animals were dead because they seemed to be stuck to the floor".

Inevitably one was inspired to ask what would have happened if the animals had lived in a natural and relatively well conserved natural environment, with access to the minimum needed humidity levels and shade, despite temperature changes. Would they have died or would they have survived simply by finding pools and shade under the bushes, without recourse to animal keepers turning on the taps?

Evidently the caimanes were not victims of El Niño but rather to having been displaced from their natural environments, many of which most surely have disappeared or been deteriorated to such an extent that they have lost their capacity for resistance and resilience when faced with climate changes.

Even though we can not assert that those six caimanes were the first victims of El Niño the experience is didactically illustrative of our own vulnerability when faced with changes in our environments and when the territories of which we form part loose their natural capacity to offer security from changes in climate and when the "cultural protheses" which should substitute such natural mechanisms do not operate in an opportune and expedite way.

Another example which is equally didactic, but far more dramatic, is the case of the estimated 15000 persons, mainly aged, who died in France during the the 2003 summer, supposedly due to the unusually high temperatures. Soon, however, it became obvious that the main causes were not high temperatures but the lack of human "warmth". Society and culture seemed to have lost the capacity to reduce the affective and physical vulnerability of the aged when faced with climate change.

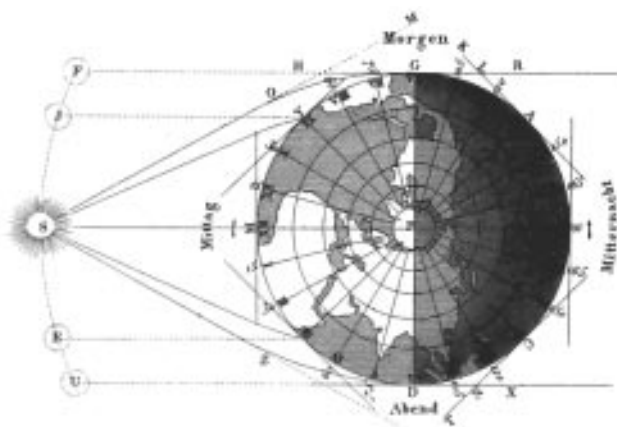
We hope that the following pages help us all understand a little better how we as a species are loosing our ability to be in tune with the dynamics of those territories that are part of us, and that help us also to find solutions.

GUSTAVO WILCHES-CHAUX
Bogotá, june 2007



PART ONE

THEORETICAL CONSIDERATIONS



Chapter 1

Nature's dynamics

Planet Earth is the result of multiple dynamics

Which was which he could never make out,
despite his best endeavor.
Of that there is no shadow of doubt
No possible doubt whatever.

W. S. GILBERT, *THE GONDOLIERS*

Great strides have been made in perfecting scientific and technological methods for analyzing the earth's climate. We now possess instruments such as satellites and meteorological radar systems which enable us to monitor atmospheric phenomena in real time. Nevertheless, the fact still remains that we have little or no knowledge about many of the way in which the Earth's atmosphere *thinks and behaves* as it interacts with our planet's other components, and with certain external factors, such as radiation and solar magnetism. This lack of information leaves us humans with a lot of unanswered questions.

At school we were taught that the Earth is made up of a series of layers, each of which is composed of a different material: the **atmosphere** is made-up of air; the **lithosphere**, of rocks; and the **hydrosphere**, of water.

In fairly recent times, however, the Russian biochemist V.I. Vernadsky (1863-1945) and the French philosopher Teilhard de Chardin (1881-1955) each separately proposed the existence of a thought, mind or reason layer which they named **noosphere**. The North-American Alvin Toffler (1928) spoke of the **infosphere**, the information layer that has become more tangible since the advent of the internet³. Perhaps the most evident expression of these layers, which reflect the mark left by the human species on the planet, is what we call "Culture".

What we weren't told at school – at least not explicitly – was how these "layers" interact (particularly the atmosphere, the lithosphere and the hydrosphere). Nobody told us that they are not concentric, like the layers of an onion, but that they intertwine in their physical structure and function in varied and complex ways.

The conditions that enabled life to develop on Earth around 4 billion years ago – and which still allow it to exist – derive from this interaction of structure and function. The molding of these structures with natural processes, added to their relationship with Culture, materialize in what we call "territory". Territory will be one of the main subjects of our present discourse.

A similar awareness of the interrelationship between the planet's different "layers" had already been expressed by the French naturalist Jean Baptiste Lamarck (1744- 1829). Vernadsky took up this line of thought when in 1928, using a term coined by the Austrian Eduard Suess (1875), he wrote "The Biosphere", a book which has since become a classic. As the author puts it in his preface, the purpose was to "grab the attention of naturalists, geologists and particularly biologists, so that they would understand the importance of quantitative research on the interaction between life and the chemical properties of the planet". The **biosphere** is therefore defined as that space on the planet where life exists, the "territory of life" at

³ In his book *The Third Wave* (1980), Toffler stated that the rise of "mass culture" is a result of the relations between what he himself called the technosphere, sociosphere and infosphere.

a planetary level. Or better still, the biosphere is life itself witnessed through its concrete territorial expressions: ecosystems⁴.

The biosphere is the end result of the dynamic interaction of all of the planet's ecosystems (human communities are also part of this interplay). What allows us to realistically call this "a living planet" is the fact that matter is characterized by a particular dynamic. In other words, Planet Earth embodies self-regulatory and homeostatic processes equivalent to the human immunological system, as was shown by the British atmospheric chemist, James Lovelock, in his "Gaia Hypothesis" (1972).

We could postulate, in a somewhat arbitrary way, that the dynamics that lead to life all occur in the relatively narrow "space" between

the approximately nine thousand meters above sea level, represented by Mount Everest at its summit, and the eleven kilometers below sea level, represented by the Marianas Trench in the Pacific Ocean.

All of us living beings (humans and others) exist in this vertical "space" of approximately 20 kilometers. But our continued existence depends on processes that take place at a much larger scale, one which extends all the way from Planet Earth's nucleus itself, at a depth of six thousand kilometers, to places up to 100 kilometers above sea level. Processes occur in this extended "space" that determine – in the short, medium and long terms – some of the conditions under which life can exist. In a similar way we depend on a multitude of processes which take place on the Sun and within its general area of influence.

⁴ An ecosystem is the result of the multiple interactions which, in a given space and time, connect one species with another, and living beings (animals, plants, microorganisms) with the so-called abiotic or supposedly non-living components of those ecosystems (minerals, humidity, luminosity, temperature, and so forth). Wilches-Chaux, Gustavo, *De nuestros deberes para con la vida* (Popayán, 2000).

The layers of the atmosphere

A good deal of the phenomena we call “the weather” occurs in the **troposphere** (from *tropos*: change), the altitude of which varies from between eight kilometers in temperate latitudes and eighteen kilometers in Equatorial regions. Within the troposphere we find the highest density of air and 99% of all the water vapor contained in the atmosphere, with a higher concentration (approximately 3% more) in the inter-tropical region- to which it owes its characteristic humidity. Thus an inseparable unity is formed in the troposphere, between the atmosphere and the hydrosphere.

In this layer the temperature drops vertically at a rate of approximately six degrees Celsius per kilometer until it gets to the **tropopause** (between 8 and 18 kilometers above sea level, depending on the latitude) where the **stratosphere** begins.

In this part of the atmosphere, which can reach up to 25 kilometers, the air’s temperature stays constant, even though the altitude itself varies.

From the **stratopause** upwards, temperatures start to rise and can reach 500 degrees Celsius at an altitude of 50 kilometers.

In the stratosphere, at altitudes that oscillate from 20 to 30 kilometers, we find 90 per cent of the ozone there is in the atmosphere (10 parts

per million – ppm – as opposed to the 0.04 ppm found in the troposphere).

Ozone (O₃) is a highly toxic gas (which explains why it is used as a germicide), but despite its harmful effects on human beings, life on Earth would not be possible without it. This gas appeared when gaseous oxygen (O₂) rose to the upper layers of the atmosphere. O₂ is a byproduct of photosynthesis. The predecessors of today’s plants began to make use of oxygen nearly two billion years ago⁵.

In the delicate and fragile **ozone layer**, this gas absorbs most of the sun’s ultraviolet (UV) radiation. This radiation has wavelengths of 280 to 320 nanometers and directly affects the DNA of living cells in both animals and plants. This gas also contributes to the atmosphere’s thermal balance, since UV radiation converts into heat when it comes in contact with the ozone molecules.

At the point where the stratosphere terminates (at an altitude of approximately 50 kilometers), we enter the **mesosphere**, which reaches an altitude of 80 kilometers and where temperatures drop as low as minus 83 to minus 94 degrees Celsius.

After the **mesosphere** there is the **thermosphere**, which goes up to between 100 and 200 kilometers. Here, given there are almost no gases capable of absorbing the intense solar

⁵ Or possibly even earlier, if we give credit to researchers who, based on large deposits of iron oxide found in Río Tinto (Spain) and other parts of the world, state that there have been abundant quantities of gaseous oxygen in the atmosphere for approximately the last 2,700 million years.

radiation, temperatures rise to anything from 700 to 1,300 degrees Celsius. After the mesopause, comes the **exosphere**, whose upper limit

can arbitrarily be set at 1,000 kilometers. And that is where the atmosphere dissolves into extra-terrestrial space.



Remember that the Earth's diameter is approximately 12,000 kilometers at the Equator. The height of the atmosphere, which also forms part of the planet, is equivalent to only a small fraction of that diameter.

The troposphere, where "climate" and "weather" materialize, rises to an altitude of no more than between 8 and 18 kilometers.

Climate and Weather

Let us begin by defining what we mean by climate.

I received an e-mail from a colleague in France a few months ago and at the bottom was the message: "Climate is what we expect and weather is what we get." This says it in a nutshell. Weather is day-to-day values of temperature, rainfall, pressure, winds, etc., and climate is the mean of these variables over some suitably long period of time.

But climate encompasses more than just weather variables. A more general definition of climate is the average behavior of the land, ocean, atmosphere, and cryosphere (ice masses) systems over relatively long periods of time. There is not a rigidly-defined period for the averaging process, but for many operational applications a 30-year period is used. This definition acknowledges the interactive role of land, water, and ice in determining atmospheric properties. The cryosphere includes the ice masses of Antarctica and Greenland as well as North Polar sea ice and mountain glaciers. Ice masses are very important because their physical dimensions can change, thereby changing the amount of radiation reflected from the surface of the earth. They are also repositories for enormous amounts of water, and so their change in volume influences the amount of liquid and gaseous water in the atmosphere and liquid water in the ocean".

TAKLE, EUGENE S., 1997⁶

Eugene Takle summarizes his definition as follows: "Climate is a mean climatic behavioral pattern, over lengthy periods of time, in relation to fluctuations in the weather".

In other words: climate is like a person's temperament, an essential part of his or her personality, what is commonly called a person's *way of being*. Weather, on the other hand, would be the person's mood at any given moment or when faced with a particular circumstance.

Somebody with a generally sunny and placid personality can experience moments of sadness, anger or depression, just as a person of an unyielding and aggressive temperament can enjoy exceptional moments of happiness and benevolence. Or somebody who is normally lazy can go through periods of great enterprise and activity or, on the contrary, a hyperactive person can temporarily lapse into periods of complete quietude.

As Takle explains, what he calls the "climatic system" depends on something more than merely atmospheric factors in the strict and conventional sense⁷. He goes beyond the dictionary definition of "climate"; namely; "a series of atmospheric conditions that taken together characterize a region".

Furthermore, climate and weather do not depend simply on interaction between all the

layers into which, in a somewhat arbitrary fashion, we have divided the terrestrial "organism" for the purpose of studying it. It also depends on factors foreign to the planet's internal dynamics, such as radiation emissions from the Sun in its various activity cycles. These, in turn, are related to solar magnetism and to the Earth's position in its orbit around the Sun (movement in transit).

Even the effects the **solar wind**⁸ can have on us depend on its interaction with the Earth's magnetic field. This is the result of a combination of electrically-charged particles in the Earth's nucleus, the convection currents that generate its heat and the planet's rotation⁹.

Other factors, such as the angle of the Earth's axis or the rotation period are not to be considered independently of the planet's internal dynamics. For instance a great earthquake produced by plate tectonics can slightly alter the axis's angle, as is believed may have happened with the Indonesian earthquake of the 26th of December 2004.

Two scientists, Benjamin Fong Chao from NASA's Goddard Space Flight Center and Richard Gross from the organization's Jet Propulsion Laboratory, who routinely check the effects of earthquakes on the Earth's shape and rotation, and also study changes in polar movement, state that:

⁶ Takle, Eugene S. 1997. <http://www.geology.iastate.edu/gccourse/model/basic/basiclecture.es.html>

⁷ "The wholemass of air surrounding the earth". (Marrion-Webster On Line).

⁸ Constant flow of electrically-charged particles proceeding from the Sun, or "corpuscular solar radiation". Among other effects, the solar winds push the tails of plasma or ions from comets in the opposite direction from the Sun. They flow at a speed of between 250 and 1,000 kilometers per second.

⁹ The study of paleomagnetism in rocks proceeding from the bottom of the ocean has enabled scientists to determine that ever since the planet began to exist, several inversions of the terrestrial magnetic field have been produced, as a result of which the North and South Poles changed places. The last change occurred 780,000 years ago. There are signs that lead us to suppose that the geomagnetic inversions, during which the Earth was temporarily deprived of its magnetic field, lead to periods of extremely cold climate. (Hardy, Ralph et al., *El Libro del Clima*, page 168. Hermann Blume, Ediciones Madrid, 1982).

"The earthquake of the 26th of December displaced the mean position of the North Pole of Earth by about 2,5 centimeters (1 inch) in the 145 degrees longitude east direction, more or less towards Guam in the Pacific Ocean. This movement follows a long-term seismic tendency identified in previous research. The tremor also affected the Earth's shape. Chao and Gross calculated that the flattening of the Earth at the poles (flattened at the tips and swollen at the equator) decreased a little, approximately one part in 10,000 million. This confirms the tendency of earthquakes to make Earth less flattened at the poles and make it more spherical".

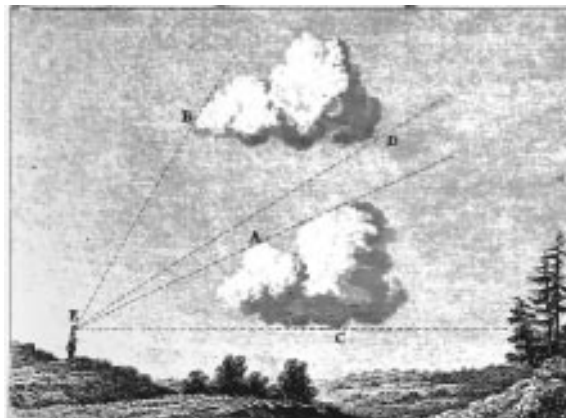
They also detected that the earthquake diminished the day's length by 2, 68 microseconds (a microsecond is the millionth part of a second). In other words, the Earth spins a little faster than it used to. This change in the speed of rotation is related to change in the flattening of the poles. It is like an ice skater who brings his or her arms closer to the body producing a faster spin.

None of these changes have been verified by quantitative measurements. For the present they

have only been calculated. However, Chao and Gross expect to ratify the changes when they receive up-to-date information on the Earth's rotation from sensors placed on the ground and in space¹⁰.

In any case, these and other very small and gradual changes, often imperceptible in the short run but accumulated over millions of years, as well as some abrupt changes, like the one possibly produced by the impact of an asteroid on Earth 65 million years ago, determine why climate – that most "stable" characteristic of the *temperament* of terrestrial ecosystems – finds itself subject to a process of constant change.

This means that not only can a person with a stable *temperament* have different moods, but that this same *temperament* tends to undergo transformations. Not for nothing is it said that people who were placid in their youth and adult life often become irascible and unbending when they get old, or, vice versa.



¹⁰ http://science.nasa.gov/headlines/y2005/lojan_earthquake.htm
Find at Science@Nasa: How the Earthquake Affected Earth

Climate variability: a characteristic feature of the Earth's *temperament*

And so, the concept of **climate variability** emerges. This is not necessarily synonymous with **global warming** even though at the present time the heating of the planet, according to many experts on the subject, may be one of its more obvious causes.

Over the 4.500 million years since the Earth's crust first "cooled down", changes in climate have occurred (and continue to occur) – changes that are not exclusively atmospheric, but part of the planetary landscape in general.

We have already mentioned how, around 2.000 million years ago when living things invented photosynthesis, the first green plants started to capture carbon dioxide from the atmosphere and to liberate gaseous oxygen, which then produced ozone. Many anaerobic species were unable to transform themselves sufficiently to survive in an atmosphere charged with oxygen; others did not manage to take refuge in places with no air and so became extinct. Some species, however, discovered how to "breathe", and these went out and populated the Earth. Thanks to the fact that the ozone layer reduced the incidence of harmful radiation from the Sun, these new species were not obliged to live in primordial oceans or pools; they were able to climb out onto the land and expand over the dry surface of the planet.

Until around 180 million years ago, what are now the five separate continents were united

in a single "mass" to which today's geologists give the name **Pangea**.

One part, which coincides in general terms with the continents of the northern hemisphere – North America, Europe and Asia (except for India) – bears the name **Laurasia**. The portion that coincides with the Southern hemisphere – South America, Africa, India, Australia, the Antarctic and New Zealand – is known as **Gondwana**.

Around 165 million years ago, what is now North America broke away from the rest of Laurasia, and the North Atlantic started to take shape.

Later the Antarctic broke away from Gondwana and then, around 90 million years ago, South America broke away from Africa. From this rupture the South Atlantic was born. 60 million years ago the plate or earth's crust portion on which the Indian peninsula is found separated from Africa and started to drift northwards towards the Asian plate. The frontal collision between both plates, which still continues, formed the crease or "wrinkle" on the Earth's crust known as the Himalayas.

The collision between that fragment of Gondwana which constitutes the South American plate and the plate over which the Pacific Ocean lies, led to the formation of the Andes, that other major "wrinkle" on the earth's sur-

face. This reached its actual height only 2 or 3 million years ago and still grows at a rate of a few millimeters – and at some places, centimeters – per year.

Sixty-five million years ago, an asteroid crashed into the Earth where the Gulf of Mexico is now located (near to the town of Xichulub), producing an alteration in climate that destroyed the environmental conditions under which dinosaurs could live. It was then that our mammal ancestors, who had hitherto been confined to hiding among the rocks, were able to come out and conquer the Earth.

Only just three million years ago, North and South America were united by the Panama isthmus. This did more than merely serve as a bridge which the great mammals from the North crossed on their way south. In fact their presence brought about the extinction of a great many species, many of them marsupials¹¹. Another effect of the isthmus was to place an obstacle in the way of equatorial currents which had been causing a rise in the temperature of the Atlantic, and this contributed to the cooling of the Antarctic and to the freezing of the Arctic (the ice sheet which forms the North Pole)¹².

After the planet's "natural heating system" was cut off, the northern continents were displaced towards the polar region due to the tectonic plate effect. Thus, two-and-a-half million years ago, ice began to cover Europe and this coincided with the advent of *homo erectus*. This was not the first nor would it be the last of the great glaciations. 500 million years before, a large portion of the Earth's surface had already been covered by ice, and the same phenomenon was to occur again later.

Even more recently, the planet went through great changes, like the one around 4.000 years

ago that caused the Sahara to cease to be an ecosystem rich in flora and water, and turn into the desert we know today. Another case is the change from the extremely cold period which prevailed during the Iron Age, 2.300 to 2.900 years ago, to warmer periods like that which allowed the Vikings to settle on Greenland between the years 950 and 1.250 A.D.

Around that same time, about a thousand years ago, great Meso American and South America civilizations (such as the Chimú culture in Peru) disappeared, possibly due to causes linked to changes in climate.

Between 1450 and 1850 approximately, "minor glaciations" or "little ice ages" occurred. Such a period forced the Vikings to abandon their settlements on Greenland¹³. One "minor glaciation" lasted from the beginning of the XV century until 1814, which was the year the river Thames froze over and London celebrated an "Ice Fair". It was also around that time (1812) that Napoleon and his armies suffered their great defeat on the Russian tundra.

As the present text is compiled, the NASA's Goddard Institute of Space Studies confirms that the year 2005 has been the hottest (in terms of mean yearly temperatures on the Earth's surface) since systematic records began at the start of the 19th century. The second-highest temperatures were recorded in 1998 and, as a consequence of the El Niño, they kept rising in 2002, 2003, and 2004.

At the same time, however, the year 2006 began with a cold spell that caused the death of hundreds of people in Russia and Greece, while extremely and unusually heavy snow storms swept the east coast of the United States.

¹¹ Animals, such as the kangaroo, whose womb is an external bag known as a "marsupio"

¹² The Gulf Current still carries warm water from the tropics as far north as the British Isles, enabling people there to enjoy livable temperatures.

¹³ In his book *Collapse: How Societies Choose to Fail or Succeed*, (Penguin, 2004) the North American author Jared Diamond explains why the Vikings from Norway who inhabited Greenland were unable to resist the effects climate variability. In the terms we are propounding here, processes of deforestation, erosion and over-exploitation of the soil, combined with extremely hierarchical and inequitable forms of government, among other factors, led the Greenland Vikings to lose their "territorial security".

Volcanoes and climate changes

There is yet another process where the atmosphere, the lithosphere, the hydrosphere and the biosphere, of course, are knitted together. And that is volcanic activity.

Volcanoes cause solid, liquid and gaseous materials found below the Earth's crust to rise to the surface and be ejected into the atmosphere.

Over millions of years, material which has settled at the bottom of the ocean, the product of erosion and sedimentation, sinks under the tectonic plates in the so-called "subduction zones". This occurs when the oceanic plates slide under the continents as a consequence of plate tectonics. Centuries later this matter returns to the surface through volcanic eruptions and gradually becomes fertile soil in and on which life can flourish.

Great volcanic eruptions alter the Earth's climate at a local, regional, and global level. Aerosols turn into particles of sulfur dioxide (SO₂) which remain in the atmosphere, creating a "shield" that reduces the amount of heat coming from the Sun, which in turn lowers the temperature and ocean water levels.

In June 1991, after 600 years of inactivity, the Pinatubo volcano in the Phillipines produced the greatest volcanic eruption of the 20th century. A swathe of clouds charged with sulfuric

acid wrapped itself around the planet for several weeks.

According to research by experts from the Center of Atmospheric and Marine Research of Tasmania, Australia, published in Nature magazine(...) oceans need from ten to thirty years to recover their temperature level after events such as the Chichon, 1982, or Mount Pinatubo, 1991, explosions -the cases that have been most carefully studied. Simulations indicate that the eruption of Pinatubo in 1991 produced a drop of six millimeters in the level of the nearby ocean for approximately one year. This has been recovering at a rate of 0.5 millimeters per year, and the same recovery is anticipated over the next ten years, lower than the 1.5 observed average for the rest of the seas. The mean rate of the previous fifty years was 0.4 millimeters per year, and in the last ten years an accelerated increase of up to three millimeters has been registered¹⁴.

Among the environmental effects that can be attributed to the eruption of Pinatubo, one should include the abnormal snowstorms that have occurred in Jerusalem and the withering away of corals in the Red Sea¹⁵.

Despite all this, other research carried out by the Environmental Science Department of Rutgers University in New Brunswick, N.J., and financed by NASA, indicate that while the Pinatubo eruption had a cooling effect on the sea, it simultaneously brought about an increase in the "positive phase" of the so-called "Arctic Oscillation" by means of which winds

¹⁴ [http://earthobservatory.nasa.gov/Study/Volcano/Orsearch: Climate-Change Volcanic-Eruptions](http://earthobservatory.nasa.gov/Study/Volcano/Orsearch:Climate-ChangeVolcanic-Eruptions)

¹⁵ Magazine *Science*, February 2002.
<http://eob.gsfc.nasa.gov/Newsroom/MediaAlerts/2002/200202157818.html>

transfer heat from the oceans to the continents, generating greater heat in the high and medium regions of the northern hemisphere. The same investigations demonstrated the destructive effect of volcanic eruptions on the ozone layer which also contributes to polar heating¹⁶.

Pinatubo's eruption constitutes a clear and recent example of how a process belonging to the lithosphere has a direct effect on two of the atmospheric layers (the troposphere and the stratosphere), as well as on soils and seas. Not to mention its effects on the human communities directly affected by the mud flows, piroclastic flows, gaseous emanations and ash and rock falls.

Similarly, there are clues that allow us to conclude, for instance, that the reactivation periods of the Galeras volcano in southern Colombia could be linked in some way to seasons of heavy rainfall. In other words, for reasons not yet clear, the rain, a phenomenon of the troposphere, could be "triggering off" volcanic activity. In March-April, 2006, settlements near to Galeras were on alert as they faced a possible eruption and this in the middle of a season of especially heavy downfalls affecting large areas of Colombia.

A curious, but not well known fact, is that on the 13th of June 1991, only hours before the violent eruption of Pinatubo, and in the same region, typhoon Yunya was formed. It helped to alter the normal monsoon patterns and became a determining factor in explaining why the distribution of ash from the volcano did not coincide with what had been foreseen on hazard maps¹⁷. This is an extreme example of how the atmosphere, the hydrosphere and the dynamics of the Earth's crust can interact.

On the effects of the eruption in the immediately region, C.J van Westen, from the Earth Resources Research Department of the Geo-information International Science Institute in Enschede (Holland), relates the following¹⁸:

One of the most significant effects of the extensive coverage of deposits resulting from the piroclastic flow was the change in hydrological conditions. Given that the alluvial valleys which existed before the eruption were totally swamped by piroclastic deposits, a new system of drainage was developed above the level of the piroclastic flows, channeled in a manner which was partially different from the pre-existing model. The most remarkable example was the new covering at the point where the Sacobia and Abacan rivers meet. The deposits of piroclastic flow cover this meeting point for almost 20 kilometers and were deposited in the upper regions of the Abacan river basin. Consequently, during and im-

mediately after the eruption, lahars produced by the Yunya typhoon did not follow the Sacobia's pre-eruption river bed, but were drained off along the Abacan river valley, causing destruction in the city of Angeles. The Sapangbato upper river basin was also redirected towards the Abacan river basin".

Van Westen's study includes a careful follow-up on the Pinatubo eruption's impact on the hydrography and topography up until the end of 1993. To give some idea of the magnitude of this impact, we transcribe another segment of his study:

"The valleys have grown rapidly in the upper section of the basin near the point of convergence of the two major valleys. This process of massive erosion was increased by a great secondary explosion that occurred on 6 October 1993. As a result of this explosion, an immense secondary piroclastic flow headed in the direction of the Pasig river. This event led to the Pasig capturing the whole of the upper river basin of the Sacobia and producing an important change as it carried lahars from the Sacobia to the Pasig. From reconnaissance that can be viewed in aerial photos, one can see that the secondary piroclastic flow covered the major Gully-Gullies with hot deposits of piroclastic flows at least 20 meters thick, in both the Sacobia and Pasig river basins. This event left no clear evidence of secondary craters due to the intense subsequent erosion, but only wide flat valleys. The capture occurred during the passing of typhoon Kadiang. The relative time of the capture could be reconstructed by comparison with the change in magnitude of the lahars in both channels, as this was recorded by acoustic sensors in the lahar monitoring station.

As a result of the capture of the upper section of the Sacobia river basin, the Pasig's erosion increased dramatically. Rapid erosion both vertically and laterally over the flows of piroclastic deposits, which were still very hot, produced numerous secondary explosions along the river Pasig. In the lower regions of the Sacobia river, the valley's vertical incision increased, reaching the height of pre-eruption deposits and creating vertical walls of up to 50 to 80 meters high.

At the present time, the upper levels of the piroclastic flow have been totally eroded and remains of the second level can be observed only on the Eastern side of the river basin. On the level of the lower terraces the erosion, in different spots, was as significant as those of the piroclastic deposits in 1991, which are underlying them. The temporary capacity of the lake to retain water has considerably diminished due to the deposits of lahars in the Yangca river. In 1993, no lahars were produced that could be associated with the break up of the lake, due to the fact that the barrier created by lahar deposits in the Yangca was very much higher than the river's active channel. In 1994, however, the barrier formed by the lahar deposits broke down, generating an immense lahar in the Pasig river and in the river basin downstream"¹⁹.

¹⁶ <http://www.nasa.gov/centers/goddard/news/topstory/2003/0306apin.html>

¹⁷ Scott Oswalt, William Nichols, John F. O'Hara, *Meteorological Observations of the 1991 Mount Pinatubo Eruption*. <http://pubs.usgs.gov/pinatubo/oswalt/>

¹⁸ C.J. Westen, *Modelamiento de erosión en depósitos de flujos piroclásticos en el volcán Mount Pinatubo, Filipinas*. <http://www.itc.nl/external/unesco-rapca/Casos%20de%20estudios%20SIG%05%20Amenazas%20por%20volcanes/Amenazas%20por%20volcanes.pdf>

¹⁹ Idem

Climate, weather and chaos

As we have already seen, many variables come into play when one attempts to describe Planet Earth's *temperament* and its *moods*, or to predict the Earth's long-term behavior in one region or another.

Some of these factors are extreme and their origin often goes far back in time. Solar radiation, related to the fluctuations of the Sun's magnetic field, is one such case.

Other factors are not so far removed. There is, for instance, the angle of the Earth's axis as it courses along its orbit, occupying a particular position at different times of the year.

There are factors which are intrinsic to the planet's evolutionary dynamic, like the terrestrial magnetic field or the long and short term multiple effect of continental or tectonic plate drift. First there is the change in position of the continental plates on the globe; and second, volcanic eruptions and their effects on soil, water and the two atmospheric layers (troposphere and stratosphere) which receive the impact of such eruptions.

Then there are topographic factors, such as the way flatlands, mountains and valleys have an effect on winds and clouds and, as a consequence, on precipitation. And of course, latitude and height above sea level, which are perhaps two of the factors most evidently related to the climate of any given area.

There are also factors directly related to the existence of life on Earth, such as the way atmospheric composition was altered from the moment life invented photosynthesis (which is still the fundamental Process (in capitals) of the biosphere); the production of methane by the great insect colonies, ruminant animals and the organic waste deposits of human communities; and, the manner in which a particular kind of vegetative covering affects a specific territory's way of absorbing, utilizing or reflecting light and caloric energy from the Sun.

And, as if that were not enough, there are the numerous direct and indirect impacts of human activity on a particular territory whose real effects on the transformation of climate are still a matter of debate.

The multiple interactions between the factors mentioned above (and many others too numerous to include here) are so extensive and so complex that it is impossible – at least from a conventional or “lineal” perspective – to even begin to understand exactly how the Earth's atmosphere, in its *way of thinking and behaving*, interacts with the rest of the planet's components.

The North American meteorologist and mathematician, Edward Lorenz, endeavored to understand the atmosphere's *way of thinking* in order to predict its behavior more accurately. And, in the light of what we have written above, it is perhaps not surprising that he should have

come up with the fundamental principle of **chaos theory**, known as “**the butterfly effect**”. In an address to the American Association for the Advancement of Science (1979), Lorenz stated that when a butterfly flutters its wings in Brazil, it may very well cause a tornado in the United States.

By virtue of the “butterfly effect” – also known as “sensitivity to initial conditions” – apparently insignificant differences in the starting conditions of a process (or in the initial data on which a model is “run”) can lead to enormous differences in the long-term results of the process (or in the model’s predictions)²⁰. From this Lorenz concludes that it is impossible to realize precise long term atmospheric forecasts since not all of the multiple variables that influence the model can be known with precision in advance. Any unconsidered disturbance, no matter how small, or any minute error in the data the model has been fed, can lead to entirely different results.

This does not mean that significant advances have not been made in our ability to make short-term meteorological forecasts, or to foresee, for instance, the number of tropical storms that will probably occur during the coming season, or the possible path of future hurricanes – all of which can be ascertained within an increasingly accurate range of possibilities.

As if wishing to demonstrate that the name chosen to describe the “butterfly effect” is much more than just a metaphor, modern computers, when generating graphs from the apparently “disorderly” data provided by a chaotic process, produce what is called the “Lorenz Attractor”, a figure that resembles lepidopterous wings.

“Sensitivity to initial conditions” serves not only to explain the difficulties of accuracy with weather forecasts. It also helps us to understand why a seemingly insignificant factor, when compared with other variables that intervene in a system, can generate qualitative modifications which may substantially transform the system’s behavior.

This is one of the arguments on which some scientists base their conviction that our behavior has become more and more decisive in de-

termining the course of the climatic changes we are experiencing, despite how insignificant the impact of human activity on the biosphere might appear to be if we compare it with all other factors that influence climate and weather. Such changes could create conditions that endanger the very survival of our own “civilization” on the planet.

A small tack or nail may seem insignificant when compared with the automobiles and trucks that travel at high speed along super-highways. But if the tack punctures the tire of a vehicle that is moving at over 200 kilometers per hour, it could cause an accident of enormous proportions.

The ways in which our species contribute to climatic change include:

- new uses of land which many times transform the way the biosphere absorbs and processes solar radiation;
- the planting of pastures for grazing on terrain previously covered by wetlands or forests;
- deforestation;
- the expansion of cities – “islands of heat” – over surrounding rural areas;
- the unleashing of great quantities of carbonic gas (and the carbon that Nature had kept “locked up” for centuries in coal and petrol deposits); and the introduction into the atmosphere of gases that destroy the ozone layer.

All of these factors contribute to the heating of the planet on a global scale. And, at the local level, they express what those changes signify to each particular region.

We have not as yet got round to talking about the way our species helps to create certain hazards conditions that may spark off disasters. That discussion will come later. For the moment we limit ourselves to stating that we human beings are one more factor causing climatic alterations. To what extent are we to blame? That is the subject of heated debate (perhaps yet another contribution to Global Warming!), involving all those who, in one way or another – either from the perspective of science, politics or environmental or development management – have taken up the issue.

²⁰ In another field of mathematics, we have no problem in making an approximation between π (pi) and 3.1416. However, π represents a reason whose value possesses an infinite quantity of decimals. If we were working with a model for atmospheric predictions, in the long term we would obtain one result starting from 3.1415926535897932 and a completely different result if we started from 3.141592653589793238. The two last digits (-3 and -8) represent the flutter of butterfly wings.



Two-and-a-half million years ago the landscape that we contemplate today on the high mountain heath at Sumapaz in Colombia, over 3.500 meters above sea level, was almost a thousand meters lower; that is, at the level of the present-day city of Bogotá (2.600 meters).

Up until 28,000 years ago, the terrain occupied today by the savanna of Bogota was one great lake. Between 45,000 and 25,000 years ago, the mountain range which borders Bogotá to the east was covered with glaciers which, during that period, reached their greatest extent. At times the ice may have made contact with the forest at altitudes of between 2.700 and 2.000 meters above sea level, that is, below the city's current altitude.

Climate changes and climate variability

Women are better endowed than men to perceive cosmic cycles, since in their organisms the cycles are much more evident.

However, men and women, and in general all living beings, work according to cycles, the most immediate of which is the so-called “circadian” cycle or rhythm (from the Latin *circa* = near and *dies* = day), that dictates, amongst other things the hours for sleeping and being awake. If you tamper with that cycle, it will catch up with you sooner or later.

In times when the survival of human communities depended on their knowing how to tune in precisely to Nature’s “mood”, nobody could afford to ignore the phases of the moon, or the dates when each season began and ended, or the life cycles of plants and animal populations.

Great feats of prehistoric human architecture, like the Stonehenge observatory in England, were both sacred centers and practical tools for recording the passing of the Sun through previously-determined points on the horizon. When viewed from specific places in the “Solar temple”, these points marked the summer solstice (longest day of the year), the winter solstice (shortest day of the year), and the autumn and spring equinoxes, when night is exactly the same length as day.

By means of their pyramids and calendars, the Mayas assured that the life of their Empire and its inhabitants were in harmony with the cosmic cycles. The so-called ethno-astronomies systematized a profound knowledge of the heavenly bodies, something which was – and still is – common to all those cultures that are closely bound to the rhythms of Nature:

For the Sikuani Indians who live in the Vichada (an Amazonic region of Colombia), what we call “The Milky Way”, is a giant serpent:

which holds sway over everything and into which nobody may enter because it fills the whole universe”. So the chief among all supernatural beings ordered two eagles to lift the serpent out of the Earth and to place it in the sky so it would cease to trouble men. Thus the constellation we call Taurus, they call “The Crocodile’s Jaw”; the Southern Cross is “The Tortoise” and the conglomerate of stars we know as “The Pleiades”, or “The Seven Goats”, they call **Ivinai**, “and when it appears in the sky it is summer, and when it sets beyond the horizon, in March and April, it coincides with an early abundance of fish when water levels start to rise, and the *bachaco* (ants of the *Atta* species) fly a little. Then, when Ivinai vanishes altogether, in the second half of the month of April, the *bachaco* ants start to fly in swarms²¹.

Ever since the emperor Constantine imposed Christianity as the “official religion”, all mythologies or “bodies of belief” started to be called “pagan” (from the Latin *pagus* = countryside, forest).

²¹ Álvaro Baquero, *Etnoastronomías Americanas*, quoted by Wilches-Chaux, Gustavo in *Del Suelo al Cielo (Ida y Regreso)*, (Ed. CISP, Bogotá, 2003).

We who are members of an “urban species” are so good at self-deception that we think and act as if our everyday lives can be lived without any kind of dependence on natural cycles, of which we know little more than what is required to distinguish day from night. And that is only because our bodies remind us unfailingly that we need to get some sleep. If sleep were not necessary, we would probably do away with nighttime – just as we have in fact “blotted” out the stars with the aid of electric light bulbs.

Nature, however, like Time, marches on.

We have already seen how, within certain parameters of climatic stability (that is, fidelity to the *way of being* or *temperament* of a given sector of the Earth, which is characterized by the permanence of “normal” average levels of temperature, moisture, wind speed, atmospheric pressure, etc.), changes in the weather occur. In other words, the *moods* of the atmosphere vary in such-and-such a territory and under particular circumstances.

But that *way of being* is not permanent either: variability is an intrinsic characteristic of climate, and is manifested in a sequence of oscillations or “deviations” from the norm²².

These local and short-term changes – *moods* – determine the weather, and are part of climatic variability. Changes in more extensive regions, or for longer periods of time, may span a number of seasons (multi-seasonal), a number of

years (multi-annual), a number of decades (multi-decadal) or a number of centuries.

Some examples of these prolonged fluctuations of the weather include abnormally hot and dry summers, as well as extremely cold and snowy winters, and consecutive series of severe winters, or vice versa. And it can occur that a mild winter is followed by a strong one. In general, all long-term phenomena are associated with changes in the atmospheric circulation that covers great extensions. At times, these persistent manifestations occur simultaneously over vastly distant and apparently unrelated regions of the hemisphere, or even the globe, and result in abnormal conditions and in unusual temperature and precipitation patterns²³. During the last few decades, scientists have discovered that important aspects of climatic inter-annual (from one year to the next) variability in planetary climate patterns are related with the cycle known as the phenomenon of El Niño²⁴.

Inter-annual climatic variability refers to the fluctuation in time of the different meteorological elements in a region. This fluctuation is generally established in relation to a historical average. Over time, climate behaviour is typified by maximum and minimum extremes and oscillations under (and close to) the average. The ENSO phenomenon is the main known source of large-scale climatic variability. However, ENSO is only one of the many oceanic-atmospheric phenomena that produce variability. Hurricanes, seasonality, thermal domes of the oceans, high and low pressure systems, are also components of a complex dynamic system which produces climatic variation year after year²⁵.



²² Ministerio de Ambiente y Recursos Naturales de Guatemala, *Ponencia sobre los impactos del Cambio y la Variabilidad Climática* (GEF/PNUD, October, 2002).

²³ A “pattern” is a group of elements which, when expressed jointly, show a high degree of repetition or regularity. Lavell, Allan, *ENOS, Patrones de Riesgo de Desastre y su Gestión: Elementos Conceptuales y Bases de la Investigación Comparativa*. In Allan Lavell “Riesgo y clima: proceso, patrones y gestión en América (IAI - La Red - Oxfam, 2007).

²⁴ NOAA – Climate Prediction Center www.epc.ncep.noaa.gov/products/analysis_monitoring/ensocycle/clim_vari.html; http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensocycle/clim_vari.shtml

²⁵ J. Retana. Rosales, R. *Efecto de la variabilidad climática sobre la producción bovina de carne en la Región Chorotega de Costa Rica*. Revista *Tópicos Meteorológicos*, IMN, July 2001, Vol.8 No. 1.

“The first pieces of the El Niño puzzle were put together thanks to atmospheric studies. In the early part of the twentieth century, British mathematician Sir Gilbert Walker, Director General of Meteorological Observatories in India, took advantage of existing weather data to make a substantial breakthrough in atmospheric science. In 1899, the monsoon rains on which Indian farmers depend failed, triggering a devastating famine. Asked to find a way to predict such weather vagaries in the future, Walker began sifting through some 40 years’ worth of temperature, atmospheric pressure, and rainfall data culled from a worldwide network of weather stations. He noticed a kind of seesaw relationship between atmospheric pressure in the eastern South Pacific (east of Tahiti) and the Indian Ocean (west of Darwin, Australia)—that is, if pressure was high in one region, it was usually low in the other and vice versa.

In a 1928 paper presented to the Royal Meteorological Society, Walker named this seesaw pattern the Southern Oscillation and devised a yardstick that measured pressure differences between the two regions. He observed that, when pressure was very high in the east and low in the west, the monsoon rains in India were heavy. When the pressure difference was small, the rains failed and drought often ensued. Moreover, Walker’s research showed that drought conditions hit not only Australia, Indonesia, and India but also parts of sub-Saharan Africa, and at the same time there would be mild winters in Canada. Because he had plotted certain time-lag correlations between these pressure differences at different times of the year, Walker also believed the measurements could be used for long-range forecasting for some locations.

Despite his insight and vision, Walker was unable to identify the physical processes responsible for the Southern Oscillation, and for the next three decades numerous factors conspired to dampen further research on the phenomenon. Chief among them was that from 1930 to 1950 the climate signals marking the Southern Oscillation and El Niño were much less pronounced than they had been, and interest in the subject waned. Then in 1957 a confluence of events in climate, science, and international politics brought a resurgence of interest.

That year the Soviet Union launched *Sputnik*, the first artificial satellite, spurring a dramatic increase in support for scientific research of all kinds throughout the West. As it happened, the year also ushered in a large El Niño. Although this caused an unusually forceful impact, it might have passed unnoticed, except that 1957 had been designated as an International Geophysical Year, a year when scientists from all countries cooperate to improve existing understanding of the solid Earth, the oceans, and the atmosphere. As a result, scientists around the world were conducting intensive measurements of the planet. Among the data they gathered were not only atmospheric measurements but also sea surface temperatures throughout the Pacific—information that had not been available in Gilbert Walker’s time. Some researchers in the 1950s noted that high sea surface temperatures off the coast of Peru seemed to correlate with a small difference in pressure across the tropical Pacific. Indeed, scientists at the Scripps Institution of Oceanography convened a group of scientists in 1959 to discuss the phenomenon. However, it wasn’t until the late 1960s that meteorologist Jacob Bjerknes, of the University of California, Los Angeles, described a mechanism that linked Walker’s observations of the Southern Oscillation to El Niño”.

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http://www7.nationalacademies.org/opus/elnino_3.html



ENSO what?

ENSO is an acronym that has been in use for some years now to refer to “El Niño Southern Oscillation”.

When it was observed that the twelve-monthly periods in which the Pacific Ocean heats up as a consequence of El Niño tend to be interspersed, at irregular intervals, with cold years in which the sea’s temperature is below normal, such periods began to be identified as the years of Niña, or La Niña. When neither of these two alterations takes place, we have what are known as “neutral years”.

According to research carried out by Kevin E. Trenberth, a New Zealand climatologist and mathematician at the National Center for Atmospheric Research in Boulder, Colorado, the

ENSO phenomenon is typified when, in the region known as “Niño 3” (between latitudes 4° N and 4° S and longitudes 150° W - 90° W), in the course of six or seven consecutive months, there are records of heating or cooling in the oceanic waters of at least 0.5 degrees Celsius above (or below) a basic line established with reference to the mean temperature of the water in the 1959-1979 period²⁶. Thus, for example, according to the World Meteorological Organization (WMO), the 1997-1998 ENSO was one of the strongest ever recorded, with abnormalities in temperature on the sea surface (TSM) of between +2 and +5 degrees Celsius above their normal value²⁷.

Based on this characterization, the following episodes of El Niño and La Niña have been recorded between 1950 and 2000:²⁸

EL NIÑO

Start	Finish	Duration (months)
Ago 1951	Feb 1952	7
Mar 1953	Nov 1953	9
Apr 1957	Jan 1958	15
Jun 1963	Feb 1964	9
May 1965	Jun 1966	14
Sep 1968	Mar 1970	19
Apr 1972	Mar 1973	12
Ago 1976	Mar 1977	8
Jul 1977	Jan 1978	7
Oct 1979	Apr 1980	7
Apr 1982	Jul 1983	16
Ago 1986	Feb 1988	19
Mar 1991	Jul 1992	17
Feb 1993	Sep 1993	8
Jun 1994	Mar 1995	10
Mar 1997	Mar 1998	12

(Source: Kevin E. Trenberth, December 1997)

LA NIÑA

Start	Finish	Duration (months)
Mar 1950	Feb 1951	12
Jun 1954	Mar 1956	22
Mar 1956	Nov 1956	7
May 1964	Jan 1965	9
Jul 1970	Jan 1972	19
Jun 1973	Jun 1974	13
Sep 1974	Apr 1976	20
Sep 1984	Jun 1985	10
May 1988	Jun 1989	14
Sep 1995	Mar 1996	7
Jul 1998	Jun 2000	23
Dec 2000	May 2001	5

(Source: Kevin E. Trenberth, December 1997)

As can be observed in the above tables, ENSO corresponds to what meteorologists call “cuasi-periodic phenomena”; that is, phenomena that occur with certain periodicity, but not at regular intervals. Some researchers, using approxi-

mate figures recorded over the last fifty years, state that the lapse of time between one ENSO and the next varies from between three and five years, while a really intense ENSO is experienced every 15 to 20 years.

²⁶ Magaña, Víctor 1999, *Los impactos de El Niño en México*, IAI, SEP-CONACYT, México, D.F., México.

²⁷ Zevallos Moreno, Othón, *Riesgo asociado a ENOS y variabilidad climática en Ecuador*, in “Riesgo y clima: proceso, patrones y gestión en América” (IAI - La Red - Oxfam, 2007).

²⁸ <http://www.atmosfera.cl/HTML/temas/nino4.htm>

What is El Niño?

To understand the phenomenon, let us begin by briefly describing how winds and the sea interact in the tropical Pacific.

Between a high-pressure (anticyclone) nucleus located in the vicinity of the Tropic of Cancer (northern hemisphere) and another near the Tropic of Capricorn (southern hemisphere), a low-pressure zone (or “barometric depression”) is formed, one that is known as the Zone of Inter-tropical Convergence (ZITC), whose width is equivalent to approximately twenty degrees latitude. This is where the Trade Winds normally blow from east to west – or more precisely from the northeast and southeast towards the west; that is, from South America towards a region of lower barometric pressure in Indonesia.

As they move along, these Trade Winds drive the superficial warm layers of the Pacific Ocean towards the Indonesian coasts, where they accumulate and produce a slight increase in sea level.

Beneath the ocean surface a cooler countercurrent flows in the west-east direction. This surface is near to the South American coast and is loaded with plankton in suspension and nutrients, thus creating conditions for an abundance of fish (the Cromwell Current). This countercurrent interacts with the celebrated Humboldt cold-water current coming up from

the southern ocean, pushed northwards by winds from the Antarctic. Peruvian fishermen depend on these marine life rich waters for their prosperity, as does the economy based on the excrements of guano birds.

Still within the “normal” scheme of things, as far as the sea’s surface temperature is concerned, this cycle shows higher values in the equatorial region of both oceans in contrast to the surging of cold subtropical waters. During the summer months in the southern hemisphere, the equatorial strip with its warmer surface temperatures moves towards the north, while the waters to the south of the equator cool down. In the semester that follows, the strip of maximum surface temperature moves southwards, practically reaching the equator; towards March and April the strip of warmer waters in the Pacific is found further north than its Atlantic counterpart.²⁹

For reasons still not totally explained by science³⁰, every so often the low-pressure zone of Indonesia shifts to the center of the Pacific. This alters the direction and force of the winds, which start to blow from west to east. As a result, the direction of the tepid surface current also reverts, and instead of cold water, it is water of higher-than-normal temperatures which starts to accumulate. The immediate effect is that the water becomes void of nutrients, causing the migration and large scale death of birds and fish and consequent disaster for the fishing and guano industries. As we will see later, in 1972-73 and in 1982-83, Peru suffered catastrophic economic consequences as a result of El Niño³¹.

²⁹ Reinaldo García, *Caracterización de las tasas pre-El Niño en el suroccidente de Colombia*, Departamento de Geografía, Universidad del Cauca, Colombia.

³⁰ There is research which links the phenomenon to cycles in the Sun’s orbit as it moves around the center of mass in the solar system. See Landscheidt, Theodor, in <http://www.johndaly.com/theodor/solarnao.htm>

³¹ Gustavo Wilches-Chaux, Meyer, Hansjürgen, Velásquez, Andrés, “La Costa Brava”, en *Colombia Pacífica*. Fondo FEN, Colombia. T. II (Bogotá, 1993).

So, an almost imperceptible alteration in temperature of the Pacific, sometimes less than half a Celsius degree one way or the other, brings about variations in the inter-annual manifestations of climatic variability in different regions of Earth, some of which would seem to have nothing at all to do with the Pacific's equatorial strip.

El Niño South Oscillation (ENSO) is an unpredictable phenomenon that generates critical conditions as a consequence of a group of associated events around the planet, which have not been understood in their entire complexity. Those effects are not always represented in the same way, but rather as a series of irregular climatic conditions that include changes in temperature and atmospheric phenomena of different intensities. In fact, over the last 25 years, stronger and more frequent El Niño events have been registered than in the 1940s to 60s (Gray, 2005), and their effects have been totally diverse in different parts of the planet. These dissimilar climatic conditions, which happen to be affected by variations of intensity that span a few decades, can trigger natural phenomena and environmental alterations that, combined with determined social vulnerabilities, are susceptible to producing catastrophic consequences in some places, while in others they generate merely minimal changes.

According to Sweetman (2000), these multi-decadal variations of ENSO first became evident in the fifties, when La Niña episodes (dry) surpassed in number the El Niño (wet) ones. Since then, however, the number of El Niño events has increased considerably.

Given the varying types of effects that ENSO produces in different parts of the planet, it has become difficult to associate this macro phenomenon with particular hazards such as hurricanes, tornadoes, droughts and others. But since 1997-98, when El Niño was especially strong, scientists have sought to establish possible links between this phenomenon and natural events that are capable of wreaking havoc on communities.

It is a well-known fact that a slight alteration in the temperature of the sea's surface provoked by ENSO, particularly when this occurs in the eastern Pacific Ocean, significantly increases the possibility of extreme hydro-meteorological phenomena such as droughts, floods and storms. What we do not yet know is how a specific ENSO event may affect climate beyond the tropics (Sardeshmukh *et al.*, 2002).

It is well known also that ENSO, during its warm phases, suppresses hurricane activity in the Atlantic basin (Tartaglione *et al.*, 2002).³² This is deduced from the fact that hurricanes are more intense during the cold ENSO phases (La Niña) than in the warm ones (El Niño).

La Niña years are associated with approximately 75% of damage registered for the 1950-1990 period in Florida and the east coast of the U.S., equivalent to losses of 55,000 million dollars (at 1990 prices). This may be compared to only 2,500 million dollars worth of damage registered during the warmer ten years; that is, when El Niño was occurring³³.

Similarly, Tang and Neelin (2004) discovered that ENSO and the surface temperature in the North Atlantic also constitute important factors in determining the frequency and intensity of hurricanes. These researchers argue that the relations between these factors possibly take place through "tele-connections" in the troposphere's temperature. Saunders and others found that ENSO contributes significantly to variability in the number of intense tropical cyclones in the north of the Atlantic Ocean and in the Northwest Pacific. A revision of the period 1900-1997 for the Atlantic, and 1965-1997 for the Pacific Northwest, demonstrated the differential impact of the cold and hot phases of ENSO on the landfall in different regions.

In the Caribbean, for example, there is a direct relationship between the cold ENSO phase and the impact of hurricanes on land, these being 65% during the cold phases and only 18% during the warm ENSO phases (Tartaglione *et al.*, 2002).

Likewise, it was suspected that ENSO also had to do with the generation and characteristics of tornadoes. Hagemeyer (2001) suggested that in Florida tornadoes are exceptionally strong (intensity of F2 and higher), but that the probability of their occurring increases during the dry phases of ENSO. In fact, data recorded after 1950 confirms the direct relation between tornado activity and intense ENSO. The two most extreme El Niño events (1982-83 and 1997-98) produced the most significant tornadoes to be registered in that State. (Hagemeyer, 2001).

It is important to understand the different effects that El Niño and La Niña can produce in different parts of the planet. Apparently El Niño unleashes a stronger but more variable response than La Niña. While the former is associated with more humid meteorological conditions in some parts of the world, La Niña gives rise to dryer conditions. In general these effects of ENSO are tele-connected with effects in other regions. According to Morehouse (2000), El Niño implies more humid conditions than normal during the winter semesters in the southeast and southwest of the United States, while simultaneously conditions tend to be dryer than usual in the northeast of the Pacific.

Likewise La Niña, whose occurrence is linked to a significant cooling of the Eastern Pacific waters, translates into abnormally dry conditions in the southeast and southwest of the U.S., but more humid than normal conditions in its Pacific Northwest (Morehouse 2000).

This doesn't mean, however, that ENSO generates these opposite effects in an automatic way. As Sardeshmukh (2002) points out, ENSO does not have opposite effects

³² Tartaglione, Carissa A., Shawn R. Smith*, and James J. O'Brien 2003 ENSO Impact on Hurricane Landfall Probabilities for the Caribbean. *Journal of Climate*, Vol 16, Issue 17, September 2003.

³³ Figures don't include the effects of the 2005 hurricane season.

(nor the same effects) on climate patterns in a uniform manner in different parts of the world. For example, during El Niño periods there is a significant risk of heavy rainfall and flooding in California, and during the La Niña periods the risk of drought and forest fires increases in Florida. This, however, cannot be taken to represent a regular pattern of behavior on the part of the ENSO phenomenon.

Observations made over the last decade demonstrate that the wetter and drier conditions that El Niño y La Niña bring about become, respectively, the precursors of floods and droughts. An example of this occurred during the 1997–98 ENSO phase, when because of the phenomenon of teleconnection, dryer conditions in the northeast of the US were paralleled with more humid conditions in the southeast. Rainfall in Florida was 200% above normal for the months of October and December. Immediately following this wet period La Niña set in, and between April and June, 1998, Florida suffered the hottest and driest season registered during the last 104 years (Laing et al., 2000).

Understanding the likelihood of weather variations and tele-connection patterns in both ENSO phases, it is rea-

sonable to link this phenomenon with the occurrence of a number of associated natural events. Jones, Shriver, and O'Brien show that ENSO influences rainfall rates in Florida and other parts of the world. They indicate that heavy Autumn rainfall in the Galapagos Islands is frequently followed by wet winters in the southern United States. The extended flooding that occurred during the fall of 1997 and early spring 1998, is unequivocally associated with ENSO.

The effects of ENSO on wildfires are more evident. According to Goodrick and Brenner (2000), the interaction of ENSO with Florida wildfire activity during the past decade has been recognized. Swetnam (2000) confirms the influence of ENSO in creating conditions for forest fires. Using tree-ring analysis from 1600 to the present, Swetnam indicates that ENSO has a significant influence on fuel load buildup and fire potential, especially in extreme events. A wetter El Niño is generally associated with exuberant seasonal vegetation, particularly fine grasses, which turn into fuel during the dry season. Therefore, the confluence of a wetter than normal El Niño with a drier than normal La Niña, creates an enormous potential for wildfires³⁴.



³⁴ Anthony Oliver-Smith *et al*, "Patterns and Processes of Vulnerability to Hazards in Florida", in "Riego y clima: proceso, patrones y gestión en América (IAI - La Red - Oxfam, 2007).

Chapter 2

Territory and community dynamics



Nature + Culture = Territory

Territory is a social, political and economic construct expressed in the existence of regions with human, productive, economic, political and social features relating to their natural resource base and geographical characteristics.

ALLAN LAVELL

Territory is not just a physical space or a geographical point of reference. It is also the complex and dynamic result of an indissoluble marriage between Nature's dynamics and the dynamics of the communities which form part of it.

Communities relate to their territory in different ways. Some of these are material, as is demonstrated in the use of the natural resources and environmental services the territory provides and on which communities depend if they are to live and grow in a humane and dignified fashion, with an adequate standard of life.

Tangible environmental services include water, air, solar energy, foodstuffs (alimentary security and sovereignty) as well as the fertility and stability of the soil, a factor which is indispensable if one is to occupy the territory, move around it and produce goods.

Intangible environmental services are different from the above, but no less important and necessary. They include a sense of belonging and of identity and, also, the possibility of aesthetic enjoyment of the landscape, whether by day or by night, as a source of learning, inspiration, recreation and tranquility.

We also relate to our territory in a symbolic fashion when we baptize certain features of the land, when we adopt and modify, either formally or informally, already existing names,

when we gather information on the place's history and memories and when we impregnate each of the place's components with a special significance. All of these relationships contribute, in part at least, to the way in which a territory makes us experience fear or uncertainty, or on the contrary, feelings of security. Our direct experiences with the territory (or the recollection of experiences our ancestors lived previously in that same territory) largely determine the "emotional baggage" which we bring to bear on a specific place, a factor which, in turn, influences our relationship with it.

The concept of **territorial security** is borne out of the interaction of all these factors and brings with it the challenge of rediscovering the civic and integral meaning to be ascribed to the second of those two words—security.

Territorial security is intimately linked to sustainability (and to what has been dubbed "sustainable development"). This embraces our relations with (and within) a specific territory in such a way that the dynamics of Nature do not pose a threat to communities, nor do community dynamics pose a threat to the place's ecosystems. That is to say, territorial security is twofold: it benefits both communities and Nature itself.

Stability is perhaps one of the more important environmental services for human beings. This signifies the permanence in space and time of

the conditions which make life possible. This does not mean there will be no change, but rather that such change will take place within certain predetermined parameters to which living beings (and above all, us humans) are able to adapt. In other words, the dynamics of change should not go beyond the limits of our ability to adapt. These limits or parameters are closely related to matters of **culture**. Or better still, they **are** culture, if by “culture” we mean a combination of creations and processes through which human beings leave their material and symbolic imprint on a particular territory.

The dynamics of Nature are diversely affected by many human activities. And, for this reason, certain changes in Nature, manifestations of such dynamics, turn out to be greater than our capacity for adaptation.

This happens, and will continue to happen with growing frequency, so long as culture is thought of more and more as a tool attempting to dominate Nature (we use the word “attempting” because, despite the arrogance of many human beings, Nature will always show itself to be much more powerful than us), and used less and less as a mechanism for adaptation and dialogue with Nature. Lovelock has already dissertated on this situation in his Gaia Hypothesis: ecosystems – and the biosphere in general, of which our human communities are part – are endowed with self-regulatory or homeostasis systems, as occurs in our own organisms. These have the aim of reestablishing a **state of stability** or **dynamic balance** when disturbed by a particular external or internal action.

Eugene Odum (1913-2002) and other classic exponents on the matter of ecology have taught us the meaning of concepts such as *resistance* and *resilience*. The former refers, metaphorically, to the ability to avoid a goal in football. Or, to further apply the metaphor, *resistance* represents the team’s ability to prevent the ball from getting near the goal posts (that is, to avoid a hazard). On the other hand, *resilience* refers to the ability of the football net to recover its former shape after a goal has in fact been scored. Both resistance and resilience are related to those self-regulatory or homeostasis mechanisms to which Lovelock has referred.

In our own bodies, *resistance* represents our ability to stave off sickness even though we are permanently immersed in an ocean of pathogenic agents. This ability to resist is the result of multiple, interconnected factors, such as the endowments of our immunological system (which co-evolves as our lives develop) and depends also on our nutritional levels. It de-

pends no less on emotional and cultural factors to which we are subjected, both as individuals and as members of society. Antonio Gramsci, the renowned Italian early 20th century political scientist and philosopher, once made the very important observation that our health depends on our relationship with ourselves (with both our body and our spirit) and also with our ecological surroundings and our community.

Resilience is our ability to recover following illness, an ability which not only depends on physiological or corporal conditions, but also on emotional, psychological and cultural factors. It depends too on individual and social factors: we don’t get sick nor are we cured on our own, but as integral members of a social tissue.

At this point in our argument we must introduce a fundamental concept regarding risk management: **vulnerability**.

Vulnerability has been defined in many ways. However the following definition enables us to understand the concept both as a function of resistance and resilience and at the same time as their opposites:

“Vulnerability is an internal risk factor of an element or group of elements exposed to a hazard. It relates to the physical, economic, political or social predisposition or susceptibility of a particular community to be affected by, or to suffer adverse effects, when a dangerous phenomenon, of natural, socio natural or anthropogenic origins, should occur. It also represents those conditions which make autonomous recovery either impossible or extremely difficult. Differences in the degree of vulnerability of a social and material context when faced with a dangerous phenomenon determine the selective nature and severity of its effect.”³⁵

Let us now introduce the analogy of a spider and its web to help us understand the concepts of vulnerability, resistance and resilience. From now on we will use this analogy a great deal to illustrate our arguments.

The mesh, net or spider web is considered to be “resistant” when it can withstand, without rupture, the effects of an external or internal action. This resistance also includes the spider which has spun the web as the concept also includes the ability to avoid hazards and, as a result, prevent risks. For example: when the spider establishes his web in a place sheltered from the wind.

On the other hand, the spider is vulnerable when it proves unable to resist the effects of such actions. In that case, the probability of the action may be seen as a threat or hazard.

³⁵ Allan Lavell, in *ENOS, Patrones de Riesgo de Desastre y su Gestión: Elementos Conceptuales y Bases de la Investigación Comparativa*, en Allan Lavell, en “Riesgo y Clima: Proceso, Patrones y Gestión en América” (IAI – LA RED-OXFAM, 2007)

The spider is considered to be “resilient” when, following the breaking, tearing or destruction of its web by an external force such as wind, heavy rain, an intruder, or a falling tree, the spider is capable of spinning his web again and thus recovering territorial control.

Does vulnerability constitute an attribute (almost always negative) which is exclusive to human communities? Or can one speak also of the vulnerability of ecosystems?

This is open to debate. Those who believe or argue that vulnerability can only be applied to human communities – argue that to speak of ecological or environmental vulnerability in the same breath can only lead to confusion and result in internal contradictions in the use of the concept, thus reducing its analytical and heuristic powers. This way, they argue, we could end up equating what are essentially manmade processes with processes of natural environmental transformation – the so-called “succession” – by means of which Nature or the natural environment transforms itself.

Lavell (2004) has suggested that:

“Natural environmental transformation refers to the process by which nature or the natural environment transforms itself, including processes that have existed since the formation of the earth and which have moulded and changed its surface, its flora and fauna in a continuous manner. Reference is basically made to processes where nature interacts with other unmodified or essentially unmodified natural elements (ecosystems, rivers, mountains, slopes, coastal zones, etc). Examples can be found with the impacts of earthquakes on watersheds and slopes, hurricane impacts on forests and mangroves, or spontaneous fires that regenerate ecosystems. To speak of environmental destruction or environmental loss in these cases would be anti-evolutionary or anti-natural. A more correct use of notions would suggest the idea of transformation, change or regeneration and not destruction or damage. The former terms are the product of subjective and anthropocentric interpretations. Even when transformations affect society, reducing the quantity and quality of potential resources, these processes are in themselves natural and cannot be considered in the same way as direct event impacts on society, its goods, heritage, or material structures. Thus, the frequently used notion of ecological or environmental vulnerability refers to a type of vulnerability which is quite different and in no way comparable with social or human vulnerability. In fact, it is probably more convenient to speak of different levels of environmental resistance, resilience or fragility instead of vulnerability, and thus avoid confusions and contradictions. This argument also applies to the use of such notions as *environmental disaster* instead of more objective statements such as wide or large scale environmental change or transformation associated with the occurrence of large scale, natural physical events. In disaster risk and disaster studies confusions and contradiction are intro-

duced when the same word, disaster, is employed to depict both social and natural scenarios.

Natural phenomena which modify or transform other natural scenarios are inevitable and have occurred since the origins of the Earth. With very large scale phenomena society can do nothing to impede or change these. Intervention is thus essentially reduced to prediction, adaptation and, eventually, response.

On the other hand, with lower scale natural or environmental processes society frequently intervenes in order to modify them. This is the case, for example, with the control of the natural flooding of rivers, the control of spontaneous-natural fires, the modification of slopes in order to permit agriculture or construction and deforestation permitting expansion of the agricultural frontier. Here, the possibility of future negative impacts always exists as is the case where dykes and dams break, construction on land fill areas is subjected to greater seismic intensities or deforested areas generate increased flooding, landslide and drought patterns. Environmental change and transformation which takes place in highly intervened, modified or weakened ecosystems and environments constitutes a very distinct context and problem to that associated with purely natural transformations of the environment. In the case of direct social losses in modified natural environments, intervention processes have many times generated new socio-natural hazards or rendered the scale of natural physical events more powerful, thus generating increasing losses once the event occurs.”³⁶

Those of us, including myself, who believe that it is possible to speak of “vulnerable ecosystems”, not only share many of the notions expressed by Lavell in the preceding paragraphs, but we even base our arguments on his when we state that human beings often “vulnerabilize” ecosystems when attempting to control or simply exploit them, without due respect for their integrity and dynamics. It is extremely dangerous to reduce the concept of ecosystems to “natural resources” taken as a whole. That is to say, there is no irreconcilable contradiction here, but rather a difference of focus.

We believe that “vulnerabilizing” ecosystems signifies affecting their capacity to resist and to be resilient. We block off their immunological system, so to speak, just as AIDs does in human beings.

Perhaps the most obvious example we have witnessed in recent years was the case of hurricane Katrina when it hit the Louisiana coast line on the Gulf of Mexico. The immunological or self-regulatory system which enables coastal areas to absorb, without trauma, the periodic visits of hurricanes (that are, in fact, an integral part of that territory’s natural dynamics), includes mangrove swamps and wetlands, as well as the course and shape of the area’s rivers and the topography of the coastline. All of

³⁶ Idem.

these factors or features have evolved jointly, as have the tropical storms themselves. This evolutionary process has occurred with a view to resisting the storms' impacts, or even reaping positive benefits from them. Over the past hundred years, however, very many of the elements that make up this self-regulatory system have been destroyed or at least altered, to the extent that they have lost their ability to resist hurricanes.

That is to say, human intervention intended to "develop" the coastal terrain, employing the dominant concept of what constitutes "urban development", led to ecosystem vulnerability (or, as Lavell would say, a loss of ecosystem resistance and resilience). On the one hand, this process converted hurricanes into a threat for those very ecosystems, and, of course, for the human communities that reside in that territory. But, it also converted other elements of the ecosystems into new hazards for the communities.

In fact, much of the damage caused to the region's inhabitants was not a direct result of the hurricanes winds, but, rather, of collateral hazards such as the flooding of Lake Pontchartrain or the storm surge which careered inland. It should be obvious that these hazards were intimately related to the hurricane. Nonetheless, many insurance companies have since alleged that damage was not caused by the hurricane itself and are thus denying payment to the victims who were insured against "high winds", but not specifically against side effects, such as flooding.³⁷

At this point we only mention the case of Katrina, since its lessons are both recent and explicit. But other examples abound. And, as our readers will later realize, the study on which this book is based demonstrates how human activities, when they relate to territory in an unsustainable manner, open the way to environmental changes which will later contribute to risk and finally, disasters.

The discussion about whether or not natural ecosystems may or may not become vulnerable has more than merely theoretical implications. It also has practical ones since, when faced with concrete situations, we are enabled to close the cycle and understand the relation between hazards and vulnerabilities as a single continuum.

In 2004, under an agreement between Colombia's International Conservation organism and the Water Supply Company in Bogotá, we suggested alternative ways of managing the urban wetlands of Tibabuyes (otherwise known as *Juan Amarillo*/Yellow John). These wetlands cover some 800 hectares within the urban area as opposed to the 50000 hectares that existed

at the beginning of the 20th century. Our study noted how, in the indissoluble marriage between communities and the surviving remnants of the wetlands, the communities' vulnerabilities threaten those very wetlands. Thus, for example, in the economic sphere, due to low incomes people are unable to gain access to terrain apt for housing construction and land up occupying and destroying the remaining remnants of the wet lands. At the same time, the vulnerability of these wetlands and other watersheds (due to their desiccation or illegal occupancy carried out along their shores and river banks) eventually poses a threat to the communities themselves. We need go into no further detail on this point, since the graphics on page... are self-explanatory.

So, disasters may be interpreted at the local or regional level as being the result of the loss of an ecosystems' capacity for self-regulation (the blocking or deterioration of their immunological system) added to the loss of the communities' ability to adapt to environmental change. This inability to adapt prevents them from resisting the effects of a hazard, and from recovering adequately within a reasonable lapse of time after disasters occur. In other words, we are referring to global vulnerability.

However, when it comes to talking about the general or global level of the biosphere, we believe that quite the opposite is the case.

Let me explain. Processes such as Global Warming and its effects on natural phenomena like hurricanes or El Niño and La Niña can be interpreted in either of two ways.

One, they can be seen as the result of the impact of human activity on the biosphere's self-regulatory mechanisms, and more concretely as a deterioration of those self-regulatory mechanisms due to human activities. More simply put, we might say that human beings have eliminated the biosphere's ability to self-regulate.

On the other hand, however, we could come to the opposite conclusion: that far from having deteriorated the biosphere's self-regulatory mechanisms, these are in fact in good shape. Thus, it can be argued that due to a process such as Global Warming and its impact on the natural phenomena we have described above, the self regulatory mechanisms are reacting in order to get rid of the plague inflicted on them by humans (for the moment, that is the theory I personally subscribe to)

Our job as agents in the process of risk management – whether it be as theoreticians or activists – is to prevent natural, socio-natural and anthropogenically induced phenomena from

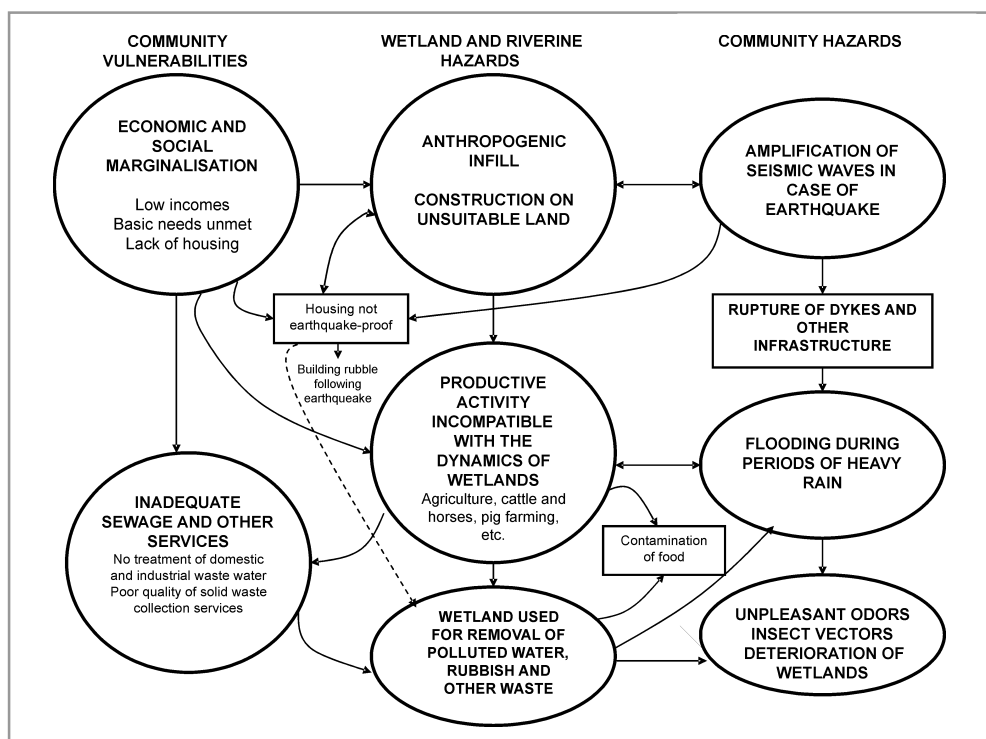
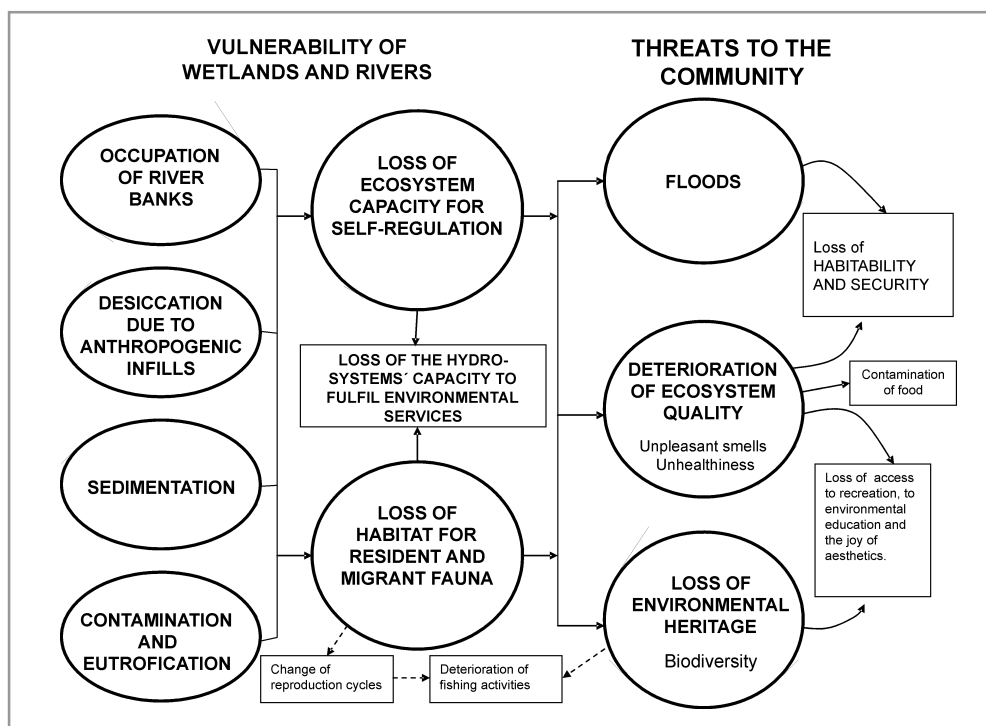
³⁷ By december 2006 there was no decision from the US Justice.

becoming hazards for human beings and, as a result, prevent them, if possible, from contributing to risk and disaster. Are we therefore impeding the biosphere’s self-regulatory mechanisms – or if you will, its immunological system – from fulfilling its proper function? Are we then favoring the plague?

I personally believe that the only acceptable ethical standard is that which has human happiness as its ultimate goal. Our challenge, therefore, is to work for the benefit of human happiness, for human security in the face of the Earth’s dynamics and in the face, too, of

our own dynamics. But we are also called upon to guarantee that our species does not become a menace to the ecosystems.

To achieve this means adopting an ethical standard that, amongst other things, obliges us to recognize Nature’s right to participate in the decisions which affect it. What we mistakenly call “natural disasters” are really the voice of Nature raised in irate and furious protest at our refusal to listen and take notice of what Nature was trying to tell us in a reasonable tone when we were making our human decisions³⁸.



³⁸ Gustavo Wilches-Chaux, “Ethical Bases of Risk Management”, UNDP Expert Group meeting on risk management and adaptation, Havana (Cuba), 17-19 June 2002. http://mona.uwi.edu/cardin/virtuallibrary/do_cs/1140/1140.pdf

Spider webs and territories

Earlier we spoke of the resistance of a spider's web as it withstands varied internal and external forces, and we compared this to a given territory's ability to withstand a threat or hazard. We also spoke of the spider's resilience as he spins his web again after it has been destroyed, comparing this to a territory's capacity to recover from the effects of a disaster. But none of the above is confined to the realm of mere literature. What we are talking about is a truly functional metaphor, a tool that we can actually use.

The author of these notes has used the example of the spider web for years in order to illustrate how different factors that determine the vulnerability (or sustainability) of a system are inter-connected (or on the contrary, isolated from one another). Similarly, different agents and institutional and social sectors converge in a given territory.

Some time ago, in a talk where I employed this example, a member of the audience drew my attention to the fact that even when the spider's web is destroyed, as long as the spider survives the possibility that he will rebuild his web exists.

This sparked off a series of reflections that contributed notably to our understanding of the relationships that exist between us, as living beings, and our territories, and also between those territories and the multiple fac-

tors or external (and sometimes remote) processes whose effects materialize or are expressed and experienced locally, and therefore also affect us.

Can we validly assert that the spider web is the spider's territory?

Maybe it is not *all* of its territory, since the spider moves in a wider world than its web. But, it is the way in which this little animal claims the territory as his own, both materially and symbolically. That territory is also made up of branches and walls, places where he weaves the threads of his web. And, there are climatic factors such as wind and rain, as well as the sun's rays which render his net visible, and the heat that dries his web after the rain has ceased to fall. There are the animals and people who happen to go by and maybe even walk into the web, not to mention the insects that are trapped there, or the spider's predators, and so forth. The spider web marks off the area in which (and from which) the spider exerts its influence over, or is affected by other things.

Nor is the spider web completely different from the spider who has woven it. Rather, it is a secretion of that very spider. Spider and spider web constitute one indissoluble unity, even when the web has not yet been spun, or when for some reason it has been destroyed. In this case, that unity is composed of different parts: namely, the spider and all its potential webs,

the latent ones, all those that the spider is capable of producing – in a word, all the spider webs that the spider could manage to spin in his lifetime.

Likewise a territory can be understood as a “secretion” (in quotes this time), either real or potential, material or symbolic, of the human beings who form part of it and live in it. This is why we said that territory is much more than a mere physical space or a geographical point of reference.

A territory involves an indissoluble unity with the communities’ dynamics and the ecosystems which make it up. The territory without these communities would be a different territory altogether. Taken apart from their territory, these communities also become something else. This represents the drama of displaced peoples: they lose their territorial security, their sense of identity, of belonging. They become anonymous.

The fibers and the fabric of a spider web may be very strong, but if the tree it hangs from is weak, or if the soil where the tree is planted is soggy and liable to erode, then vulnerabilities exist which threaten the spider and its web. In such a case, the spider has certainly not been the cause of the soil’s vulnerability, neither that of the trees.

This is not true of the “*matapalo*” and other parasitical plants³⁹, which grow and derive their strength from sucking on the host tree, making it vulnerable to insects, showers, wind, and suchlike. When the parasite becomes strong at the expense of the tree it is unwittingly threatening itself, as do those human communities that embark on so-called “development projects” that lead to the destruction of the ecosystems which those very same communities inhabit. Both of these – parasites and communities – are undermining the ability of their respective territories to offer the **territorial security** they require.



³⁹ One should not confuse these species of the *Lorantáceas* family (commonly known as “*golondrinas*”, “*guateparjaritos*”, “*matapalos*”, etc. that are truly parasites on their host plant) with orchids and bromelias, misnamed “parasites”. The latter are *epífitas* (from *epi* meaning over, and *fitos*, plant) which do in fact live on a tree, but do not have a parasitical relationship with the tree.

Territorial security: another spider web

We have spoken earlier about territorial security. We said that such security is the result of the interaction between a series of factors that enable a territory to offer **stability** to those who inhabit it, stability being understood here as permanence in space and time of the conditions that make life possible.

Simplifying complex systems and processes, let's say that the main factors – some of them natural, others anthropogenic – affecting a territory's ability to offer stability and security to its inhabitants are the following: alimentary and sovereignty security, ecological security, social security, economic security and institutional-juridical security.

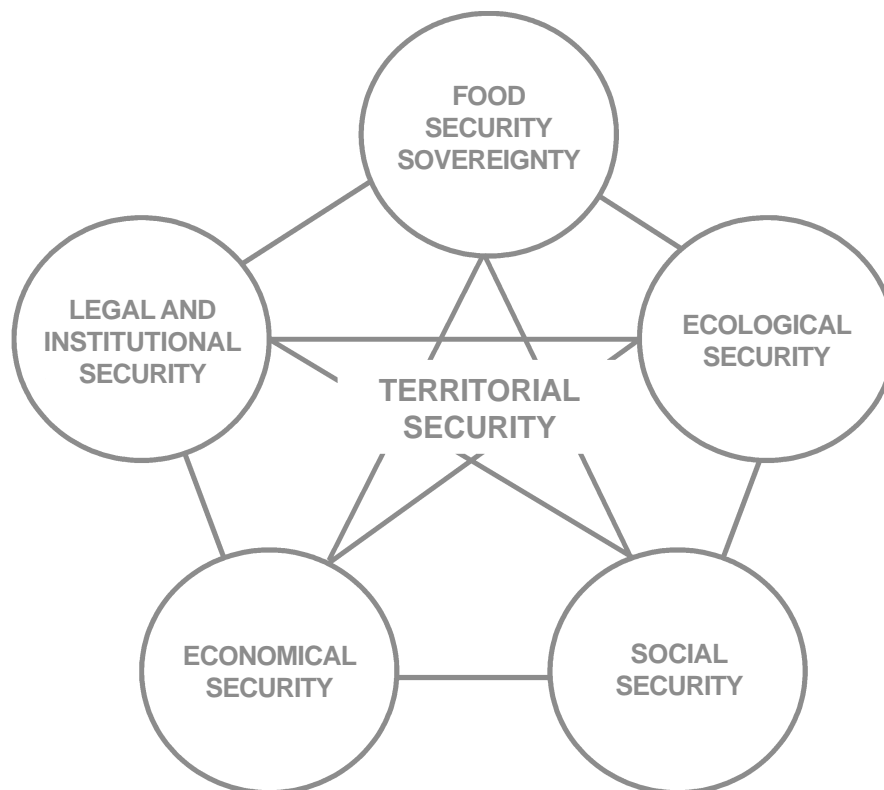
As we will see later, when we start to analyze vulnerability and sustainability as nets or spider webs, the most important elements are not "securities" seen independently or in isolation, but rather the fabric formed by the multiple and dynamic interactions between them. This is shown in the following diagram, in simplified form. These "partial securities" are no more than indicators, hooks we can hang our hammocks on, so to speak. Real territorial security is the spider web that these hammocks form when they are linked together. One of the hooks may be very strong – in fact they may *all* be strong – but if the cords that hold them together are weak, then the web it self will be weak.

Let's look at what each one of these "securities" refers to⁴⁰.

Food security is a territory's ability to guarantee its inhabitants the basic foodstuffs they require in order to guarantee their right to live a quality and dignified life. Theoretically speaking, food security in a particular region depends on its being linked to the global economy, so that at any moment the products necessary for the adequate nourishment of its population can be acquired from elsewhere. Therefore, a region can guarantee its food security if it manages to generate the economic resources needed to enable it to gain access to such markets. In such a case it would not matter if the region stopped producing food altogether in favor of urban industrial activity, or if it puts all its efforts into the production of a single crop. From this point of view, it doesn't matter either if the region's farmers stop producing food and turn to growing illegal crops, since the marketing of the latter will provide them with sufficient resources to import foodstuffs from other regions.

Our day-to-day experience demonstrates how, on the contrary, genuine food security should not depend on fluctuations in the global market. We see, too, in coca or poppy-growing areas for example, that money of itself does not ensure that people will be properly fed. Food is once again shown to be provided by essential and direct relationship between human communities and their productive environment (the land) rather than the result of a relationship with abstract financial markets. This explains the rise of urban agricultural schemes of various kinds. In Cuba, for example, by the production of urban "organoponic" crops, people have overcome some of the

⁴⁰ Gustavo Wilches-Chaux. *Cuy-dados Intensivos*. Published by ENDA Latin America (Bogotá, 2004).



ill effects caused by the economic embargo the country has been submitted to for decades. It also overcomes Cuba's erstwhile economic dependence on a single agricultural product, namely sugar cane. In other Latin American countries similar urban agricultural schemes are being introduced, although they are still relatively marginal.

Food security does not only refer to the amount of food needy persons can access, but also to its quality. It should not depend on chemical products or transgenics which, instead of making us more autonomous, render us more vulnerable, as well as affecting our ecological security. That is why the concept of "food security" is broadened to include "food sovereignty". In practice this deals with the right to consume culturally acceptable products, dishes cooked in a way that is part of our identity. That is why "*la cuisine*" (or home cooking) is part of any nation's cultural heritage. Food has to retain its cultural significance, apart from the calories or other nutrients it presumably supplies us with. If we are what we eat, then we should not be made to consume "things" which are foreign to us.

(This is very evident in a disaster situation when some of the so-called "humanitarian aid" which arrives consists of foodstuffs completely unfamiliar to the affected communities. The supposition behind this is that those who are suffering the effects of a disaster ought to be ready and willing to consume whatever is offered them. Remember, too, that when you are a long way from home, amongst the things you most miss is the food you are accustomed to, above all the special flavor of your mother's cooking).

Ecological security consists of the possibility that Nature's dynamics avoid generating hazards for communities, and that community dynamics do not threaten

ecosystems. It also refers to Nature's ability to sustainably offer the community those environmental goods and services required to live with quality and dignity. One of these services is the capacity to absorb, without trauma – or to cushion the effects of – extreme environmental changes resulting from global, regional or local processes. By this means, these changes do not exceed our capacity for adaptation. A concrete example of this is where the environmental services a territory offers allow the potentially destructive impacts of ENSO to be ameliorated or cushioned.

By **social security** we mean a territory's ability to offer its inhabitants opportunities for decent employment and dignified labor, the resources necessary to guarantee quality and dignity of life. The term also refers to the existence of those conditions necessary for a healthy existence, in accord with Antonio Gramsci's integral conception of this (cited previously). That is to say, the possibility of enjoying a balanced relationship with ourselves (both with our bodies and our minds), as well as with our environment and community. Social security embraces matters such as employment and access to institutionalized curative and preventive medical attention. But it goes much further than that. Within the notion of territorial social security we also include relations between the different members of a community. And that means solidarity, reciprocity, a sense of belonging and of identity.

By **cultural security** (which, acknowledging the relations between all the dimensions of security, could also be seen as a component of social security, in the same way as energy security⁴¹ can be seen to be part of ecological security) we refer to the ability of a territory's inhabitants to appropriate territory by means of symbols. This

⁴¹ Energy security is a territory's ability to offer its inhabitants -and their ability to make good use of- whatever conditions are necessary in order to obtain the energy required to ensure that society actually functions.

then allows them to discover the meaning of their existence in relationship to that territory (including aspects such as belonging, purpose and identity) and to live in, and enjoy it without having to renounce anything essential, least of all one's capacity to create—that is to say, one's cultural identity. When unfamiliar phenomena appear, or when those we are familiar with acquire incompatible dimensions and characteristics, our hitherto well-known territory becomes foreign to us, and may even, at times, appear to be a terrible and aggressive force with which we can no longer identify at all. The loss of ecological security thus becomes cultural vulnerability.

By **economic security** we mean the ability of a territory, State and society in general,⁴² to offer its inhabitants equitable access to production and wealth and to indispensable goods and services. This presupposes the existence of different options for producing wealth and generating resources. It also implies the existence of alternatives, such as the exchange of goods and different forms of economic solidarity in order to produce, offer and provide access to such goods and services as the community may require. Economic security also includes a region's productivity and competitiveness.

Vulnerability and poverty is not the same thing. They are not synonymous, although in many cases it is easily shown that poverty — one of inequality's most tangible expressions — is the cause of many kinds of vulnerability. Such vulnerability could be greatly reduced if all of the community's agents and sectors had greater access to opportunities and to the goods and services which are essential for genuine development to exist.

Let us not forget that poverty is not just a lack of sufficient economic income. More generally, it relates to the lack of those conditions that make it possible for people to exercise their right to a decent and dignified life. These conditions are, to some extent, the "synergical" result of the interaction between the sum of the factors that form our spider web. This is why we must be careful with programs designed to "combat poverty", especially when they are focused exclusively on the economic aspect, on generating income. They may be confronting communities with false alternatives, such as obliging people to choose between being employed and enjoying a clean environment, or between conserving their culture or bettering their economic situation.

Juridical-institutional security refers to a territory's ability to offer its inhabitants a State that acts as a public

service and to which everyone has equal access. This is not because we are all "equal" in real life, but because the State itself is charged with recognizing our differences and catering for the special requirements of the different sectors of society. The term also refers to the "rules of the game". These should be clear cut and not modified according to the whim of particular interests or circumstances which favor the dominant sectors of society. We could also understand this dimension of security as referring to an individual's (or a particular human group's) assurance that society does possess effective mechanisms which guarantee respect for human rights, starting with the right to a decent and dignified life (including economic, social and cultural rights). People also have a right to acquire skills in the management of risks, since these constitute a concrete tool for defending people's right to life in the face of certain hazards, whether of an anthropogenic or natural kind.

Looking at the "spider web" from this particular angle enables us to deal with the subject of risk management from a human rights perspective and to understand why researchers — such as the Peruvian, Pedro Ferradas — take vulnerability to be the expression of a given community's failure to exercise its rights.⁴³

When faced with what kind of hazard should territorial security be offered to the inhabitants?

The answer is: any kind of hazard, whether it is from phenomena associated with ENSO (which is what we are studying here) or from the impact of free trade agreements that affect local products. We should also include changes in land use and other measures taken with a view to reducing the impact of free trade, or taking advantage of it.

When we analyze phenomena such as ENSO and how they affect different countries, we find that there are territories that have been weakened in their ability to resist due to the fact that land use has been modified in accordance with a given, inadequate, concept of development, or with a view to satisfying the demands of foreign markets. Such development projects often disregard the primary ecological vocation of the soil and are sometimes carried out without considering the way the land acts as part of an ecosystem's self-regulatory mechanism.

⁴² It is worth noting that the State and the Government is not one and the same thing. The State is the political expression of an organized society, while Government is (or should be) the temporary administrator of the State's resources for the benefit of the whole community. The State is like a residential unit, with its inhabitants and its houses or apartments, its communal areas, its collective equipment — such as water tanks, electric cables, communal meeting place, recreational facilities, and so forth — while Government is equivalent to the administrator of the housing estate.

⁴³ Commenting on the draft of this document in a workshop we carried out in Piura (Peru) in April 2006, as guests of the non-governmental organization CEPRODA MINGA, Ferradas presented data showing that in 2001, 17 per cent of peasant families in Peru (that is, one out of every six families) suffered from "shock" as a result of natural disasters and this left them in conditions of extreme poverty, which they had been unable to recover from at the time the study was made.

Vulnerability / Sustainability: new spider webs... or the same ones viewed through a magnifying glass

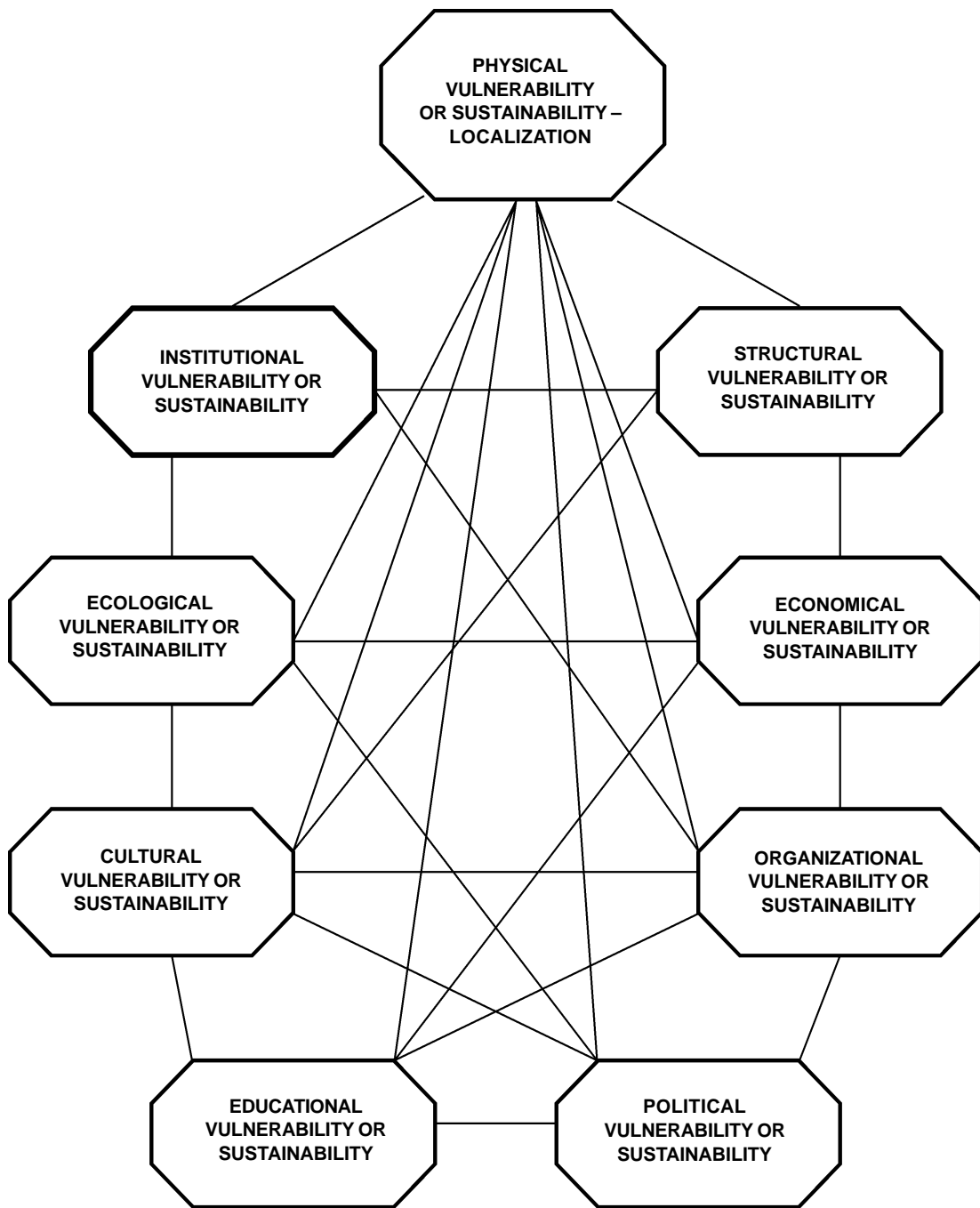
Nearly 20 years ago, in 1988, I wrote a text entitled "Global Vulnerability"⁴⁴ in which I showed how a territory's ability to resist a hazard does not depend only on the greater or lesser strength of physical structures or on their location near (or far removed) from the place where the hazard occurs. Weakness or strength depends also on a series of factors which may be of an economic, social (organizational), political, educational, ecological, ideological, cultural or institutional nature. At the time I believed that what determines or reduces a community's vulnerability when faced with a hazard was the greater or lesser strength of each of these factors.

Today we have a clearer idea of things. We now know that when we speak of territorial security, there is one factor which is as important, if not more important than those previously mentioned- the strength of the net as such and the fabric that forms the links or hammocks between its different parts. This also turns out to be valid when the mesh refers not to key factors, but to key actors. A society may have very strong social actors, but if the lines of communication between them are

weak or non-existent, then that society will be unable to resist the effects of a hazard when it materializes.

Once again, Katrina comprises a recent example we can learn a great deal from. In this case there was insufficient communication between key actors, like the scientists, who knew perfectly well (and had predicted) what was likely to happen if a hurricane of Katrina proportions were to strike, and other powerful key actors (such as the police, State and local authorities). Nor were the authorities in general ready to transform scientific knowledge into decisions that could have reoriented development plans. One can detect a similar lack of communication between other institutional and social actors in the Gulf states (and between those states and the nation as a whole), which meant that they were not only unable to prevent the Katrina catastrophe, but that they are also still struggling to solve enormous problems of recovery months after the event. The above situation, which is repeated over and over again in many disaster contexts, allows us to see disasters as communication failure between human actors, and between ecosystems and communities.

⁴⁴ This was first published in the book *Herramientas para la Crisis: Desastres, Ecologismo y Formación Profesional*, SENA, Colombia (1988)



THE "SPIDERWEB" OF VULNERABILITY / SUSTAINABILITY FACTORS

The complexity of a system's social fabric is not limited to the community's organizational aspects but also embraces the whole network of relationships and interaction between the different factors on which the system's vulnerability or sustainability depends. Sustainability depends on the resistance or resilience of the "spider web", that is to say, on its ability to withstand the effects of, or recover from an external impact. The impact could be an earthquake, an exceptionally heavy winter season, a generalized economic crisis or an armed conflict. More important than the individual characteristics of each of these factors are the relationships between them. The factors themselves are like nails hammered into the wall. The relationships are the hammocks or cords which we hang between those nails.

From Wilches-Chaux, Gustavo,
 "Un viaje por los caminos de la comunicación social y la gestión participativa del riesgo".
 CISP / DIPECHO (Manabí – Los Ríos, Ecuador; Bogotá, Colombia, 2005)

The choice of these vulnerability-sustainability factors is in fact arbitrary. We could have grouped them together in just six factors, or on the contrary, we might have itemized them in even more detail. The main thing is to have a clear idea of the complexity of both concepts and of the fact that both have their origin in a series of interactive and constantly changing dynamics.

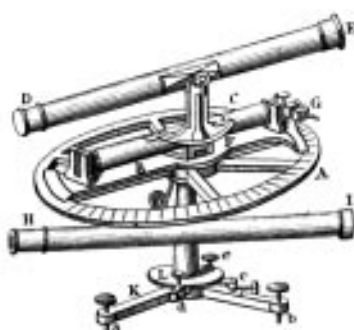
When faced with a complex system like this, seen both theoretically and in the context of taking decisions which will in some way affect the community's life (sometimes for generations to come – as in the case of deciding whether or not such-and-such a relocation should be recommended), we are faced with two possibilities.

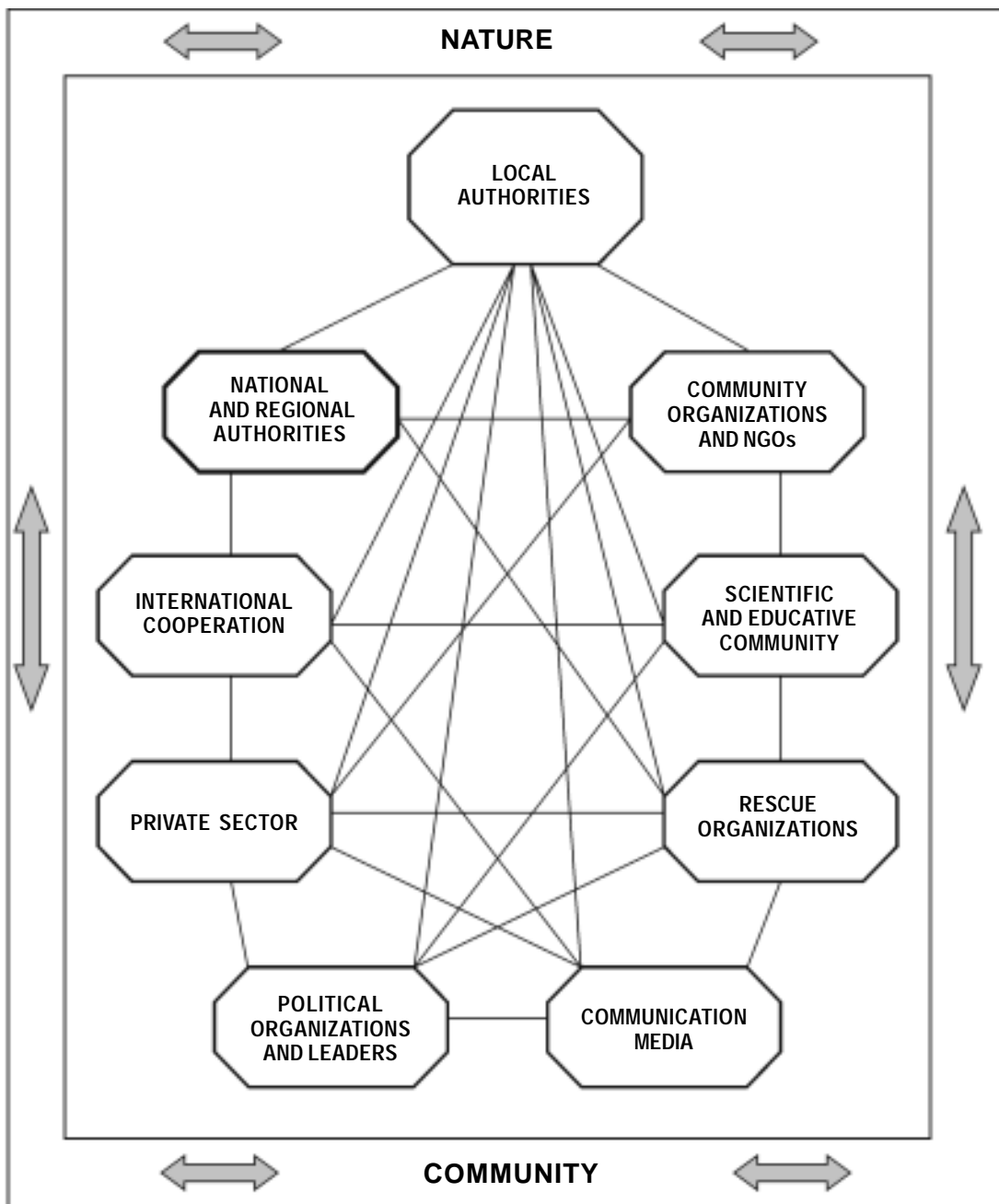
First, to do nothing. The situation's complexity scares us and renders us incapable of taking the required decision. We believe that there are too many variables to be taken into consideration, and we find it impossible to take responsibility for the enormous number of possible effects such a decision might have.

On the other hand, the situation empowers us. The "spider's web" shows us that it doesn't matter what our position is in the system nor from which "nails" (or "hooks") we may be hanging, any decision will possibly influence the whole web and all the hooks as well. If we are teachers and are hanging on an educational nail, we may be able to conceive some way of shaking the spider's web. The same applies if we are members of a municipal council, or if we are entrepreneurs, or researchers, or members of a community organization or an environmental NGO. The main thing is to be aware of the system's complexity and integrity and of its capacity for action when seen from our local position.

We must also be clear that, as with the Rubik Cube, progress with one of the factors does not necessarily mean progress with the whole scheme. On the contrary, progress with one of the cube's faces could mean that the other sides of the same cube are in disarray, even when we thought we had them well ordered. Thus, for example, to take a case from real life, promoting the use of gas stoves in an indigenous community may signify progress as far as the cube's ecological side is concerned, since it reduces the use of firewood and therefore eases pressure on local forests. But, it can also mean a step backwards as far as the culture is concerned, since culture is transmitted from one generation to another and this is done orally, in family reunions held around an open fire, and not around a gas oven. To promote a single crop in a community, taking advantage of high prices in the national or international markets, could mean economic progress, but signify a backward step in ecological, and eventually in cultural matters too, in so far as both depend on the conservation of bio-diversity.

From WILCHES-CHAUX, GUSTAVO,
"Un viaje por los caminos de la comunicación social y la gestión participativa del riesgo".
CISP / DIPECHO (Manabí – Los Ríos, Ecuador; Bogotá, Colombia, 2005)





In the case of those nails (or hooks) that figure in the previous spider web, we replaced the sustainability and vulnerability factors with a series – albeit incomplete – of actors and social sectors, all of them framed in a permanent and complex flux of interactions between Nature and the community.

In this case, the threads which hold the different actors and sectors together represent channels and languages for communication. As in the case of the previous spider web, strong threats ought to create a sustainable network, capable of resisting without suffering undue trauma.

Good communication between all the actors and social sectors, between them and Nature, and between them and the community in general, constitutes an essential ingredient of sustainability.

For different reasons one of these communication channels may weaken or break down. This can occur between actors and sectors, but also between them and Nature itself (with which – whether they realize it or not – they constantly maintain a series of interactions). When any one of these channels weakens or breaks down, conditions arise under which an internal or external change may turn into a hazard, or even a disaster.

These communication channels are not always of equal weight; the specific “weight” of each depends on the experience of a community at a particular moment in time.

Let us take an example. The role played by the international community in our local communities may be insignificant at certain times and definitive at others. This happens, for instance, when an external agent invests heavily in a particular territory, or when, following a disaster, a massive amount of international aid flows into the territory.

In both cases – as we know from direct experience – our communications spider web often breaks down. Under what are known as “normal” conditions, investments from abroad are usually the result of agreements between governments and private companies, but these do not always take into account the interests and concerns of other social actors. Even less are they concerned with ecosystems, which may well be affected in diverse ways by such investments.

The communications spider web tends to fail even more so in *post-disaster* situations. Here it may be asserted that donations are sometimes more geared to the needs of the donor than those of the recipient. A large amount of money is often spent by national authorities or international cooperation bodies on relocating communities affected by a flood, for example. But communities are sometimes moved to areas that are prone to landslides. In such a case, what has really happened? There has been a huge communications failure.

A second example: a region’s politicians and the private business sector may reach an agreement with the national government or with the international banking system to build a given item of infrastructure – a reservoir, for example – without sufficient regard for the impact such an enterprise may have on the communities it will displace or on the flora and fauna that will be drowned as a result. Sooner or later, society as a whole will pay for this. Somebody will have to “foot the bill”, so to speak – in other words, face the consequences of the serious ecological disruption, the ensuing social conflicts, or both. The saddest and most unjust aspect of all this is that those who caused the damage in the first place are often not those who will suffer its consequences. Future generations will inherit the debts of their forbearers.

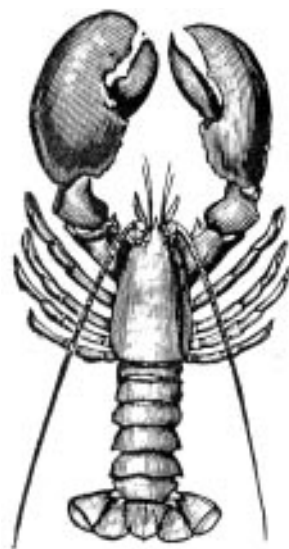
Those of us who work in the field of social communication ought to identify with those linemen who go about in trucks with long ladders attached to them, armed with pliers and screw drivers and protective gloves, and whose job it is to repair electric cables that have been damaged by high winds.

Or better still, we should see ourselves as linemen aware of our social responsibility when designing and installing new electric grids, or carrying out preventive maintenance without waiting til the storm has already occurred.

Communication is a complex, permanent, many-sided and reciprocal process involving the exchange of information between institutional and social actors (or sectors). This requires mutual confidence, the identification of shared concerns and the building of a common language. Only with this may we hope to awaken (and consolidate) people’s awareness of the community’s need to understand how to live in an harmonic and sustainable manner with the dynamics of their territory.⁴⁵

From Wilches-Chaux, Gustavo,
“Un viaje por los caminos de la comunicación social y la gestión participativa del riesgo”.
CISP / DIPECHO (Manabí – Los Ríos, Ecuador; Bogotá, Colombia, 2005)

⁴⁵ From “Estrategia de Información y Divulgación Pública para la Gestión de Riesgos”, consultancy commissioned with LA RED (Red de Estudios Sociales en la Prevención de Desastres en América Latina) and other specialized firms, in the Dominican Republic financed by IADB in 2000 and 2001. The full results of this consultancy can be found at: www.desenredando.org



Chapter 3

The manifestations and impact of ENSO in the study regions

A summary of the argument so far

In the first chapter of this book we took a close look at the different ways in which the Earth's layers are held together and interact, and we spoke of the enormous number of factors which, in one way or another, intervene to determine climate and weather in any given region. We learned, too, that climatic variability is not only an "external influence", but also an intrinsic characteristic of the biosphere. We said that ENSO, with its El Niño, La Niña and "neutral years" phases, is but one of many expressions of this climatic variability.

In the second chapter, we explored the dynamic meaning of the word "territory", which is the result of a dynamic interaction between Nature and culture, between ecosystems and communities. We understand that territory is more than merely a simple physical space or geographical reference point, because one of the dimensions through which human beings relate to one another is through affection, which has to do with what we call "symbolic appropriation". This means that the territory we inhabit constitutes our emotional map. Every detail bears the mark of our experiences with that territory, either directly or via the passed on and accumulated memory of our ancestors.

In the second chapter we also attempted to understand in what way a spider "dominates"

its territory, both materially and symbolically, through its web. We referred to the strengths and weakness of their threads and the strength and weakness of the branches from which the web hangs, and we did so in order to introduce such concepts as a territory's sustainability and vulnerability, including the resistance and resilience of the relations between ecosystems and communities. As long as the spiders live, we said, thousands of potential spider webs will continue to exist.

In the present chapter, we will examine how the phenomenon ENSO has expressed itself in the different regions studied during the IAI-LA RED research project.⁴⁶

In the light of what we have discussed in earlier chapters, we will endeavor to understand why (to continue the analogy) the "spider web" of certain territories proved unable to resist manifestations of the ENSO phenomenon without trauma, and why, as a result, disasters occurred. In other words, we ask why a territory (and the ecosystems and communities which make it up) has lost its ability to cohabit with this particular expression of the Planet's life-climate variability⁴⁷. We also need to understand why similar phenomena of lower intensity today cause disasters, whereas in the past they did not do so. Does this mean that the "spider web" has broken down or that the branches from which it hangs have become too weak?

⁴⁶ Interamerican Institute for Global Change Research and Red de Estudios Sociales sobre Desastres.

⁴⁷ In this field the gravity of the disasters is measured in accordance with the Magnitude Index (MI) which reflects negative effects on material goods, services and people and the duration of those effects. In this case magnitude refers to the effects of the disaster, as distinct from the seismological field, in which the magnitude (measured in degrees on the Richter scale) denotes the quantity of energy unleashed by the earthquake. See Herzer, Hilda et al, *Regiones y ciudades bajo el agua en Argentina. Una historia recurrente*. (Research document IAI/ENOS-LA RED (2005).

The temporal, spatial and semantic patterns of risk

A pattern is a group of elements which, when unfolded, manifests a high degree of repetition and regularity. Patterns constitute the basis for establishing relationships between causal factors and the forms adopted by the factors and conditions we are analyzing. Changes in patterns (whether normal or regular) and the appearance of anomalies within that regularity, indicate changes in the structure and operation of the causal factors, which are therefore the object of interpretation and analysis (Lavell, 2007, under preparation)⁴⁸.

The IAI-LA RED project established the existence of three types of pattern as a basis for analysis: temporal, territorial and semantic patterns.

The analysis of these patterns is based on information registered in the data base known as DESINVENTAR, developed by LA RED over the last 10 years. This data base allows an analysis of hazard incidence and their impacts on different territories and social groups. DESINVENTAR embraces both large and small disasters (that is to say, events associated with different levels of loss), and enables us to gauge the regularity and recurrence of the physical threats which spark off these disasters. However, given that DESINVENTAR does not record all the physical events that occur – since many are not associated with damage and loss or these have simply not been recorded by any source of accessible information – the

system cannot be used to fully analyze risk patterns, but rather patterns of risk associated with disasters or occasion of loss and damage that have actually occurred.

The **temporal pattern** refers to the regularity in time (daily, weekly, monthly, annually, every five years, once every second year, and so forth) with which the factor or factors under study actually occur. This comprehends one or another of the following analytically significant conditions:

- The periods of occurrence of ENSO episodes classified according to the phenomenon's intensity.
- The temporality of the ENSO phenomenon with reference to other manifestations of climatic variability.
- The temporality of various kinds of physical hazard with relation to the different intensities of ENSO.

The term **territorial pattern** refers to the regularity in the spatial or geographical expressions of the hazards, and to the variability and risks associated with the ENSO phenomenon and with climatic variability in general. That is to say, it refers to the places where hazards are manifested. In the IAI-LARED research project, territorial patterns constitute the basic pattern or framework around which other considera-

⁴⁹ Allan Lavell in "ENOS, Patrones de riesgo de desastre y su gestión: elementos conceptuales y bases de la investigación comparativa", en Allan Lavell, "Riesgo y Clima: Proceso, patrones y gestión en América" (IAI - La Red - Oxfam, 2007)

tions are introduced, such as the semantic and temporal patterns of hazards and considerations with regard to vulnerability.

And finally there are **semantic patterns**. This term refers to the permanence or repetition of the same kind of hazard (or group of hazards) during and between different phases of the ENSO phenomenon (floods, gales, landslides, droughts, storms, hurricanes, and so forth). This regularity can only be identified with reference to different territorial expressions of the variables, such as the relationship to certain cities, productive areas and specific social groups located in the territory. This may be done with reference to ENSO periods in general or where these have been classified according to their intensity.

With regard to the relations between ENSO and different hazard events and patterns analysis and decision making is complicated because in some countries and regions, hazards associated with ENSO are the same as those that form part of climatic variability in non ENSO years- droughts, floods, landslides, plagues or storm surges, for example. In other words, such things can happen whether there is an ENSO or not. This is the case with parts of Central America, Argentina and Mexico for example

On the other hand, in other regions ENSO may usher in hazards which only occur (or occur only in such a predominant fashion) when they are linked to certain phases of this phenomenon. This is the case for instance with heavy and extensive rainfalls in the arid areas of Peru, like Piura, or snowfall in low-lying terrain in that same country. These are exceptional cases, since they do not coincide with the better-known and normal expressions of climatic regularity in the areas affected.

In other areas or regions, such as Brazil's northeast, ENSO related hazards may be a more extreme version or expression of normal climatic phenomena, like drought and aridity.

These different contexts and relationships cause different problems and present special challenges.

When a phenomenon is repeated with similar expressions and intensity, and with periodical regularity, it is obvious that one must adapt. This is the case with communities that live in latitudes where heavy snowfall is part of everyday life during a certain period of each year, or of communities in the Amazon basin who not only live with flooding, but depend on the benefits that flooding brings with it.

Problems arise, however, when the intensity of the phenomena goes far beyond the community's capacity for adaptation, as has been happening recently with hurricanes in the Caribbean, or is happens with unusually long droughts or torrential rains, or when these occur outside the normal season for such phenomena.

And things become even more serious, of course, when these phenomena occur regularly, but with a recurrence that goes beyond a community's living memory and therefore, for all practical purposes, turn out to be exceptional. Or when they are definitely unheard-of phenomena, as was the case with the Catarina hurricane that struck Brazil's South Atlantic coastline in March 2004, where no hurricane had ever been recorded, or not at least since the nineteen sixties when the first artificial satellites were launched into orbit.

All of the above mentioned situations have concrete and practical effects and although it is true, on the one hand, that we now enjoy a greater capacity for predicting and monitoring the ENSO phenomenon at a global level, our ability to anticipate its potential expressions at the local level is still very precarious-it is at this level however that decisions have to be made by the majority of people.

In Chapter 1, we analyzed the enormous number of factors that determine the climate and the weather in any particular place. This means that a phenomenon which may be global, regional or (if you like) "national", may make itself felt in a differentiated manner at the municipal level.

As we are unable to anticipate what kind of damage threatening events are really likely to cause, it is hard for us to create local risk scenarios. In other words, envisage with foresight, what might occur in future phases of ENSO.

Added to this is the fact that a given territory's ability to resist or to exhibit resilience (ecosystems plus communities) is also ever-changing. That is to say, the "spider web" may have become stronger, but more probably it will have become weaker, more vulnerable,, and as a result of this a phenomenon which was fairly innocuous, may in the future turn out to be extremely damaging.

Let's see what Lavell has to say on this subject:

"Neither society nor the environment are static. Consequently, the degree of risk also varies. For example: between 1983 and 1997, the two most intense ENSO years in the 20th century, the environment in affected areas,

regions or countries underwent important changes. Deforestation, soil erosion, the destruction of mangrove swamps, changes in land use, the conversion of former agricultural and rural areas into urban settlements, and so forth, gave rise to enormous transformations, processes of environmental degradation and a general weakening of the ecosystems and their capacity for resistance and resilience. In both of these ENSO periods, the heavy rainfall or prolonged droughts associated with them were similar and unleashed almost equal amounts of energy. However, due to the above-mentioned transformations, the second phenomenon, which occurred in 1997, fifteen years after the first, caused greater accumulated destruction and damage. If we examine these events merely from the viewpoint of the physical hazard (that is, excluding the risk perspective as such, which requires that we take into account the levels and kinds of exposure and vulnerability that exist in the affected areas), we may postulate that a good part of this difference was due to the impact of prolonged processes of degradation which, in the end, led to the appearance of new socio natural hazards, such as landslides, flooding, soil erosion, droughts, and so forth. Because of this, the hazards associated with ENSO not only caused greater harm to areas which had already been "touched", but also to areas which had not been affected by earlier events of this nature...

Time is a continuum and the present is constructed on and is a continuation of the past. A threat directly linked to an ENSO period (flooding, drought or landslides) or to climatic variability in non-ENSO years, has its own past and future. That is to say, it does not exist independently of its environmental and social context. The environmental context includes the potential for humans to transform natural physical events into hazards and finally into damage and loss. The social context refers to aspects and characteristics that facilitate human vulnerability and, consequently, an increase in the risk associated with physical natural or socio-natural events. Both of these contexts are dynamic, continuous and often linked.

Risks and hazards associated with ENSO are not an isolated function nor are they static. Two ENSO occurrences may generate physical magnitudes or intensities which are of an almost equal magnitude, and yet their impact in each case may be quite different. This difference can only be understood if we take into account the economic, social, historical, environmental and political context of the zones and inhabitants affected.

The task of analyzing risk patterns associated with ENSO offers a serious challenge. Here, we will take examples from a particular risk and disaster scenario to illustrate our arguments.

In 1998, in Central America, the impact of rainfall associated with Hurricane Mitch was more severe in terms of erosion, landslides and flooding than would have been the case if droughts and forest fires had not occurred previously, between 1997 and 1998. Both of these types of event were also associated with El Niño, a factor which had generated vulnerabilities that then became hazards.

A second factor that contributed to an increase in the hazard level was the fact that Mitch occurred towards the end of a normal rainy season, when the soil was already heavily saturated. In the case of El Salvador, many zones affected by Mitch were later affected by the impact of earthquakes in January and February 2001 and later an intense drought between 2001 and 2002, which also affected other countries in the region. Finally, several areas affected by these successive events were also severely shaken by a fall in coffee prices at the start of the present century. Clearly the risk occasioned by (or associated with) these events one by one cannot be understood without taking into account the impact of the others on subsistence levels and on the vulnerability and fragility of the population in the affected areas.

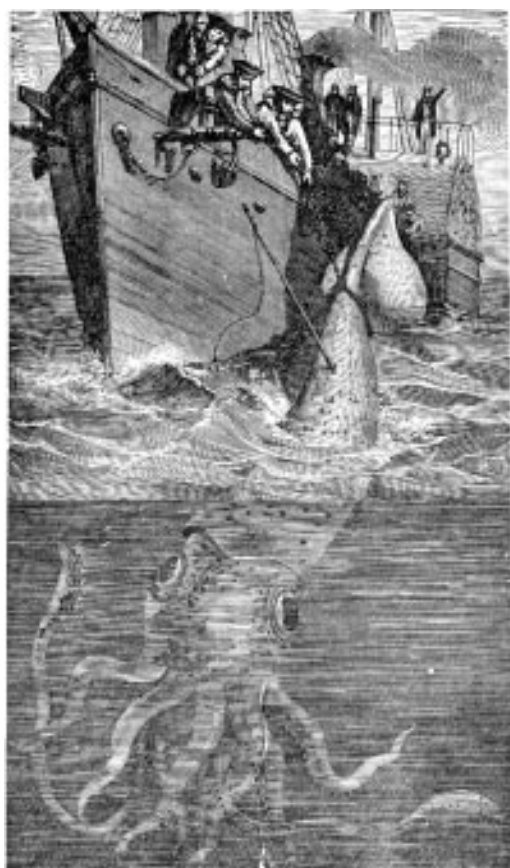
To sum up, the risk associated with a particular ENSO occurrence should not be examined on its own, that is, without taking into account the context of societies and environments in a constant state of evolution and transformation.

This supports one of the arguments adduced during the IAI-LA RED project, namely that ENSO cannot be properly analyzed if divorced from the risk which it has helped to construct. We should look upon ENSO as a dimension of climatic variability, or global climate change, operating in a context of social and economic transformations that affect the levels of vulnerability or resilience of a society, and therefore also affect the degree of risk.

With the advent of neo-liberal globalization – which is the most recent phase of a capitalism characterized by extreme social exclusion – these ideas will be of even greater importance in the future, since they refer to changes in risk patterns, and to the vulnerability and risks associated with ENSO, and also to climatic variability and change".

Chapter 4

Risk management and territorial sustainability



Territory and risk: two offspring from the same marriage

Several pages back we were talking about the ingredients that make up a territory, and we said that a territory is the result of an indissoluble marriage between the dynamics of ecosystems and the dynamics of human communities. In other words, between nature and culture.

This same marriage gives birth to risk, which is the product of the convergence of certain hazards with factors that cause the communities – and at times the ecosystems – to be vulnerable.

In other words, the concepts of hazard and territory, although far from being synonymous, do constitute human, socially constructed concepts.

When we talk of a hazard we mean that such-and-such a phenomenon is likely to occur. And we are referring to a phenomenon which is either natural, socio-natural or anthropogenic in origin⁴⁹ and which represents a danger to the community or to the ecosystems exposed to its effects. If such a phenomenon or event represents a danger it is because the communities and ecosystems are vulnerable to its impact. That is to say, the “spider web” is unable to withstand the impact of the football or of recovering its former shape after the goal has been scored (here we must apologize for mixing our metaphors!)

From this viewpoint, vulnerability is the opposite of resistance and resilience and of sustainability too. A community or ecosystem becomes vulnerable when its resistance and resilience is lost or weakened in the face of given hazards.

When nature’s dynamics (or some of nature’s manifestations) become a threat for the community, and when the dynamics of the community threatens the ecosystems, the relationship between them becomes unsustainable. This lack of sustainability is manifest in the existence of multiple hazards and vulnerabilities, and consequently in the appearance of risks that may easily turn into disasters.

When two people find that their relationship is no longer sustainable, their marriage normally breaks up. But in the case of ecosystems and communities, the “marriage” between them is almost always indissoluble. That is, both form part of a partnership called “the territory”, and in practice separation is impossible, except in certain very unusual cases when the community is relocated or completely abandons its original territory. In such cases a new marriage is contracted which may establish a new unsustainable relationship.

Sometimes one of the parties is convinced that marriage means staying together “until death do us part”. He or she therefore attempts to deny

⁴⁹ **Natural hazards** are those that arise out of Nature’s own dynamics, such as the eruption of a volcano, an earthquake or a tsunami. Or, El Niño and La Niña, when they occur in “normal” conditions. **Socio-natural hazards** are those that occur because of human intervention in the natural environment. Many of these are similar to events occurring in nature. For example, landslides or sinking ground levels are socio-natural when they are the result of inadequate management of river basins and hillsides. Hurricanes and other phenomena associated with ENSO become socio-natural in so far as Global Warming (which is also partially influenced by human factors) alters its characteristics. And **anthropogenic hazards** are those caused totally by human activity, such as contamination or industrial accidents (see Lavell, 1996 (“Degradación Ambiental, Riesgo y Desastre” en Fernandez, M.A. Ciudades en Riesgo. LA RED-OFDA-AID, Quito) for a first discussion of these different types of hazard and their significance for risk management).

or eliminate the other, and even give the other party a Christian burial. However the relationship is likely to continue-with the dead party's ghost!!

As we commented earlier, Bogotá is a city of almost eight million inhabitants built mainly on flat ground which formerly consisted of wetlands, most of which have now been buried under tons of bricks and cement. However, the wetlands have not disappeared and their presence can be seen in the way some buildings, constructed on what was once a lake, now tend to sink. The effect of the wetlands can be seen, too, in the way water behaves when there is a heavy downpour or in the reaction of the soil in the event of earthquakes.

Through (or beneath) the city of La Paz, in Bolivia, almost 220 rivers and streams run, seventy per cent of which have been "imprisoned" in tubes, channels or "vaults". Many of the city's inhabitants are quite unaware that these rivers exist, just as most people in Bogotá are unconscious of the wetlands and rivers that have been buried beneath them. From time to time, when the soil water levels become un-

sually high, the rivers and streams of La Paz rise to the surface to remind people that they are still there, alive and kicking, as happened dramatically in 2002.

For most of the 20th century, the inhabitants of the North American Gulf of Mexico states tried to divorce themselves from the wetlands and mangrove swamps that constituted essential elements of that territory, now mostly covered with cities. In fact, what the people did was not so much divorce themselves from these factors, but rather they tried to eliminate them. They dried them out, they destroyed the vegetation, displaced the natural elements of the land. Thus the territory lost its ability to live harmoniously with tropical storms and hurricanes, which are expressions of nature's dynamics in that part of the Earth. As a result, these phenomena became a hazard. During the 2005 hurricane season it became extremely evident that relations between communities and the coastal ecosystems had broken down. They had become unsustainable, just as they were indissoluble. Even temporary separation – that is the emergency evacuation of the most vulnerable communities – became almost impossible in most cases.

The scenario where risks materialize

In accordance with the process dynamics of hazards, we may classify them, as we have seen previously, as being natural, socio-natural or anthropogenic. Or, depending on where they occur, we call them global, regional or local.

In the field of hydro-meteorological phenomena, the present over-heating of Planet Earth is a typical global phenomenon, the cause of which can not be found in a single dynamic, but rather in the interaction between natural and human processes. Nor does it originate in just one part of the Earth, although clearly, certain regions contribute more than others to this warming process. Planet Earth is not heating up as rapidly in one place as in another, nor in the same way, nor are the effects of this process of change the same in all ecosystems and territories.

Likewise, although the planet as a whole – or rather, the biosphere – tends to get warmer, this does not mean to say that certain regions cease to experience intense winter spells, such as that which caused the death of over three hundred people in Russia and Central Europe in 2006. NASA's Goddard Institute for Space Studies asserted that 2005 was the hottest year during the last hundred, according to existing registers of information. Nevertheless, a few days after that year had come to an end the east coast of the United States suffered the heaviest snow storms in all of its history.

Other phenomena originate in certain regions of the earth and their effects may be limited to those same regions or, on the contrary, they may affect other parts of the planet. Such is the case with ENSO and this is why a slight change of the average climate in the Pacific Ocean gives rise to various alterations in the planet's climate as a whole, some of which are experienced as extreme hydro-meteorological phenomena. Therefore, the said alterations constitute local manifestations of a regional phenomenon.

And a third group of phenomena, such as those directly linked to deforestation and changes in land use in a given locality have local causes and produce local effects. The effects of a "normal" winter season – or of a not-so-normal one – in a river basin which has been deprived of its vegetation can be perceived immediately, and the relationship between cause and effect is completely lineal.

In fact, phenomena of global origin are closely related to those of regional or local origin. Thus, for example, there is evidence to show that the planet's Global Warming is having an effect, amongst other things, on the characteristics of two phenomena of a regional kind; namely, hurricanes and El Niño.

There is evidence too, as we learned in Chapter 3, that certain manifestations of global and regional phenomena depend on the particular traits of the local economic, social and envi-

ronmental scenarios where they materialize. That explains why a relatively “mild” El Niño may cause greater damage than a “severe” one if its impacts are felt in a territory where the prevailing ecosystem and society have been degraded or deteriorated.

And, for example, an accumulation of local phenomena, such as the destruction of large areas of tropical jungle, atmospheric contamination and the pollution of seawater, added to the “worldwide urbanization process” and the consequent multiplication of “urban heat islands”⁵⁰, could lead to a “qualitative leap” or an emerging behavioral pattern like Global Warming, which is qualitatively more complex than the sum of local processes.

An interesting example of how a local scenario can produce planetary effects was the eruption

of the volcano Pinatubo, where sulfuric gas emissions traveled around the Earth for several weeks, with measurable effects on global climate. Another example, in a different field, was the 11 September attack on the World Trade Center’s Twin Towers.

Whatever may be the causes and the geographical origins of the processes that generate hazards, there is no doubt that such hazards generally materialize or manifest themselves at the local level. This helps us understand why risk management must be an essentially local affair. That does not exclude, of course, the possibility of efforts at the regional or even world level in order for example, to reduce emissions of “hothouse gas” through mechanisms such as the Kyoto Protocol, and thus eventually “freezing” Global Warming.

⁵⁰ Urban Heat Islands (UHI) is a concept that refers to warming in large cities as a result of changes in land use, the accumulation of activities (and of human beings) in relatively concentrated spaces, and phenomena derived from these conditions, such as a territory’s growing inability to reflect solar energy. Scientists are divided about just how much these “urban heat islands” contribute to Global Warming. A majority seem to agree that their contribution is “insignificant”, and some even allege that the evident heating up of the cities has been erroneously interpreted as evidence of the planet’s Global Warming.



GRR...

Getting Radical with Risk

Ever since life first appeared on Planet Earth about four thousand million years ago, all living beings – and we humans (and human communities) were potentially included right from the start, albeit in an embryonic form as bacteria or proto-bacteria – have been co-evolving along with our surroundings. In response to the need to survive when faced with environmental change, human beings have transformed themselves, as have all other living creatures in like manner. As we change, we alter the environment also, and we do so in a two-way process which is both complex and unremitting.

In the course of time, this process has led to the extinction of a great many beings. Millions of species were forced out of the game when they proved unable to adapt to environmental changes. As each one became extinct, the surviving species transmitted to their descendants certain genetic traits and learning processes which enabled them to remain on Planet Earth, and to transform it.

Some species became extinct due to external intervention, as when an asteroid struck the Earth's surface some 65 million years ago. Others were eliminated by certain "disasters" caused by those very living beings which had survived. Such was the case of gaseous oxygen, which appeared about 2000 to 2,700 million years ago. In this case, as in many others, the "spider web" of interactions that made po-

ssible the existence of certain species was destroyed for ever. Others, however, survived to spin new "webs" for themselves.

When the first recognizable predecessors of human beings appeared, some two or three million years ago, and before we began to establish ourselves as the "dominant" species (around 100,000 years ago) and to invent Culture, all living species had as main allies in the evolutionary process, both a great deal of time and a wide range of genetic options for trial and error. Millions of years were at our disposal, time enough for whole species to disappear and for others to adapt and evolve. However, ever since we human beings began to be aware of ourselves, and to be conscious of the Cosmos, we realized that we could not afford the luxury of leaving our survival to mere chance, neither as a species nor as individuals. That is when we began to discover and to invent a series of tools useful for creative adaptation; that is to say, for conscious evolution. The overall name for this phenomenon is Culture.

At many stages in human history, Culture has helped us to adapt. At other times, it has impeded our adaptation.

From this viewpoint, risk management can be understood as a cultural tool with which we consciously respond to the challenge of evolution – or better still, co-evolution – in order to remain on the face of the Earth.

How do we do this? Through institutional and social intervention (both of which are cultural phenomena) exerted on factors that generate hazards and vulnerability, in order to reduce, as far as possible, the product of this vulnerability. In other words, to limit the risk factors and prevent a hazard from becoming a disaster. We also want to ensure that when, despite our best preventive measures, a disaster does occur, we will be able to rebuild our “spider web” adequately and in the shortest possible time.

If we broaden our way of focusing on threats and vulnerability that arise in a given territory, and if we make both concepts as dynamic as possible, we can briefly state that the purpose of risk management is the following:

- to prevent human activities from threatening ecosystems, and to prevent the dynamics of the ecosystems from threatening communities.
- to contribute to the ecosystem’s and the community’s resistance and resilience, in other words, sustainability and territorial security.

From this point of view, risk management can be understood as synonymous with environmental management for sustainable development, which implicitly includes the need to engage in social, political, economic as well as cultural and institutional management, given that the concept “environment” goes beyond merely ecological contexts and embraces all those factors which interact in a given territory. Furthermore, to the degree to which an inversely proportional co-relationship clearly exists between a lack of environmental sustainability (that is, risk) and governability, risk management will often mean development and the maximum application of the ability to handle conflict situations.

The term “risk management” is usually accompanied by a series of adjectives, such as integral, local, participative or prospective. In the present text, if we have omitted these adjectives, it has not with the intention of excluding them. Rather we believe that genuine risk management ought to include all of them – and others as well – just as humanity will one day understand that all development must be integrally “sustainable” if it is to be truly regarded as development at all.

Perhaps one of the adjectives not explicitly referred to should be the word “radical” – GETTING RADICAL WITH RISKS – along with several of the uses of that much-feared term as defined in the dictionary:

- Of or pertaining to a root

- Fundamental, part of a root
- In favor of extreme reforms, especially in a democratic sense
- Extreme, uncompromising, intransigent

Risk management is a continuous process embracing everything from the handling of risk-generating factors with a view to preventing disasters, down to the reconstruction of communities and the recovery of ecosystems affected by disasters. The term also includes preparation for facing eventual emergencies and the institutional and social responses required to meet them when they occur.

Each and every one of these responsibilities corresponds to different social actors. Depending on the process’s characteristics and the moment at which it occurs, these actors ought to take on leadership roles in a kind of “roster”. Some will play a supporting or secondary role, but all of them will be necessary and complementary. Only thus will it be possible to have a decisive effect on the roots of the problem, on the real causes that have led to the particular hazard. Otherwise, even though we may talk about “risk management” and use the term “disaster prevention”, all we are doing in fact is white-washing the situation.

For the past two decades, many institutional and social actors have adopted risk-management language and refer to sustainable development. For many, this is in accordance with their way of thinking and of acting, which in turn reflects a new understanding of what causes disasters and hazards. In general this means that a lot of people understand the biosphere in a new way and also better perceive the role we humans play within this. For others, however, the use of such language is merely a matter of cosmetics. Such actors cannot see the wood for the trees, and worse still, they urinate at the foot of certain trees to mark “their territory” and thus place an obstacle in the way of other actors who may wish to get in on the act.

Another implicit adjective, therefore, when we talk about risk management, is the word “democratic”, not only in the formal meaning of the word, but also in its all-inclusive sense. For “democratic” means many things; it is horizontal, allied to life, committed to building autonomies, able to appreciate diversity, respectful of differences, open to dialogue between those who know and those who don’t – dialogue in which each group or actor is aware of his or her limitations and potentialities. When risk management is genuine, there is no room for authoritarianism, no matter who exerts authority. On that point we can be intransigent, as we are, too, in making sure that the humanistic sense of words like “democracy”, “security” and “freedom” be fully restored.

Prevention: saying “no” to hazards

In common usage, the word “prevention” means “stopping something from happening, making its occurrence impossible”⁵¹. However, in the strict sense and within the particular terminology of risk management, prevention is often understood as a jointly employed series of measures taken (or actions carried out) to avoid a physical phenomenon actually materializing as a hazard. And as we have seen, a hazard refers to something that is likely to occur and which represents a threat to those communities and ecosystems that are exposed to its effects. In other words, prevention means saying “no” to a hazard⁵².

In the language of risk management (as opposed to disaster management), however, the concept must be broadened. Consequently, risk prevention is defined as a combination of “measures and activities planned with anticipation to prevent new risks or to avoid their occurrence. This means working with reference to probable hazards and vulnerabilities. Thus seen, risk prevention deals with Prospective Risk Management, whereas the mitigation or reduction of risks is a matter for Corrective Management. Given that total prevention is rarely possible, prevention has a semi-utopian connotation and must be seen in the light of considerations about what degree of risk is acceptable, a concept which will be socially determined at its different levels”⁵³.

When hazards derive from phenomena that form part of the planet’s natural dynamics, it is

impossible to prevent them from occurring. There does not exist – not yet, at least – any way of avoiding a volcanic eruptions, or earthquakes and tsunamis. Certain procedures for aborting hurricanes while they are gestating are not only of doubtful efficacy, but even, in some cases, due to the altering of the hydrological cycles in the hurricane’s area of influence may lead to greater losses than those associated with the direct damage caused by the storms themselves. To put it in a general way, we can assert that climate – fortunately – is still beyond our control. Just imagine what it would be like if we human beings could manipulate climate and turn it into a weapon of war, or make it into something of great commercial value.

El Niño and, in general, those strictly natural phenomena related to ENSO and to climate variability – which can, in turn, also be influenced by climate change – are unavoidable. We can’t “cool down” the Pacific Ocean in order to suppress El Niño, any more than we can cool the Caribbean to deprive it of the “fuel” it needs to produce tropical storms. Nor can we warm the waters of the Pacific in order to take some of the sting out of La Niña.

This does not of course mean that it is useless (or senseless) to take measures to reduce the emission of the gases that produce a greenhouse effect on the atmosphere. With regards to this, even in the most optimistic scenario, several generations will have gone by before

⁵¹ Oxford Dictionary

⁵² When one speaks, either personally or institutionally, of developing a “prevention culture” – or more appropriately, of introducing the notion of prevention into a culture – one is referring to the broad intention of converting risk management into a “normal” mode of behavior, something that includes a community’s “way of being”. That includes the hope that communities will become aware of the consequences that their actions have on their natural and social surroundings.

⁵³ Allan Lavell, *ENOS, Patrones de Riesgo de Desastre y su Gestión: Elementos Conceptuales y Bases de la Investigación Comparativa*, in Allan Lavell, “Riesgo y clima: proceso, patrones y gestión en América” (IAI - La Red - Oxfam, 2007).

the effects of this reduction become apparent. And secondly, such a reduction will have its effect precisely on the human component of climate change, and not on the natural evolutionary process of the planet.

The same is not true of socio-natural hazards, the result of inadequate use relations between humans and their natural environment. Nor is it true of anthropogenic hazards, since these are totally attributable to the activity of human beings. In both these cases one can act on the factors which have generated hazards with a view to avoiding them, or at least of reducing their frequency or their destructive force.

In some cases, such as urban contamination or industrial accidents, human "authorship" is easy to discern.

The same cannot be said of hazards such as flooding, landslides or forest fires, which may be natural or socio-natural. Each event has to be analyzed separately in order to determine its true nature.

A landslide, for example, may be a totally natural occurrence, as was the case with the majority of some three thousand landslides recorded in the Colombian region of Tierradentro following the 6th June, 1994 earthquake. This quake occurred right in the middle of an intense rainy season when the steep mountainsides were totally saturated and not even those covered with natural vegetation were able to resist its effects. The ensuing landslides blocked the area's rivers and streams and caused an avalanche of mud and debris which in some places attained a height of seventy meters. In Pakistan, similar landslides were sparked off in an area affected by the October 2005 earthquake.

Other landslides, like that which occurred in Villatina (a *barrio* in Medellín, Colombia) in 1987, and that which affected Santa Tecla (in El Salvador) after the earthquake on the 13th of

January 2001, must be catalogued as socio-natural phenomena. Although the latter was unleashed by an earthquake, it was also due, in part, to an inadequate handling of water resources in the higher reaches of the hillsides, which collapsed. Such inadequate handling of water resources also helps explain the Villatina case.

In other landslides, there is an even more direct cause-effect relationship between human intervention and the phenomenon. Such is the case, for example, when a landslide occurs due to cuttings made in mountain slopes during the construction of roadways.

In all of the aforementioned cases it would have been possible to avoid the hazard, or at least to have reduced the magnitude of its effect.

In the vast majority of the local impact cases studied in the IAI-LA RED project it seems clear that these are related to socio-natural as opposed to natural hazards, despite the fact that they occur during the different phases of the ENSO phenomenon, which is still predominantly a natural event.

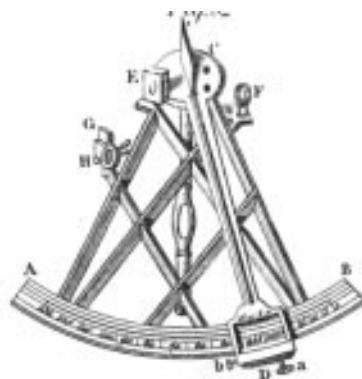
In conclusion, let us not forget that hazards are not single, isolated events, but rather complex processes where a natural happening, such as a hurricane or an earthquake, normally unleashes a series of chain reactions, which in turn may be natural (like the landslides in Tierradentro, or a tsunami after an earthquake or a tidal wave associated with a hurricane) or socio-natural (as was the landslide at Santa Tecla or the floods in New Orleans due to the collapse of the dykes) or anthropogenic (like fires caused by gas leaks during a storm, or the sacking of shops and other such disturbances in public order after a hazard has materialized). Although it is evidently impossible to avoid an earthquake or a hurricane or a tsunami, it is possible to take measures ahead of time and thus prevent a disastrous chain reaction (reduce exposure or vulnerability or both).

Mitigation: strengthening the “spider web” in order to say “no” to vulnerability⁵⁴

In accordance with the terminology we have employed in this treatise,, mitigation consists of strengthening the “spider web” that is created by the interaction between the various actors and factors that converge in a given territory, with a view to increasing the territory’s ability to withstand the effects of a hazard (resistance) and/or to recover from the effects of the hazard once these have materialized (resilience). Since many of these hazard factors are ecological, mitigation includes the strengthening of ecological resistance and resilience, while recognizing that natural factors are inseparable from cultural and anthropological ones.

As we will see later, the results of the IAI-LA RED project abound in examples of how “spider webs” have been strengthened, either by reinforcing the “nails” or “branches” which serve as their support, or by strengthening the “hammocks” themselves, the interaction between actors and factors.

The summary provided in the second part of this book of some of the major conclusions of the IAI-LA RED study intends to demonstrate how, in many cases, the spiders web has been strengthened, either by strengthening the nails or branches or the hammocks or interaction between these.



⁵⁴ In the terminology of climate change, the word “mitigation” has a slightly different meaning: one thing is to reduce the emission of gases that produce a hothouse effect in the atmosphere and another is to reduce its sources. The concept of “adaptation” is nearer to that of “mitigation” as we understand it in these pages. It can be defined as: “A natural adjustment either by human systems in response to present or expected climatic change or its effects, which reduces the damage or makes use of the occasion for its own benefit. There are various kinds of adaptation: they can be either anticipated or reactive, private or public, or either autonomous or planned.” (*Glosario de Términos en Cambio Climático – Cambio Climático en México*).

PART TWO

CASE STUDIES

Summaries

ENSO manifestations in Argentina⁵⁵

Among the more outstanding results obtained, one can underline the relationship that exists between, on the one hand, the Argentina's Northwest and the Paraná river basin and, on the other, ENSO occurrence and the number of recorded disasters.

Some outstanding associated events are: the floods on the Paraná (linked to El Niño), droughts in the northeast and the Pampa (linked to La Niña) and landslides in the northwest (linked to both phases).

Amongst the social-vulnerability factors that contribute to the increase of disasters in urban areas one can mention the following:

- Uncontrolled and unregulated urban expansion without control.
- Lack of maintenance of urban infrastructure.
- Increases in risk construction in the city.

Risk management itself faces various problems:

- Decisions are arbitrary, haphazard and disjointed, and influenced by politicking.
- The local urban focus is not complemented by a river basin-oriented focus.
- Response as opposed to prevention dominate the action scenario

Methodological commentaries:

- The local scale helps to clarify patterns.
- ENSO is not a parameter to articulate overall risk management due to the influence of other existing risk dynamics.

The database on disasters occurring in Argentina between January 1970 and December 2001 contains 13,974 registers or reports. The majority of these disasters were triggered by floods and storms. Over 55% of reports refer to this type of phenomena. They are the most recurrent and cause the greatest negative impact, in social and economical terms.⁵⁶ The Argentine disaster inventory shows that during those 32 years, floods and storms led to 1,7 million evacuees – 93% of the total number associated with all disasters– and destroyed 28.000 homes – 60% of the total.

Next on the list are fires – some 1300 events, 9.16% of the total. These were concentrated in urban areas, fundamentally in the city of Buenos Aires and adjacent urban areas (77%). In fourth place was snowfall –with 710 reports, 5.1% of the total. These occurred mostly in the Patagonian region (87%). With less than 4% of total reports, but very relevant due to their impact, were forest fires, droughts and gales.

77.5% of reports correspond to disasters of hydro meteorological origin (10.797). When comparing the sum of the **Magnitude Indexes (IM)**⁵⁷ of these, it becomes clear that those of hydro-meteorological origin are not just predominant in frequency but also in their impact on society, since they make up 82% of the sum of all IM's.

Among the disasters of hydro meteorological origin, floods account for 53% of registers and more than 60% of the sum of the "magnitude indices". Next, are storms (14%), snowstorms (6%), drought (4%) and forest fires (3.9%). Even though there are fewer registers of droughts than of forest fires, the impact of the former was greater.

WHAT IS THE INCIDENCE OF ENSO EVENTS ON DISASTER RISK IN ARGENTINA?

Multiple climatic factors act as triggers of disasters, among them the ENSO phenomenon – in its Niño or Niña phases.

The most probable effects of each phase, in accordance with the historical evidence available in the country, are the following.

For hot events - El Niño:

- Increase in river flows and levels in Mesopotamia⁵⁸ (Northeast of Argentina –NEA) and excess of rain in an extensive strip of the north east of the country, towards the end of spring and summer.
- Rains, equal to (or greater than) the climatic mean in the Humid Pampa. Nevertheless, the region shows internal heterogeneity in drought and humidity, which vary territorially and temporally.

⁵⁵ Based on "Regions and Cities under water in Argentina: a recurrent story", by Hilda Herzer, María Graciela Caputo and Alejandra Celis in Lavell, A, "Risk and Climate: Process, Patterns and Management in the Americas (IAI-LA RED- OXFAM, 2007)

⁵⁶ SOCIAL EFFECTS: Deaths, wounded or ill, evacuees, affected population, destroyed or affected dwellings, effects on education and health. ECONOMIC EFFECTS: transportation, public services (energy, communications, potable water, sewage), industry, agriculture and livestock . (Classification by Economic Commission for Latin America-ECLA)

⁵⁷ The Magnitude Index-MI-measures the negative effects of disasters on material goods, public services and people, as well as their duration. It provides a measure of the impact of a disaster in comparative perspective.

⁵⁸ River flows are greater than average flows due to upper basin rainfall occurring in neighbouring countries.

- Temperatures superior to the mean values, in the Northwest of the country (NWA), from May to April.
- Excessive rain, in the center-west region of the country, from June to November and temperatures superior to the average values, from May to April, in the same region.
- Droughts in the Northwest of the country (NWA), especially in the province of Salta.

For cold events- La Niña:

- Precipitation inferior to the habitual (droughts) and temperatures inferior to the average values in the provinces of La Pampa, (Buenos Aires, Santa Fe, Entre Ríos, La Pampa and Córdoba), particularly between October and December.

The phases of the ENSO cycle were taken from the NOAA chronology since it presents clear criteria to establish the events⁵⁹ and because it is the only chronology that shows indices for every trimester for the 32 year period under consideration⁶⁰.

Analysis of Weather

The years with the greatest number of records of hydro-meteorological origin are, in descending order: 1981, 1973, 1984, 2000, 1972, 1986, 1998, 2001 and 1987. **Thus, no correlation can be established between a determined phase of the ENSO cycle and a larger number of disasters of hydro-meteorological origin registered on a national scale.**

In order to analyze the levels of manifest risk associated with ENSO in Argentina, the records of disasters were grouped together according to whether they occurred during a Niño, a Niña or a neutral period. It is in this last period that we find the highest concentration of records, followed by the Niña phase, and finally by El Niño. However, when comparing the number of records with the total duration of the phases, the number of disasters caused by weather conditions was greater during the Niño phase than other phases. That is, hydrometeorological disasters were of greater recurrence during the Niños, intermediate during the neutral periods and lower during the Niñas.

Analyzing the eight climate and hydrology related triggering events one by one the following results were obtained:

Floods

Of the total number of the disasters associated with floods in the country (5.529), the incidence is similar for the neutral and Niño phases, and lower for the Niña. However, during the Niño

phases, the monthly average of floods was 30% higher than in the neutral phases and more than twice that for the Niña events.

In other words, during Niño events, at a national level, there is a greater probability of floods than during neutral and Niña phases. In the latter, the probability is the lowest of all phases. It is important to mention here that due to the high recurrence of floods, the risk associated with them is considerable in all phases.

Storms

Storms (2,199 recorded), defined here as heavy rainfall and, winds, follow a different pattern to that of flooding. During the past 32 years, there are more records of storms corresponding to neutral periods than to El Niño or La Niña. However, the average number of storms per month was approximately the same in all phases of the ENSO cycle. That is, no relationship was found between this cycle and the storms.

Droughts and forest fires

Droughts (435 records) and forest fires (509 records) present a similar pattern between. This is partly explained by the environmental conditions which exist during droughts, which obviously favor forest fires. Both events occur with a noticeably greater frequency during Niña periods, to an intermediate degree in neutral ones and to a lesser degree in Niño periods. Besides this, the average records per month underline this pattern, since the average frequency of drought was almost four times greater during the Niña phases than during the Niño ones, and almost three times greater than in neutral periods. In the case of forest fires, the frequency was, on average, 2.2 times greater during Niña phases than during Niño ones, and 1.7 times greater during the neutral periods. In this case, during the Niña periods the risk of drought and forest fires clearly increased by comparison with other eras.

Gales

In the past 32 years, out of 431 cases of gales recorded in the country the greater number occurred during the warm phases and cold phases as compared to neutral periods. If we take into account the number of gales compared to the duration of the ENSO phases, we can see that the recurrence of these disasters was greater during the Niño times, intermediate during the Niña periods and less during the neutral stages.

Snowstorms

Most of the 710 snowstorms recorded on a national scale coincide with neutral periods (approximately twice that for warm or cold phases). However, if we divide the number of

⁵⁹ The chronology of NOAA is based on the ONI (Oceanic Niño Index) index. When this index is equal or lower than 0.5 (or equal or less than -0.5) for at least five consecutive months, it is considered that it is a hot (or cold) phase.

⁶⁰ Niño phases (month/year): 1/70 - 5/72 to 3/73 (*Strong Niño*) - 9/76 to 2/77 - 9/77 to 1/78 (*mild*) - 5/82 to 6/83 (*Extraordinary or Mega Niño*) - 8/86 to 2/88 (*Strong Niño*) - 5/91 to 6/92 (*Strong Niño*) - 3/93 to 7/93 - 4/94 A 3/95 - 5/97 to 4/98 (*Extraordinary or Mega Niño*) - 5/2002 to 3/2003 - Niña Phases: 7/70 to 1/72 (*Strong*) - 5/73 to 5/76 (*Very strong Niña*) - 9/83 to 1/84 - 10/84 to 6/85 - 5/88 to 5/89 (*Very strong Niña*) - 9/95 to 3/96 - 7/98 to 6/00 - 10/00 to 2/01 - Neutral Phases: 2/70 to 6/70 - 2/72 to 4/72 - 4/73 - 6/76 to 8/76 - 3/77 to 8/77 - 2/78 to 4/82 - 7/83 to 8/83 - 2/84 to 9/84 - 7/85 to 7/86 - 3/88 to 4/88 - 6/89 to 12/90 - 7/92 to 2/93 - 8/93 to 3/94 - 4/95 to 8/95 - 4/96 to 4/97 - 5/98 to 6/98 - 3/2001 to 4/2002.

snowstorms recorded by the number of months each period lasted, this pattern becomes less obvious. That is to say, during neutral periods the number of snowstorms per month was approximately only 20%⁶¹ greater than during the Niño and Niña periods. As a result, this pattern shows no clear relationship between snowstorms and the ENSO cycle.

Landslides

More than half of the alluviums on record are concentrated in the neutral years, some 30% during the El Niño phase and 17% during La Niña. On examining records for the duration of the different phases, one observes that the number of alluviums per month was almost the same during the Niño and neutral phases, and twice those that occurred during La Niña phases. That is to say, it would seem that during the cold phases there is greater probability of alluviums occurring than in other phases. This is clearly explained by the relationship between alluviums and soil saturation due to intense and prolonged rain associated with the Niño and neutral phases.

Hailstorms

40% of hailstorms occurred during neutral phases, while the rest occurred, in almost equal amounts, during the El Niño phase (31%) and the La Niña phase (29%). However, during the El Niño events the average number of hailstorms per month was 20% greater than during neutral and La Niña periods. That is, during El Niño events there seems to be a slightly greater probability that hailstorms will occur than during the Niña or neutral periods.

To sum up: In this analysis one sees evidence of a greater recurrence of flooding during the El Niño phases and of droughts and forest fires during the La Niña phases.

SOCIAL CONSTRUCTION OF FLOOD RISKS: THE CASE OF PERGAMINO

The municipality of Pergamino is located to the north east of the province of Buenos Aires, in the lower basin of the river Paraná and forms part of the country's main agricultural region. It occupies an area of 299,178 hectares (95% of which is farm land) and has a population of 99,112 inhabitants,⁶² of whom approximately 83% are concentrated in the main urban center, the city of Pergamino.

The city of Pergamino is located in a relatively low-lying zone, characterized by inadequate water. This is manifest in the canals built in the rural areas which increase the flow of water to the urban areas or in the manner in which

pathways and bridges have been built, forming obstacles to the natural flow of water.

The city is predominantly a rural service centre, but also presents an incipient reactivation of industrial activity. During recent decades, population growth has not been as important as the expansion of the built area and overall territorial expansion. This has occurred on farming land and thus brought about changes in hydrological dynamics. The increase in the built and paved area led to a reduction in water infiltration, favoring the accumulation of water in low lying areas and a dominance of the horizontal movement of water as opposed to the infiltration, in the more elevated areas.

The Pergamino stream traverses the city, from east to west, and the Chu-Chú stream does likewise, from north to south. The city has grown on the wetlands, occupying water logge areas. Besides this, the canals and lakes in the urban area were the object of continual subdivision, leveling, in-filling and opening up of roads and streets. Consequently, water retention areas were lost and this has permitted a slower flowing water towards the low-lying areas. On the other hand, the sewage system is highly deficient⁶³ and channels flow into the Pergamino stream through a series of lochs which are closed when the stream rises above the level of the lochs themselves. In these cases, water filters off into different parts of the city where it accumulates causing serious problems in the lower areas close to the stream's banks.

Thus, situations have arisen that increased vulnerabilities and risks and the city's fragility when faced with excess water levels.

Floods, rainfall and their relation to ENSO

Throughout the 20th century, the city has been affected by two types of flooding: first, that caused by the breaking of river levees after heavy rainfall; and second, that caused by rainfall alone. The first are more serious and are referred to locally as "extraordinary", being associated with precipitation above and beyond what is considered "normal". However, it is not easy to define what is meant by "normal" in a region characterized by a great variability in annual rainfall.

Between 1912 and 2002, 113 floods of different magnitudes occurred (Figure 14). On 48 occasions the Pergamino stream overflowed its banks, as did the Chu-Chú, and in at least 35 cases the two rivers rose to such levels that the population had to be evacuated.⁶⁴ Three cases were particularly serious, causing grave harm

⁶¹ Only months with snow fall were taken into account. Summer months were omitted.

⁶² INDEC. Censo Nacional de Población y viviendas, 2001.

⁶³ According to a 2004, National Water Institute-INA diagnosis, the pluvial drainage system is lacking in some sectors; in others it has insufficient installed capacity or sectors are not interconnected due to differences in altitude. At present the system is underdimensioned and able to deal with flows that are below those generated in the river basin.

⁶⁴ According to the Pergamino Desinventar data base, put together using information published by "La Opinión" and other local sources, major floods occurred in 1933, 1936, 1938, 1939, 1940, 1940, 1944, 1963, 1966, 1975, 1978, 1982, 1984, 1986, 1988, 1991, 1992, 1995, 2000 and 2001.

to the city: namely in October 1939, February 1984 and (the most serious of all) in April 1995.

INCREASE IN THE IMPACT OF FLOODS

Between 1930 and 1994, on at least 52 occasions rainfall rose above 55 mm per day without causing floods. In fact, on many occasions, this level of precipitation was considered beneficial for farmers. There were cases of copious rainfall in the Spring of 1945 (112.4 mm per day) and in the Summer of 1948 (115.9 mm or 242.3 mm per day) when streams did not break their banks. By contrast, floods broke the streams' banks in 1896 (55 mm per day, 228 evacuees) and 1992 (53mm per day, 166 evacuees, over a large area).

These data show that there is no lineal relationship between the amount of rainfall and the impact of flooding. In other words, this corroborates the fact that floods are not the inevitable effect of rainfall. Other factors come to bear on this relationship. This constitutes one of the fundamental arguments against those who say that hazard is the main, perhaps the *only* thing that comes to bear in the disaster equation.

However, it would appear that concentrating on floods as such gives undue weight to the inability to predict the intensity and duration of precipitation in preventing them. According to this view of things, "extraordinary" rainfall will lead inevitably to "extraordinary" damage, and when faced with such "extraordinary" circumstances there is nothing to be done but sit and wait for things to blow over. None of this is true, and if we take heed of these arguments we will fall into a fundamental error as regards the promotion and content of risk management.

Floods in Pergamino can be classified in accordance with their impact⁶⁵ as slight (46) moderate (21), serious (32) and very serious (those of 1995, 1939 and 1984). By relating these categories to the intensity of rainfall which sparked off disaster, it can be seen that, when faced with similar levels of rainfall, the impact has increased in the course of the 20th century. In general terms, as times goes by the effect of 50 or 60 millimeters has become more and more damaging. There is a tendency for the city to become increasingly vulnerable when faced with similar rainfall levels.

Therefore, we must seek other factors and processes which may help explain flooding and we should analyze how these have led to a worsening of the city's risk conditions. Many of these factors, such as the city's physical ex-

pansion, the lack of respect for topography, deficiencies in the sewage and changes in land use in rural areas are mentioned over and over again by members of the local community and in the media. But they are referred to in general terms, taken as a background to understanding what is happening. Arguments on this subject have not been further elaborated. They are treated as general concerns and nobody, no social actor, is identified as being clearly responsible for the increases in flooding.

Risk and vulnerability from the perspective of local society

An historical analysis of flooding in the city of Pergamino shows that this recurrent and associated with a process of progressive vulnerability and increasing environmental degradation. Despite this, and at the same time reinforcing the process, flooding risk is incorrectly managed in Pergamino. This is a recurrent fact and policies have not been flexible in the face of flooding.

The social understanding of the phenomenon demonstrates the persistence of a combination of ambivalent values on the part of local actors. This is due, in part, to the fact that the collective imagination regarding floods would seem to have been structured over a long period of time around a combination of recurring ideas that may be summed up in the following terms:

- An ambiguous characterization of the phenomenon, which oscillates between two poles – the "ordinary" and the "extraordinary". In general, discourse on the subject oscillates between these two forms of assessment. Society may even superimpose one on the other without being really aware of the contradiction implied by highlighting one or the other in terms of the management of risk situations and the possibility of generating stable policies for mitigating their effects.
- The explanation given in terms of external and natural causes, where the scale exceeds the possibility of any local intervention.
- Engineering works seen as an exclusive means of preventing and solving the problem. Such means are in fact at times part of the problem.
- Persisting difficulties amongst different local actors in identifying and accepting the role they play in the problem: their level of responsibility in the process of environmental degradation as well as their capacities and possibilities as regards the search for

⁶⁵ The following definitions are used: Weak: flooding of streams or due to intensive rainfall, without overflow from streams; Moderate: flooding of sectors of the city without need for evacuation; Serious: flooding with evacuation; Very Serious: severe flooding with evacuation including serious effects on people and prolonged spatial and temporal impacts.

solutions. In general, in Pergamino there is a weak predominant perception of collective responsibility in the process of progressive vulnerability, degradation and risk. The actors involved tend to comment on responsibilities and deficiencies of others, but rarely reflect on their own role, actions and responsibilities. Similarly, there is little recognition (or none at all) of local capacities, both one's own and those of others. This is translated into a lack of hypotheses as regards the types of collective action that might contribute to a search for solutions and thus risk mitigation.

A poor historical memory of former flooding processes constitutes an important element in vulnerability. The different experiences lived with emergency situations due to flooding are taken to be unconnected one to the other. They exist in a latent state, activated in critical circumstances by large-scale flooding, causing damage and loss. They also lead to difficulties in foreseeing the consequences.

If one accepts the idea of the systematic recurrence of flooding and the social actors demand a solution, municipal investment in structural and non structural measures ought to be permanent. In the case of an extraordinary, unique and singular experience, expenditure can be justified when the event is conceived as extraordinary, carried out once only and which supposedly would not have to be repeated, at least not within a time lapse of some 100 to 500 years, depending on the cycle which can be reasonably foretold.

Fragmented memory of flooding and the social practices linked with it are translated into a lack of socially agreed upon notions of risk, and also to a lack of hypotheses as regards the type of collective action which would enable the community to minimize and prevent future situations of this kind. This leads to deficiencies or severe limitations on the part of local government officials when it comes to organizing risk management in the case of flooding. An hypothesis or a clear notion with regard to ENSO, climatic variability in general and climatic change, flooding and their relevance to management is even less present.

FOCUSING ON RISK MANAGEMENT IN THE CASE OF PERGAMINO

In the case of Pergamino,⁶⁶ by means of a workshop carried out in June 2003,⁶⁷ a process was undertaken in order to attempt to reconstitute in society its own history in relation to flooding and identify the different factors that have

contributed to a sustained increase in vulnerability when faced with disasters and to reflect on risk in a collective way, especially on non structural measures designed to diminish the effects of flooding.

It is interesting to note how people solved the underlying communication problems after disasters had occurred and how many strategies point towards establishing or reestablishing communication channels which either did not exist or had been lost.

The workshop underlined the need for finding ways to promote the building up of a common language between the State, the different institutions and organizations and the local population. Likewise, the need to break down the important levels of fragmentation that exist and to integrate academic and scientific-technological institutions in a program that makes technical knowledge and capabilities available both to society and to local and provincial governments.

In risk management there are both structural and non structural instruments. The former are carried out with a view to protecting a territory through the use of engineering and structural works, which require intensive capital investment. However, structural works that can completely reduce hazard and risk do not exist. The fact that it is impossible to completely eliminate risk is corroborated by a study carried out and presented by the National Water Institute (INA).⁶⁸ If we bear in mind that the magnitude of the hazards is variable, that society's vulnerabilities are changing and dynamic, and that the works carried out ought to meet with certain requirements (a level of concrete execution, maintenance, functioning, etc.), very often, in the short term, these works become obsolete and no longer serve as protection. Moreover, new risks must be considered, risks that these very works may generate.

This forcefully underlines the need to count on a series of non structural measures that help to reduce risk. This does not imply laying aside or neglecting structural measures all together. But, it should be kept in mind that structural works do not constitute a definitive solution but rather an eventual one for particular combinations of hazards and vulnerabilities in a given territory.

Non structural components include those actions and instruments that are mobilized in the territory with the aim of reducing risk and hazards, but which are "intensive in intelligence". That is to say, they involve little financial capital and permit us to intelligently employ the resources that exist in a given territory.

⁶⁶ Based on "Regions and Cities under water in Argentina: a recurrent story", by Hilda Herzer, María Graciela Caputo and Alejandra Celis in Lavell, A., "Risk and Climate: Process, Patterns and Management in the Americas (IAI-LA RED- OXFAM, 2007)

⁶⁷ People from different sectors of Pergamino society joined the workshop, including local government, organizations representing people affected by the floods, the National Institute for Agricultural and Livestock Technology-INTA-, Water Authorities, researchers, community organizations, social workers, NGOs, communications media, etc.

The lack of a collective social memory as regards past flooding incidents constitutes an important aspect of social vulnerability. Previous cases of flooding are not linked one to the other in the mind of the population as part of an ongoing process, and new cases of serious flooding and loss take the population by surprise, without actually serving to prepare them for future occurrences.

If people were conscious of the permanent recurrence of such events, municipal investment should also be permanent in structural and non structural measures. But, if the phenomenon is considered to be "extraordinary", unique and singular, a once off investment is seen to be necessary, supposing that this does not need to be repeated in 100 or 500 years depending on the calculated period of return of such events.

⁶⁸ Study of flood control infrastructure in the Pergamino creek watershed - Rainfall drainage in the city of Pergamino.

The following are some of the non structural measures proposed by participants at the workshop:

Those linked to regulating land use

- To identify vulnerable areas within the city and provide maps that detail flood risk.
- To regulate land use in areas liable to flooding and in those not liable to flooding.
- To up date, control and respect the urban planning code in such a way that it takes into account the city's vulnerable areas.
- To implement regulations and active policies for managing rural areas that have an incidence on the city. For example, systematize information on rural land use, control erosion, regulate and control canal building in rural areas.

To improve the management process

- Cooperation amongst organizations in order to determine which are the areas of greatest risk.
- To modernize information systems in the municipality.

Maintenance and control

- Guarantee that the norms are respected and complied with.
- Control the way residential garbage is disposed of, for example, demand that this be left by the side of public highways where it can be collected and disposed of.
- Maintain the city's sewage network.
- Improve a hazard monitoring system and develop local and regional forecasts.
- Develop early warning systems and emergency plans. The system should involve several countries and place a good deal of emphasis on the transferring of information and communication. We must develop systematic communication methods between one sector and another.

Preparation for – and attending to – an emergency

- Implement a coordinated system of Civil Defense that integrates community organizations, neighborhood committees and NGOs.
- Identify new risks derived from the emergency.

- Monitor water quality, intensifying the samples at each flood site.
- Monitor health during and after the emergency.

Amongst the principle lessons to be derived from the case of Pergamino, we should note the following:

- the incorporation of a risk management policy as a basis for local urban development can only be achieved if we accept and appropriate the fact that, flooding is recurrent and that risks are collective and constructed due to a process of progressive vulnerability.
- If we persist in insisting that increased flooding is due to extraordinary factors that are external to local social dynamics then we will only increase local vulnerability vis-a-vis the phenomenon of flooding.
- Processes of territorial occupation and the production of urban space – in other words, urban expansion-, patterns of land use, the lack of regimentation for building and the severe lack of an adequate infrastructure and of basic services, combined with human poverty, are all factors which put greater pressure on the environment, exposing a growing proportion of the city's population to the risk of flooding.

(...)

Disaster management in Pergamino is characterized by a lack of continuity, the concentration and centralization of activity by the provincial government, the lack of autonomy for municipal institutions and the low levels of participation in the process on the part of the people and community organizations.

The above comment on the case of Pergamino is a more or less accurate description of the way things are as regards risk management in many other Latin American societies, not to mention other parts of the world. Consequently, the following comments are valid, we believe, for situations that go far beyond the cases analyzed here.

Adequate risk management ought to be conceived as a continuous and dynamic process, closely linked to development processes that are designed to reduce or control vulnerability. The said process should not be promoted exclusively by the State or simply by a scientific and technological system. Fundamentally it ought to be based on solid mechanisms for social participation; it is a process that should

arise in a fortified public space that enables the State and civil society to find a common ground through their various organizations.

Risk management embraces all of society's actors, even though forms of participation, effective capacity for action and levels of responsibility differ according to whether we are talking about public, private or community organizations of different kinds. Likewise, the State ought to adopt a risk "hypothesis". Society has to accept responsibility too, and should be ready, when necessary, to modify its behavior and even its most deep-rooted habits. Also it should exert control and contribute knowledge based on real experience, offering proposals on how to solve the territory's problems.

In this sense, prevention should be directly linked to *neighbourhoods*, and these ought to take on the role of control agencies through local commissions. This is active citizen action. Local development cannot be achieved unless one knows and understands one's territory, and that means not just through technical knowledge, but also real knowledge, which comes from the experience of our neighbors. We must establish mechanisms which will enable individuals to teach others what he or she has

learnt, and such mechanisms must be instrumented throughout the territory in a coordinated fashion.

Programs, plans and projects must count on society's participation. When such programs are felt to belong to the people (and indeed, *do* belong to them), they will be respected and, most importantly, an attempt will be made to carry them out. Numerous existing civil defense projects which have not received much attention, and have therefore not been put into effect, would seem to confirm what we have just said.

On the other hand, it is necessary to have an holistic and integral vision of things, to identify problems and implement policies on a micro scale within the territory, enabling us to attend to particular situations and the specific characteristics of the different groups at risk.

On a regional scale, we propose a management logic which would involve different municipalities within the river basin and would be complemented by activities on a local level. Thus, we could strengthen flood risk management at the local and regional levels, assuring that the process is sustainable

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Manifestations of ENSO in Colombia⁶⁹

Hazard types identified relate to a deficit in precipitation, water rationing and an increase in the number of forest fires.

One can detect a particular relationship between banking procedures and the occurrence of blackouts in 1971, 1976, 1979, 1981 and 1991, which leads one to believe that a link exists between socioeconomic and political management and the control of energy.

La Niña: An increase of up to 80% above the average number of disasters are reported due to hydro meteorological events.

Spatial pattern: One observes the existence of a regional multi-level reaction on the part of GIR in the case of La Niña. At the same time there has been a special focus on the upper Cauca river region, where an autonomous corporation foments activity in favor of management.

The lack of regulation as regards works carried out for structural protection, such as the invasion of dykes by nearby villages. WHAT?

Methodologically, differences can be seen between scaled activities at the territorial level, as in the case of implementing information systems and systems of early warning, as well as observatories to detect forest fires.

To establish a relationship between the ENSO phenomenon (hot and cold occurrences) and the impact in the Colombian context during the past three decades, the present analysis is based on the DesInventar disaster inventory and on studies carried out by the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM). As for the El Niño and La Niña phases and their temporal delimitation, we employ the classification proposed by NOAA (2006), based on the Oceanic Index for El Niño.

The studies carried out by IDEAM on the typical impacts in Colombia during ENSO's hot (El Niño) and cold (La Niña) phases may be synthesized in the following manner (IDEAM, 1997a, 1997b, 1998, 2002):

Impacts of El Niño in the Pacific Ocean

- An increase of between 2 and 3 degrees Celsius in the surface temperature of a large part of the Colombian Pacific Ocean coastal sectors.
- During El Niño, Pacific Ocean sea levels increased on average by 20 to 40 centimeters in Tumaco and Buenaventura.
- Changes in marine conditions, which lead to the emigration and immigration of different species and, in some cases, to the wide-scale death of colonies in the coral reefs.

Impacts of El Niño on the continental land mass

- In most parts of the national territory, an increase in air temperature during daylight hours of between 1 and 2 degrees Celsius is experienced. In the Pacific region these values reach two degrees Celsius, or more.
- A tendency to a significant falling off of air temperatures around dawn, especially on the plateaus (*altiplanos*) of Nariño, Cundinamarca and Boyacá (over 2,500 meters above sea level) and on the heaths (*páramos*) high Andean areas of Antioquia and the two departments of Santander.
- A deficit in the volume of precipitation in the Andean, Caribbean and Orinoco river basin regions, while rainfall tends to be heavier in the southern area of the Pacific region, as well as on the eastern ranges of the Andes and in certain parts of the Amazon region.
- An increase in ultraviolet radiation reaching the Earth's surface.
- Increases or decreases in water availability and supply in the country's different hydrographic regions. In some areas, the quantity and the effects of this may be reduced by over 30%. This mainly affects the availability of drinking water, hydroelectric generators, irrigation and navigation systems, among others.

⁶⁹ Summary of *Fenómenos ENOS en Colombia: Una visión nacional y regional de los impactos asociados*, by Andrés Velásquez and Nayibe Jiménez. Observatorio Sismológico del Sur Occidente (OSSO) Universidad del Valle, Cali, Colombia. This article was written with the help of Rosales, C., Aguilar, V., Ramírez F., Quintero C., Buatista M., Yander, M. A., Caicedo, J.H. y Mendoza, J. Members of the research team of the Project ENOS-IAI-LA RED and the development of DesInventar at OSSO.

- As a consequence of changes in rainfall, soils experience a decrease in their normal humidity levels, and this generates a deficit in the content of binding elements (such as clay, for example) and in the vegetation which serves as coverage. This leaves soils more prone to the propagation of fires and more susceptible to landslides and avalanches whenever there is a rainy season.
- Alterations in the terrestrial ecosystems are experienced in terms of changes in the migratory mechanisms of some species and the risk of extinction for some of these; a thawing of the surface layers of snow covered mountain peaks; a falling off of river levels and flows; the risk of fire being sparked off in the vegetation bio-mass which has already been compromised due to low humidity levels and high temperatures; the risk of rain induced flooding in southern parts of the country and/or high tides and sea levels.

Impacts of La Niña on the Pacific Ocean

- The increase in the easterly Trade Winds on the equatorial strip of the Pacific Ocean leads to an increase in sea levels along the western shores of the Pacific basin and a descent on the eastern side. In the southern section of the Colombian Pacific, this descent oscillates between fifteen and twenty centimeters.
- A lowering of the surface temperature of between 1 and 1.5 degrees Celsius in the coastal waters of Colombia's Pacific Ocean. Normal temperatures range between 26 and 28 degrees Celsius.
- La Niña stimulates the emigration of warm-water species to other regions and the immigration of relatively cold-water species. However, although no detailed information is available on the behavior of the marine environment in Colombia's marine area during the Niña (IDEAM, 1997a), the lowering of sea levels and temperatures is not considered to pose a serious threat to the marine ecosystems in this region.
- An increase in precipitation and in river flows also increases the amount of sediment flowing into the sea, a process that influences the physico-chemical characteristics of the water since it modifies the conditions of coastal ecosystems such as mangroves, lakes, estuaries and deltas.

Impacts of La Niña on the continental land mass

- In general, although the amount of solar brilliance is diminished during the colder

periods, this does not represent the predominant state of affairs, but rather these variations are observed by sections over the whole of the national territory.

- Air temperature is reduced by two degrees Celsius in comparison with normal monthly readings in the Andean and Caribbean regions. The Pacific region, on the other hand, does not register important changes in this variable.
- Over half the Niña episodes documented to date began from the second trimester of the year onwards. Rainfall during the first trimester follows normal patterns for the country's five natural regions. As from that moment on, and during the following three months, excess rainfall is clearly manifest in the Andean, Caribbean and Pacific regions. In the last six months of the second year, the effect weakens noticeably and rainfall returns to normal.
- It has been observed that the cooling of the sea's surface in the tropical Pacific is one of the conditions that favors the movement of cyclones in the Caribbean during the hurricane season between June and November. Hurricane Joan (October, 1988) coincided with the 1988-1989 Niña period; and in July 1996, when a relative cooling of the Pacific's surface was also recorded Hurricane Cesar affected the maritime and island areas of Colombia and the Guajira Peninsula.

STORM SURGES OR HIGH TIDES? they are not tidal waves

Data bases register 131 reports of??? and their effects, of which 66 were along Colombia's Pacific coast. 39 of these occurred in El Niño episodes, those of 1982-1983, 1991-1992 and 1997-1998 being the more important. Reports on...???? during El Niño were four times more frequent than those during neutral periods and eight times more numerous than those during La Niña on the Pacific coast. According to IDEAM (2002), during El Niño the average sea level in Tumaco and Buenaventura (on Colombia's southern Pacific coast) rose by 20 to 40 centimeters. These municipalities coincide with those that recorded the greatest number of reports on ????? in the data bases.

Biological events, epidemics and frosts

Only 7% of reports associated with such events have a direct relation with the 1997-1998 El Niño. The number of reports provides evidence that under-recording of information is quite common, and although ENSO does have an

important impact on marine and terrestrial ecosystems, and therefore on the economy as well⁷⁰, the lack of systematized information does not allow us to establish direct relationships with this phenomenon. Nonetheless, some studies associate the increase in certain illnesses with climate changes, as is the case with malaria (IDEAM, 1997a, Poveda and Rojas, 1997).

Cases of frost, which also indicates the impact of El Niño according to IDEAM (2002), are recorded 38 times. Of these, only seven correspond to warm periods, six to cold ones and twenty-three to neutral episodes.

Floods, torrential rain, landslides, gales and storms

Between 1970 and 2002, reports on hydro meteorological events (floods, landslides, storms, rainfall, gales, fog, etc.) represented 75% of the total number of reports for that period. Of these, 63% correspond to floods, landslides and torrential rain, whose behavioral patterns show a greater relation to ENSO's cold periods. In most of the warmer (El Niño) periods, reports associated with these events show an evident reduction. During cold periods, 2.6 times more disasters occurred than during the El Niño episodes, and 1.3 more than in neutral periods.

As for gales, as from the second half of the 1990s, an increase in reports during ENSO's warm,, cold, and neutral periods is experienced. This may probably be explained by the number of sources consulted. During the rest of the study period, increases and decreases in numbers of disasters were noted, although these did not occur systematically during any specific ENSO phase. Reports on storms followed a constant behavioral pattern over 32 years. On average, 7 reports were recorded each year, with little annual variance. The number of reports on rainfall is almost the same in La Niña as neutral periods (338 and 375, respectively), whereas in El Niño episodes these are reduced to half.

Droughts and Forest Fires

Colombia's data bases are significantly deficient in information on disasters associated with these events. Press information (the principle source) is not published as systematically as it would be for floods, storms and landslides, since it is hard to tell exactly when a drought begins and ends and its effects can become diffused in the course of time. It was not until 1997 that data on forest fires was complemented with information from Colombia's Office for Disaster Prevention and Attention (ODPA). This is why we note a significant increase in these events towards the end of the nineties. Thanks

to studies carried out on El Niño, we now know that a major increase or intensification in these events, especially droughts, are an important indicator of warm (El Niño) episodes of ENSO (Montealegre, 1998; Poveda and Jaramillo; IDEAM, 2002). Despite deficiencies in information, that available offers certain possibilities for analysis in terms of the relationship between the different ENSO phases. Thus we find 439 reports on both types of event during warm episodes, as compared to 186 during La Niña episodes. During neutral periods, there were 462 reports, but of these over half were recorded during 2000-2001, and 80% correspond to sources such as the ODPa and the Cali daily newspaper *El País* which, as we said earlier, were consulted for the last few years of the data base.

Conclusions

Our analysis on the temporal and spatial behavior of disasters is founded mainly on reports associated with floods, torrential downpours, landslides, droughts and forest fires. Due to the sources employed, the first three events are better documented in the DesInventar data base, and therefore allow us to understand more precisely their relation to ENSO warm and cold episodes, as defined by NOAA.

In Colombia, El Niño years cause a deficit in precipitation, which is translated into a significant 20% reduction of in disasters related to flooding, torrential rain and landslides. That is of course, a positive thing.

On the other hand, this same rainfall deficit favors the occurrence of forest fires, droughts and frosts in the Andean plateaus. These have negative social and economic effects such as the loss of crops, water deficits, the over exploitation of water sources, an increase in tropical diseases and an increase in the number of forest fires (most of which are caused, at least in part, by human intervention). Floods, landslides and torrential rains can account for as many as 82% of the records in certain episodes of the cold Niña period. However, reports on precipitation and on the three other kinds of events are so variable that they do not necessarily show the real relationship with ENSO's warm and cold phases.

The occurrence of disasters does not follow a specific spatial pattern in any of the ENSO phases. Reports are concentrated, as would be expected, on regions such as the Andes, the Caribbean and the Pacific, and certain areas to the west of the Orinoco river that are important for the economy or where the population is densest. It is estimated that the spatial and temporal behavior of El Niño and La Niña affect the country in a different way in the different

⁷⁰ Besides the IDEAM information already mentioned, a news item in the Bogotá daily *El Tiempo* (27 April 1998) offers an overview of the relation between El Niño, a biological event, and the region's economy: "After surviving the tremendous drought caused by El Niño, cattle began to die off due to the heavy rainfall which occurs during the transitional period from the dry season to winter, which on this occasion has been the heaviest in many years and has been the cause of the intoxication and death of over 2,000 milking cows, especially on the Savanna of Bogotá, and the valleys of Ubaté and Chiquinquirá. This phenomenon, which usually occurs in the Eastern Plains, the middle-zone of the Magdalena river basin and the Atlantic coast, caused losses valued at 5,000 million pesos, according to reports from cattle ranchers. According to ICA (Colombia's official agrarian institute) cattle are being intoxicated by an accumulation of nitrates that are absorbed by grass and, on being consumed excessively by the cattle, cause substantial changes in their metabolism".

physical, geographical or climatic regions (the Amazon region, the Orinoco basin, the Andes, the Caribbean and the Pacific).

The most notorious social and economic effects of El Niño in Colombia during the seventies were supposedly associated with energy rationing. However, it can be shown that this was really due to structural causes and inefficient State planning. In the case of the thirteen-month blackout between 1992 and 1993, the hydro deficiency, attributed to El Niño, could have been avoided with rational management and preventive action, and the application of corrective measures in the electric sector. Energy rationing was due to structural problems, deficient planning and the poor operation of the national electric grid, and – according to documents from the Ministry for Mining and Energy, the National Planning Department and the World Bank – to the fact that installed capacity was overestimated. Also, there was an excessive dependence on hydroelectricity. However, the blackout and El Niño served as a basis for the adoption of government policies, legislation and regulation that led to the dismantling of the State monopoly in the electric sector.

The effects of ENSO on the institutional structure of the Colombian State

The main socioeconomic and institutional effect of ENSO in Colombia occurred at the beginning of the fifties when the government promoted the creation of the Regional Autonomous Corporation for the Cauca Valley (Corporación Autónoma Regional del Valle del Cauca) (CVC). This was the first of its kind in Latin America, dedicated integrally to flood control, the generation and distribution of electric energy and the development and management of natural resources. To this end, the corporation modeled itself on the Tennessee Valley Authority in the United States. Works for regulating the Cauca river and managing the subterranean waters developed by the CVC since 1958 helped to mitigate droughts (which occurred on average every six years) and major floods (which occurred on average every ten years), associated with ENSO in the upper Cauca valley.

However, due to the socioeconomic problems, violence, migrations and internal displacement of the population, corruption, lack of planning and political mismanagement due to vested interests in land rental during the period in which the CVC works were carried out, these same works led to a radical change in land use in Cali, a city that grew from 241,000 inhabitants in the early fifties to some 2,300,000 in 2005.

Almost half the present population occupies former flood plain lands dried out through the use of the above-mentioned works. These sectors are made up of barrios (both formal and illegal) precariously protected by a dyke (known locally as “*el jarillón*”) in a state of evident deterioration... Despite the fact that this dyke has controlled flooding since it was built in the 1960s, urban settlements in its area of influence have been affected by deficiencies in the artificial drainage system, which was neither designed nor built to separate rainwater from the city’s water supply.

Finally, the ENSO phenomenon, little understood in Colombia before the 1983 Niño, made its entry into State policy with the 1992-93 Niño event which was blamed for the above-mentioned 13 month energy rationing and blackouts. Over the last few years, IDEAM, the national body in charge of climatic aspects and hydro meteorological alerts, has published regular daily information on the matter, and issues early warnings based on a network of monitoring systems and information provided by international groups and institutions.

The Ministry for Environment, Housing and Territorial Development, IDEAM and the Departmental autonomous regional corporations (created along fundamentally the same lines as the CVC) together constitute a National Environment System (SINA), that has disseminated early warnings on the ENSO cycle and its potential repercussions in the countries municipalities and regions. It is yet to be seen whether or not these provisions (supposing they can be genuinely verified) really are interpreted and translated into specific actions on the part of local and regional authorities and communities. And, , whether or not they are acted upon by other national government entities and potentially affected sectors.

Our perception is that scientific advances and the ability to forecast the ENSO cycle (El Niño, La Niña and the neutral years) have not yet been fully understood by local bodies or by regional and national governments. In the case of Colombia, as elsewhere, climate variations and their effects have deep repercussions on daily life, the economy and the sustainability of development, and their causes cannot be reduced to a simple matter of whether it’s going to rain or not.

However, it is important to recognize the enormous advances made when compared to 1992 or 1993 when forecasts had little real effect on State policies. Immediately prior to the 1997-1998 Niño, the decisive participation of researchers and institutions from ERFEN, a better and more speedy relationship with inter-

national organisms interested in expanding the world network, along with the permanent role of IDEAM in disseminating short-range (as well as intermediate- and long-range) forecasts has placed Colombia in a position where it has a much better chance to promote risk management associated with ENSO.

FOCUS OF RISK MANAGEMENT IN THE CASE OF COLOMBIA

After the CVC was established, and, "after a careful study of the natural and socioeconomic conditions prevailing in the region", the consultant firms of OLAP, G&H and KTAM (1956) identified a series of actions that should be carried out by the institution, actions which correspond to what we now know as risk management. While the case of Pergamino discussed in the previous section on Argentina enables us to visualize a series of fundamental processes basically concerned with community participation, in this Colombian case we can visualize how a State institution can contribute to risk management. Amongst the more salient features of the CVC intervention we may consider:

- the establishment of demonstration areas so that farmers can understand the advantages of good drainage and irrigation, and carry out research that will enable decisions as to the crops most suited to the particular soils and climatic conditions of the Cauca valley. A program of agricultural information to teach modern farming methods and irrigation and to create districts for improvement was recommended.
- in a normal year some 56,900 hectares of the Cauca river valley is flooded, as well as another 30,500 hectares by its tributaries, making a total of 87,400 hectares. This corresponds to 23% of the 380,000 hectares of the Cauca river valley taken as a whole. For fear of the damage flooding may cause, most of the area is given up to pasture for grazing, "and this for only part of the time". On the question of what is advisable for protecting against floods, the Plan (outlined by CVC consultants) suggests that "when the area to be protected is occupied by cities and towns, a high degree of protection is warranted to avoid catastrophic losses that could result from sudden heavy storms, such as those which occur every fifty or one hundred years. However, when it comes to protecting farm land more economic measures can be used, since these face occasional flooding and do not warrant the high costs of works needed to protect the population

against such infrequent occurrences. Present studies show that in the Cauca Valley, the degree of protection need not be any greater than that used for ten-yearly occurrences ...".

- zonification,, since the ten-yearly protection is not considered adequate in urban areas and " ... although fortunately there are no large urban centers in the danger zones, a decree should be issued impeding the future establishment of cities within such zones ...".
- the need for irrigation given rainfall deficits. The average annual precipitation in the low-lying zone is 1.120 mm, but every six years there is 760 mm or less rainfall, and every ten years, a mere 690 mm at most. The program for hydraulic works proposed in the development plan was carried out, in great part, during the following decades, and the CVC's management model was duplicated in other regions of Colombia. The said works undoubtedly contributed to mitigating the impact of floods and droughts in the wide area that embraces the upper Cauca river valley. Nonetheless, an analysis of urban development in Cali, the principal city located in the area of influence of the CVC and capital of the department (State) of Valle del Cauca, shows that changes in land use occurring since the Corporation adequately prepared the terrain, implied drastic changes in risk for the population settled on these lands.

The city expanded towards the hills and towards the low lands to the east which had been adequately prepared by the CVC for agricultural use but not for urban settlement. The population increased from 241,000 inhabitants at the beginning of the fifties, to 2,300,000 inhabitants in 2005. Almost one million are settled on what were formerly flat lands accustomed to flooding by the river Cauca and its tributaries and which are precariously protected by the "jarillón").

Since the construction undertaken by the CVC between 1958 and 1962, the city has not experienced large scale flooding, as occurred before the dyke was built. But the barrios still flood, mainly due to deficiencies in the drainage network, which is modified and artificial, and was not conceived to handle both rainwater and residual flows from the water supply system. The living conditions of many inhabitants, the deterioration of the "jarillón" due to the use given to this for house building, the erecting of pigsties, and so forth, the occupation of a lake that was designed to regulate a river which exists in the zone – all of these circumstances

imply the continuous construction and accumulation of vulnerability vis-a-vis hazards such as flooding and earthquakes. This has signified high risk conditions for the inhabitants and their belongings, as well as for vital infrastructure which serves the rest of the city's population (such as the sewerage plant, the Puerto Mallarino potable water plant, etc.).

Finally the study underlines an aspect of special interest for those of us who believe that the reestablishment and strengthening of communication links (what the study calls "building networks") among the diverse institutional and social actors present in the territory constitutes an essential strategy for risk management:

The development of the ENSO project in Colombia provided a framework in which the different key institutions involved in the handling of this matter and others associated with it could be brought together. The creation of tools such as the regional data base system- SRID-ENSO- or institutions like the System of Information on the Agricultural Sector in the Valle del Cauca -SISAV-, whose impact transcends the project's duration, supporting the generation of local abilities for risk management associated with ENSO, is another way in which this can be achieved. In what follows, we describe in broad outline the characteristics of these initiatives.

Regional system of information on ENSO disasters (SRID-ENSO). In the context of the ENSO risk project, OSSO, with the support of the OSSO corporation, has developed the SRID-ENSO system to facilitate the systematization of documentation and data related to the impacts of ENSO as well as inter-annual climatic variability. This data base is nourished on line by project researchers using information gathered in the course of their research. At the present time there are 527 documents available for public consultation. The system also allows us to relate written or published information to disaster information contained in the DesInventar data base and provides for debates amongst those using the data bases. SRID-ENSO is located on the project's website (<http://cambioglobal.org/desdoc>) and is administered by OSSO personnel.

Local and regional data bases. During project development, the elaboration of new local and

regional disaster data bases has been promoted, through undergraduate studies or as part of the activities of public entities working on the subject. Some of these bases are already in existence, as is the case in Pereira and Risaralda. These were constructed by a student from Pereira's Technological University and further enhanced by the Risaralda Departmental government with the support of the Autonomous Regional Corporation of Risaralda (CARDER). An Antioquia data base also exists constructed by the students at EAFIT University (School of Administration and Finance) in Medellín. Finally, data bases have begun to be created in sub-national bodies such as the Committee for Disaster Prevention and Attention in Quindío and the Sub-secretary for Disaster Prevention and Attention in the office of the governor of Valle del Cauca.

System of Information on the Agricultural Sector in Valle del Cauca (SISAV). OSSO was a founding member of SISAVA. SISAV concentrates information resources possessed by unions and enterprises so that this can be employed for the benefit of farmers and the region's agricultural development. This data base will enable users to gain access to reliable information and to tools which will assist them in farming. The ENSO-IAI project provided data bases and criteria on the subject of agricultural production and animal husbandry and on the impact of disasters on the agricultural sector in Valle del Cauca.

Colombian Observatory on Forest Fires (COFF). In 2005, COFF was created by the Autonomous University, with its headquarters in Cali. The Observatory, in its first stage of development, aims to generate knowledge on the occurrence of forest fires and their impact on the Department of Valle del Cauca. Later, their impact on the country as a whole will be examined, in order to create early warning systems and to promote preventive measures. One of the first projects carried out by COFF was the development of a Desinventar supported data base on forest fires in the region over the past fifty years. This task is being undertaken at present by students from the Autonomous University and it is hoped that, in the course of the project, new students will become involved and produce graduate studies in collaboration with COFF and DesInventar.

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 Resumen de emergencia ERFEN.

Manifestations of ENSO in Costa Rica⁷¹

In general one can note several tendencies in the behavior of this phenomenon in Costa Rica.

Semantically, ENSO is directly related to the occurrence of droughts. This has led to the implementation of preparatory actions in potentially affected zones.

Temporally, a major accumulation and frequency of reports is noted over time, particularly floods, landslides and droughts.

Over time one can observe changes in risk related activities and in the perception of risk. There has been increased intervention in preventive actions, particularly related to drainage systems for excess rainfall. Local emergency committees have been transformed into Municipal Committees, and this suggests that there has been a change in the constitution of Integral Risk Management on a local scale.

Institutionally, this change in the way of perceiving and defining the problem can be noticed when one speaks, as is the case now, of “disaster prevention” and not, as before, of “handling disasters”. This new way of referring to the problem is reflected in the naming and creation of the new National Risk Management System.

Disasters associated with natural and socio-natural hazards are the most frequently experienced types in developing countries. Harmful events related to other types of hazard, for example, technological accidents, tend to be sporadic. This is relevant not only because of the characteristics which lead to these occurrences, but also because of the scale at which they occur.

Although what we call “disasters” are impressive because of the dimensions they acquire, minor and even daily occurrences are in some ways equally important. Why? Because they enable us to understand and perceive specific vulnerability contexts, and also contribute to our understanding that vulnerability grows in ever increasing cycles if nothing is done to interrupt the process. Besides, from a research viewpoint, these small events are extremely useful for study purposes, since they have as their starting point a process focus. Large-scale disasters can be seen as the corollary of a continuous risk situation, made up of many smaller, local, “disasters” that occur more frequently than we can perhaps imagine (Lavell, 1993). Such events reflect a problem which goes far beyond risk as such. They express a state of affairs and a social, economic and, even political, way of life, which has its roots in particular types of development, where poverty, wealth distribution and institutional structures assume a concrete form. These are the aspects which finally determine when, where and how

vulnerability is constructed, reinforced and distributed, and they also explain an infinite number of hazards which coexist in a given territory.

Let us imagine that hazards comprise risk’s horizontal plane and vulnerability its vertical plane. Both planes intersect to give rise to a given risk context, and finally to disaster, or to many minor events associated with variant levels of damage.

The multi-hazard context of Costa Rica and the focus of this study

In Costa Rica’s multi-hazard scenario, hydro meteorological events are the most relevant as far as frequency and accumulated damage and loss are concerned. Floods and landslides are the most frequent events (PEN, 2003, 2004). These are particularly relevant because they increase the vulnerability of communities and low-income families.

Poverty is, in general terms, a structural component of our economic context. In Costa Rica, poverty affects 20% of the population- about one million people. And this proportion has experienced little variation over the past twenty years or so. Although poverty and vulnerability are not synonymous – that is, not all poor people are vulnerable – access to resources, economic options and opportunities that enable one to reduce vulnerability, both individual

⁷¹ Summary of *El riesgo por eventos ENOS y variabilidad climática en Costa Rica: Tendencias e implicaciones identificadas a partir de la fuente DesInventar, 1970-2003* by Adriana Bonilla, Programa de Investigación en Desastres y Gestión de Riesgos (Secretaría General – FLACSO).

lly and collectively (including education, social mobility, social security and adequate housing and environment, not to mention the ability to satisfy one's basic needs) – are factors very much determined by socioeconomic level.

Damaging events on whatever scale, although they may seem to be occasional, exhibit two characteristics of which we are not always aware: a) they occur daily, are distributed throughout the territory, and they occur in various scenarios, even though we are not aware of their occurrence; b) they correspond to another structural component which is closely linked with poverty—namely, risk. Risk has its origins in political, economic and social conditions, and its importance rests not in its existence as a product but rather as a process. This is the quality that allows us to study and conceive of risk in the most adequate manner thus allowing us to modify it through correct management.

Nonetheless, despite the structural nature of risk, the events which make it manifest—disasters—are normally “diluted” by the schematic style and the idiosyncrasies of institutions, both because of the priorities of the population on a day to day basis and the need that people have of living together and surviving in an atmosphere where harmful occurrences are at least a nuisance and which, once they occur, people do not wish to think about them again, not even for the purpose of seeking their causes and avoiding them from happening repeatedly. That is why, when we approach this problem we endeavor to offer elements with an idea of integration, and it is necessary to work on at least two levels:

- a) The exact and immediate level, which gives details of the events and their characteristics.
- b) The structural level, which contributes an analysis of the whole situation and approaches, albeit from a focus that may be more or less speculative – depending on the limitations of information data and available methods – to the fundamental causes and what are rightly called “dynamic pressures”. Both these components are behind the occurrence of these events, whose perception has been distorted by perverting the real sense of the phenomena and the manifestations proper to the terrestrial system by calling them “natural disasters” (Blaikie et al., 1996).

These levels or criteria are only our way of organizing ideas that are relevant, but for almost two decades and under different guises they have been the subject of debate, revision and reconceptualization by various specialists in

the region and in the world, in search of the most adequate scale in temporal and spatial terms which will fit the characteristics of these events in reality, understood as results of larger processes whose origins are diverse and complex. Nonetheless it is surprising how little these contributions have filtered down to certain circles. And this in turn is significant given the desultory manner in which these matters have been brought to the attention of the normal citizen who suffers the effects of these occurrences which, from his or her point of view, are most pernicious.

On climatology

It is fundamental, too, that we incorporate climate into this analysis, in accordance with the same idea of a joint vision, in the hope of contributing to the notion that references to ENSO and climatic variability in Central America do, in some way, refer to one and the same question, given that in both its phases – warm or cold – ENSO has repercussions that simply begin to become part of a global context of different climatic manifestation in the region. By this we do not deny the importance of this phenomenon with regard to the probable damage that may be associated with ENSO and its own physical characteristics, but we do wish to make clear the fact that Central America's climatology is not determined by this phenomenon alone. Evidence of this can be seen in the efforts of meteorologists in these countries to reduce to some extent the El Niño or La Niña aspects of climatology in order to let other processes be seen, processes which affect the complex dynamics of the region of which they form part (Alfaro, 2005).

In this same sense, we ought to remember that there exists a great variety of aspects related to atmospheric pressure in the Atlantic and in the Pacific, thermic variations, winds, precipitation, cold fronts and masses of air in continuous and incessant inter-relation whose effects, along with orography, contribute to creating a characteristic climatology of multiple kinds, many micro climates and high humidity, and that these make their presence felt over the major areas of Central America's territory.

Given its latitudinal location in the zone of inter-tropical convergence, as well as its characteristics as an isthmus and because of its orography, the meteors and atmospheric phenomena in general bring about a high degree of instability in all of Central America, and of course Costa Rica is no exception. In fact, constant manifestations of this kind explain why climatic variability is the norm. Although we can describe the daily meteorological behavior of the region and of the nation based on fore-

casts, as in the rest of the world, it is nonetheless true, beyond all foreseeable conditions, that the reality of local manifestations of climate tend to be erratic and carry much weight among isthmuses of an inter-oceanic kind and on the orographic effect of genetic cycles in the Caribbean. And these are but a few of the elements that contribute interesting and varied phenomena that may lead to generating harmful events.

That is why it is not incorrect to point out that there exist natural conditions that are relevant in pre-establishing a fertile area for generating risks – many and diverse risks, in fact – which will finally arise due to vulnerability of a social nature, indispensable if they are to be made manifest. It is for this reason also that, at the start of this section, we have mentioned the concept of a “multi-threat scenario”. However it is true that we have become so accustomed to our environment and its landscape that we have probably never understood, as a Central American society, and a Costa Rican one, the degree of our fragility in this particular case. That is the cause of our main contemporary problems, among which we should not exclude the threat of disasters.

On the case of Costa Rica

This study is a particular portrait, based on hydro meteorological events that have occurred in Costa Rica and have been recorded in an inventory, whose analysis is designed to reflect, in the light of the development and records of these disasters and the damage they have caused, how far this country has been transformed and the effects of social and economic change, as well as changes in the landscape itself, on the population’s vulnerability, expressed in a major recurrence of hydro meteorological events reported as we progress along the lines of the periods submitted to our study here.

In this reading, two facts should not be overlooked:

- a) The above-mentioned characteristics regarding the particular nature of the Central American and Costa Rican territories mean that, despite the importance of earthquakes and volcanic eruptions, the temporal climatic and meteorological scales – in general, shorter than the geological ones – produce, in the context of regional and national vulnerability, a major frequency in events associated with climate and with atmospheric phenomena, which results in an accumulative effect of damage caused by these events, which is highly significant.

- b) One can assume there is inevitably a slanted focus in the primary sources on which DesInventar is based, due to the fact that circulation, access to the affected areas and the capacity for coverage by the daily papers is greater now than it was two or three decades ago, and that may influence, up to a point, the fact that it is not possible to make exact estimates on the volume of events for each decade.

Risks and disasters in Costa Rica 1970-2003

4,349 hydrometeorological events were registered for the period. These represent 75.7% of the 5,742 events in the national DesInventar data base⁷².

Although they are not identical, the lines of the graph are similar, and that is reinforced by records over the last six years of study (1998-2003), a situation derived fundamentally from the accumulative effect of damage and alterations produced by hurricane Mitch and other phenomena that occurred in the region, whose effects increased the danger on the one hand, and on the other, contributed to creating new threats and to deepening local contexts of vulnerability across the whole of the national territory. The result of this is the growing number of reports registered as from 1999, which is fomented precisely by reports of a hydro meteorological nature.

(...)

In the relation between the typology of events, floods make up a total of 2,400, that is 55% of the total, followed by landslides (924) which are slightly more than 21%. Thus 76% is made up of both kinds, leaving only 24% for other categories of hydro meteorological phenomena⁷³.

(...)

On this point, we should revise the provincial significance of floods, given that they are an importance point of reference in the Caribbean and until now this aspect has not been dealt with. The province of Limón alone accounts for 501 records of floods, included in the grand total of 2,400 events already mentioned. However San José reported 597.

In DesInventar, floods refer to the entire process, in which waters overflowed the system. Thus it is necessary to make clear that there exists a qualitative difference between both provinces, since floods in the Caribbean are typical of those that occur on the plains when rivers break their banks and spill their excess sediments out onto the surrounding terrain, as well as the volume of water flowing from the upper and middle river basin. In the case of San José and other provinces of the Greater Metropolitan Area (GAM), what frequently ha-

⁷² These are accidents, leaks of toxic substances, earthquakes, volcanic eruptions, explosions and eruptions and structural fires., among others. The latter represent 67% of the total number in this group.

⁷³ This group includes sudden storms, rainfall, gales, droughts, forest fires, epidemics (malaria, for example), plagues (roya, blue fungus, rats, etc.) and heat waves.

ppens is that smaller creeks, often strangled and which flow through urban areas, slightly (or severely) overflow and affect housing along the river banks. Another source of these reports proceeds from the saturation and blocking of urban systems for draining off rainwater, a situation that in the rainy season can lead to damage to dwellings due to water flowing across highways when the sewage system is unable to channel them adequately towards the subterranean canals where they should be collected.

In this sense, the population is exposed unequally to floods in a way just as unequal as the historical access to resources assigned to people by the economic and social systems they live in (Blaikie *et al.*, 1996; Lavell, A., 1994). Many of the floods reported, especially in San José and Desamparados, correspond to popular barrios and marginal settlements located near to the banks of rivers and streams.

C. Green (1990), quoted by Blaikie *et al.*, (1996) reflects on the progress of floods in the contemporary cities of developing countries. The point that mainly worries that particular author is the rapid propagation of urbanized areas, with little concern for the characteristics of the site being occupied. He considers that the present speed at which this is happening means that the importance of rural flooding will be less, whereas flooding in urban areas will increase. This refers not only to the relative importance of the cities in their present extension, but also to future expansion in the course of the next few decades where residential spaces will have preference over areas which we now perhaps catalogue as rural.

In the case of Costa Rica, the coastal provinces are those which record greater damage caused to the population, but are not necessarily those where a greater number of general events are reported. The tendency suggests that, in accordance with what we have already pointed out, rural areas report less incidents. However, these are much more intense, whereas in urban areas the opposite occurs: a greater frequency but little intensity, and there is stimulated a progressive accumulation of data associated with the events. This point is relevant, since apparently it is the result not only of an increase and a concentration of the population in central areas, and a greater attraction, but also—and this is even more important—it would seem to stem from distribution, which is based on a disorderly expansion of urban settlements in our national context (PEN, 2004).

Our pattern of urban expansion has produced a “growing segregation of metropolitan terrain, a situation in which lower-income sectors are

compelled to group themselves in geographically critical zones, where a circular process of economic, social and environmental degradation is generated” (PEN, 2002). Socioeconomic heterogeneity in the occupation of a territory tends to become diffuse as the actual process of urbanization takes place in Costa Rica.

Research shows that, in the case of Costa Rica, in just over ten years, the urban sprawl has grown by 8.3%, following the historical tendency of the past three decades: it is a question of a chaotic urban form which expands in all directions, without planning and with little control. The major impact of these conditions is concentrated in the cantons of Desamparados, Alajuelita and Escazú, towards the south; towards the north east, Coronado, as well as Santo Domingo, San Pablo and Heredia in the central canton; and to the west, the Central Valley in communities located along the General Cañas highway.

At present, the area of greatest growth is that which is located on the periphery of the AMSJ, especially the areas of relatively little development within the GAN. Among details which highlight tendencies on urban growth between 1975 and 2005, the canton of Coronado stands out with 184%, followed by the Desamparados district with 100% growth, San Felipe in Alajuelita with 451% and Trinidad, the Moravia canton, with 242.7 % (PEN, 1999: 2002).

Droughts

Droughts represent the emblematic typology of El Niño along the country’s Pacific coastal region. Although droughts can occur that are associated with other atmospheric phenomena, as happened in 2001 due to a particular coupling over the Atlantic, very similar to ENSO⁷⁴ (Ramírez *et al.*, 2001), records show that, with each Niño event, the northern Pacific and central regions reacted with a notable diminishing of rainfall and a change in the distribution of precipitation.

Various periods in 1972-1973, 1976-1977, 1982-1983, 1991-1993 and 1997-1998 correspond to El Niño events and at the same time concentrate almost all reports of drought that have occurred in our country. This reflects to what degree this typology is characteristic of (although not exclusive to) the effect of El Niño episodes in the Pacific area of Costa Rica, as occurs in general in all of Central America .

In the province of Guanacaste there occurred 334 of the 435 droughts recorded, that is 77% (Fig. 6). From the phenomenological viewpoint, droughts have a particular characteristic when compared with other kinds of events, given

⁷⁴ In the case of Costa Rica this event, although significant, was far less severe than in Nicaragua, Honduras and El Salvador.

that they tend to be analyzed from second-hand reports, such as the newspaper articles on which DesInventar is based, and this makes it easy for there to arise a time lapse between the genesis and the consolidation of this phenomenon, on the one hand, and its dissemination through the press and other media, on the other, as happened with the ENSO events of 1997-1998.

This event caused heavy losses in our country, especially in the agricultural sector, but also in the generating of hydro electricity and in other fields (Bonilla and Lavell, 2001). The agricultural sector alone reported losses of US\$ 52.4 million, equivalent to 56.3% of losses caused to the national economy as a whole (Flores, 2001). Despite this, the dissemination of the event to the public was merely superficial, which contrasted with the activity and the generation of products and actions in national and regional bodies that are linked to the agricultural and to the hydro sector, which had never been more concentrated for action in the face of an ENSO event. According to national authorities, Costa Rica foresaw what was likely to happen and stored up foodstuffs for cattle and promoted better grazing land, relocation of stables and the excavation of reservoirs (Bonilla and Lavell, 2000). Damage was concentrated in the North Huetar region and not in the northern Pacific or central regions, as might have been supposed, due precisely to the unequal response of producers between one region and another.

Finally, given the behavior of droughts as a progressive phenomenon that is reinforced through successive stages and with effects in different fields – which give rise to a meteorological, a hydrological, an agronomic or atmospheric drought (INETER, 2002) – reports in the press and in official sources are not incorporated nor are they reckoned in the same way as events which make a more sudden impact – floods, landslides, gales, for example – but rather, once the hydro deficit has been recorded, when there are notable effects on people and on productive systems, that is when there appear specialized news and reports that announce what has occurred. Which is why a single report on drought refers to something which is going on, generally over several weeks and even months, and which corresponds territorially to vast areas of a region, or to the country as a whole.

(...)

As for the phenomenon's signal (or sign), it may begin to be significant and to generate a hydro scarcity and drought conditions in certain places even before a warm or cold ENSO period, properly so called, has been established, which would explain why we find reports of droughts several months before the moment at

which the beginning of the corresponding El Niño episode has been officially declared (Alvarado, 2006). This may have occurred during El Niño events in the seventies.

Another explanation which has been gathering adepts, and which is at present being researched by scientists in the region, is the presence of a phenomenon similar to ENSO, but in the Atlantic, the same one that was related to the 2001 drought. Apparently, when this phenomenon causes a cooling of the ocean's waters, that is, what in the Pacific we know as a negative phase or anomaly – a La Niña event – its effect is the reverse of that of La Niña in the Pacific and tends to produce hydro scarcity in Central America.

Besides what has already been pointed out, it may be that not only the anomaly's intensity but also certain knowledge that, at a particular time, we may have possessed regarding this phenomenon could have contributed notably to its effects being less, to the extent that it progresses in time, as is evidenced in the scarcity of reports for the El Niño periods of 1997-98 and 2002-2003, with respect to the 1972-73, 1976-77 and 1982-83 periods, given that an opportune intervention by the government has proven to be effective when there is a response from the private sector.

Fires

Generalized forest fires that occurred in all of Meso-America from 1995 to 1998 do not appear to have been a direct consequence of the relatively mild but extensive El Niño phenomenon that oscillated between 1991 and 1995, but probably the conditions which led to these fires were due, in part, to the sustained effect of its influence, which through a relative scarcity of rainfall did contribute to the fact that, especially during the dry season, these fires were propagated throughout all of Central America's "Dry Arch" and, in general, throughout the region's woodland areas, from Mexico to Panama.

(...)

All of this may suggest that the length of time during which the ENSO phenomenon is operative could be as important as its intensity, although the latter is what usually claims our attention. Reviewing tendencies from one decade to the next, as they are revealed in the data gathered in the course of our study, we can establish that a moderate prolonged event may cause important and lasting structural damage, whereas a severe but brief phenomenon might be associated with passing effects which are serious but not so great as the former. Of course each country and region responds differently to each event, so that this is merely a

matter for speculation based on evidence of the phenomenon's behavior in the past.

What we have found regarding the effects of ENSO in Costa Rica demonstrates very clearly that there are certain tendencies regarding spatial, temporal and semantic patterns, given that:

- a) Droughts always occur when El Niño is operating in at least two of the country's regions, and includes a spatial pattern for the areas which are usually affected, and a semantic one since drought is a typical El Niño occurrence, although not one exclusive to El Niño.
- b) When an ENSO phase prevails, reports increase to an undetermined degree on a variety of hydro meteorological phenomena, such as floods, droughts, landslides and gales, over the whole of the country, according to the characteristics of each region. These events are not peculiar to ENSO, but it has been demonstrated that they tend to increase under its influence, the opposite occurring during neutral periods. In other words, there does exist a temporality which is proper to ENSO, associated not with a semantic pattern of exclusive events, but with their quantity, which is reflected at the end of each decade.

Analysis of a growing process of risk patterns: damage versus non damage in the relation between the provinces of San José and Heredia

Heredia and San José occupy opposite extremes in records for events that have caused damage in Costa Rica. While the former is to the fore in each of the three decades under study, the latter always appears in the last place in reports, but the happenings of the last nine years – a succession of ENSO periods, including hurricane Mitch – have modified this tendency in a very noticeable manner. The overall tally in reports between one and the other provides a great deal of evidence of this.

The categories of events are coherent with what has already been mentioned for the country as a whole regarding the predominance of floods, landslides and gales, if we look at the general data for both provinces. What is relevant in this regard is the number of gales in Heredia, the typology of regular frequency in each case, the quantity of which is proportionally greater than for the rest of the country's provinces. Almost 92% of damaging events in Heredia occur within the three categories we have mentioned.

In San José, on the other hand, incidents are more evenly distributed among different

typologies of events, and gales are much more significant, equal to almost a third of the landslides reported. One notices, too, the importance of droughts, a situation of hydro scarcity that affects the availability of water for human consumption, which becomes significantly critical, and represents a similar threat in the face of the possibility that eventual rationing may be introduced.

With regard to damage, those affected by hydro meteorological events represent the only category in which Heredia has twice as many cases as San José. This is due to the fact that the 2,000 persons who were engaged in religious activity found themselves temporarily isolated because of flooding, so it was not a representative case but rather a one-off situation.

Damage in the province of Heredia does not give us a significant clue to anything out of the ordinary as far as general statistics are concerned, except for the fact that the greater part of events causing damage happened after 1998. By contrast, San José – both the province and the canton – have witnessed a sustained tendency to an increase in reports as from 1970. (...)

Heredia's Central Canton is completely urban, in the urbanizing style of Costa Rica's central cities. One of the country's main public universities, and several of its private ones, as well as different services and a regional hospital, are part of the urban landscape. Nevertheless. Especially since the early nineties, there has been a greater tendency for families to arrive and settle, above all middle-class families who wish to live outside San José but still remain relatively close to their workplace. A flourishing offer of commercial and residential sites at that time sprang up noticeably and among places affected were Heredia, Belén and Flores. However this immigration process and the occupation of terrain was something that occurred all over the province.

These elements help to explain how a change in land use in Heredia and Central Heredia has catalyzed variations in the behavior of reports of hydro meteorological events that cause damage in this locality, and in all of the administrative region to which it belongs.

The particular nature of what has occurred in Heredia is manifested by comparison with some of the main cantons in the matter of the number of hydro meteorological reports on a national scale. San José, Desamparados, Limón, Talamanca and Rurrialba. This figure manifests how the Central Canton of Heredia is the only one of all these which reported in 1999 a similar number to that of the entire previous period (1970-1998) and a marked increase as

from 2000, which was kept up throughout the following years.

This data leads us to ask, finally, what has happened in the central canton and in the province of Heredia since 1999?

In our opinion, the situation can be summed up in various points:

- a) As from 1999, a drastic change occurred in the number of cases recorded in the province of Heredia, which had the lowest number of reports on hydro meteorological events in the country. This dated from a worsening in conditions of vulnerability after the Mitch hurricane, an event which brought about a similar effect in every region in the country, although in the case of Heredia this was more noticeable. The most important nucleus of this transformation can be found in the central canton and, within it, in the districts of Heredia and Ulloa. As from 1999, the province annually recorded more than double the number of events reported each year up until 1998. That is to say, there has been a break or inflection in the processes linked to the risk of damaging events that occur in this province, an effect that has tended to become concentrated in the central areas. Vulnerability in the territory as an effect of Mitch.
- b) Over the past 20 years Heredia has received an immigration equivalent to almost 30% of its inhabitants in 1984. This will have been expressed in a dramatic change in patterns of infiltration and drainage, the lack of permeability of soil in an area of thousands of square meters. The growing offer of residential sites derived from this attraction has modified the use of land in one part of the territory, which before was agricultural and dedicated to woodlands and is now residential and commercial, and that has had an effect on the genesis of new local threats such as the appearance of new vulnerable groups, where a new organization of space has located larger populations in places liable to risk which before had not been identified as such (Blaikie *et al.*, 1996).
- c) These changes suggest total change regarding provincial behavior in terms of the provinces' propensity to suffer from hydro meteorological events associated with damage.
- d) In global reports over the past 23 years, Heredia still occupies the last place in the number of cases reported, due to the fact that the province's low profile has

been maintained by comparison with others. However, taken by itself, the province has registered from 1999 to 2003 the equivalent of 63% of all reports over the period between 1970 and 2003. That is to say, in four years Heredia has registered 1.7 times more events than in the previous 29 years.

- e) All this suggests that the province of Heredia constitutes a unique opportunity for analyzing, in real time and through a process of follow up – and as though it were in a laboratory study and an analysis of the process of risk building – the course of how vulnerability has been exacerbated and its effect on processes of urbanization and diversification in sectors such as economics and services. The behavior of events associated with damage is a criterion that ought to be studied in order to understand and compare the said process with that of San José and other provinces, so that it may be possible to recreate the scenario in which there occurs the transformation of a relatively small and barely vulnerable space, with stable conditions that allow for risk control in the face of hydro meteorological events in an area of rapidly growing risk.

THE FOCUS OF RISK MANAGEMENT IN COSTA RICA

The prejudicial effects of El Niño between the years 1997 and 1998 have been widely documented. In fact, no earlier ENSO event had been so expected nor had any received so much attention and planning to prevent pernicious consequences, which even so were caused, although to a lesser extent than would have happened if measures had not been taken to mitigate the effects of the phenomenon. Nevertheless, very little was published about these effects in the press.

The smallest number of records appear for the years 1980, 1981, 1984 and 1989, and as a result during that decade (the eighties) there are 2.5 times less reports on events than in the nineties. On the other hand, the years 1980-1989 represent the period in which the least number of cyclones occurred in the 20th century (Alfaro E., Alvarado L., 2003). This leads us to ask several questions:

1. Is it probable that, given the influence of regional cyclone genesis on the frequency and intensity of these events, the lack of storms and hurricanes might have been the root cause of the drought situation? If so, how does this fact relate to vulnerability?

2. Is Costa Rica particularly sensitive to the intensity and magnitude of tropical cyclones with regard to meteorological events that are not influenced by them? Does the reduced number of recurrences of this phenomenon during that decade represent a general decline in reports on happenings related to natural threats associated with damage, linked also to a falling off in the number of press reports on El Niño?

And as for El Niño, can we believe that ENSO's behavior in general is its response to this situation? What would this mean in terms of what the threat signifies as a component of risk?

SOME OF THE ADVANCES AND INSTITUTIONAL ACHIEVEMENTS IN RISK MANAGEMENT VIS-A-VIS HYDRO METEOROLOGICAL EVENTS IN THE PAST FEW YEARS

The impact of severe events of relatively little recurrence always tends to produce a temporal collapse and a crisis from which national institutions that are geared to respond to emergencies recover with different degrees of rapidity, depending on their own aptitudes and their knowledge of the national reality regarding multi-threat scenarios, on forms of vulnerability and on the development of a local capacity for dealing with this kind of situation. Such national institutions still tend to play their major role in interventions after the impact itself, which is the result of a historical tendency that must now be corrected. Nevertheless progress has been made in promoting initiatives with a risk-management focus. This advance has taken a long time, since people at the political and technical levels had to understand the real causes of disasters, which of course go far beyond the immediate emergencies which we all can witness. To put it concisely, this has been the path followed by the National Commission on Risk Prevention and Attention to Emergencies (CNE).

As the CNE acquired its own identity and matured its process of institutional consolidation it became evident that, in the global scenario as well as in the national one, it was necessary to place at the center of debate three elemental concepts – threat, vulnerability, risk – in order to look for concrete applications in real scenarios. This has not been so difficult with regard to threats, but is still hard to achieve in matters of vulnerability and risk, although nobody doubts their importance. The problem is largely methodological, due to the difficulty of measuring vulnerability. This has led to several imprecise notions and some omissions, such

as the repeated idea of applying these concepts to some of Nature's elements such as ecosystems, hydro resources and suchlike, or to draw up "risk maps" that are limited to spatial dimension of a threat that has been identified and a relationship that physically exhibits certain groups and objects.

In Costa Rica's case, the CNE created first a System for Disaster Management, then a National Prevention System, and more recently has set up a Risk Management System (La Gaceta, 2006). Just by looking at the way these systems have been named we can see how a change for the better has been achieved in the course of time as far as institutional focus is concerned. Until the mid-eighties, the CNE – originally the Office for Attention to Emergencies – placed the emphasis on emergencies as such, doing justice to its name, and also to disasters in general (Lavell, A. In Lavell, A., Franco, E., 1996). At that time risk was not considered, nor had anyone conceived the scale of the genesis of events associated with damage. As a result, minor localized impacts were not even discussed.

Although earthquakes and earth tremors are always present in the popular imagination, as reflected in what took place during the eighties when the main debate was centered on such occurrences and when a large part of technical and technological investment by the State and the universities was concentrated on these. A decade later, however, tendencies changed, and ENSO became relevant as a subject for study, as did recurrent events of a hydro meteorological kind which today occupy a major place in CNE's daily concerns and in those of the Center for Emergency Operations (COE), an organism created to involve the State's security institutions in such intervention and management. This involvement embraces institutions for public health and includes support for productive sectors which could be affected eventually by the impact of a disaster.

It could be said that over the past ten years rapid progress has been made on the matter of action by the national State in the face of damaging events. After the first important legal reform was passed in 1999, two other reforms have followed, one in 2002 and the other in early 2006. This last not only refers to the creation of a National System of Risk Management, as already mentioned, but also makes evident its proposal to promote change on two fronts: a) the need for different levels of social and institutional management to be involved in the process of long-term reduction, creating conditions for this to occur through instances legitimated by law, from the local level and through specific paths and procedures; b) to show that risk

is part of daily life and should be assumed as such, this being the only way to understand how risks are generated and how society can learn to live with an acceptable degree of risk and be ready to handle it.

At present, several regulations, at both the local and national levels, provide evidence of the above-mentioned progress in this matter. Namely:

- a) A law passed last January modified the figure of the "Local Emergency Committee" (CLE) which has now become the "Municipal Emergency Committee" (CME) (La Gaceta, 2006). This change of name may appear to be superficial, but if we briefly consider its implications, it becomes clear that, in the medium term, it will represent a transformation in the way management and local intervention is carried out in the face of different risks. Before, the CLE was made up of local volunteer leaders and did not necessarily include representatives of municipal government, which in some cases made it difficult for the CLE to relate to the local administration and develop processes jointly, processes that are usually promoted with the support of the CNE. From now on, the new reform obliges municipal authorities to become part of (and to work with) the CMEs.
- b) There is a tax on all rainwater drains to be paid by property owners in the canton of Goicoechea if their property has at least 8 lineal meters of frontage. The sum collected via this tax is spent on improving the municipal sewage and drainage system and is collected periodically. In 2001 this amount was estimated at between 120 and 130 million colons. And this has been a concrete way of making sure that risk management becomes part of municipal policy in an explicit way in this canton (PEN, 2002; Romero, L., Brenes, A., 2002). This initiative – a novelty in Costa Rica – aims to diminish the number of floods caused by the insufficiency of the local system for draining rainwater due to the increase in the volume of flowing water in urban communities over the past 30 years. In 2004 alone, 25% of floods reported were caused by problems in the draining and sewage system in 67 cantons (PEN, 2005). Regulations supported by commitment and economic support on the part of the inhabitants themselves contribute to generating a new and healthy perception of risk and on how risks should be managed.
- c) In the year 2001, the Controller General of the Republic ordered all institutions, public State enterprises and local governments to comply with a regulation that obliged them to include in their budgets a sum of money for the development of preventive and preparatory actions in emergency situations in the areas of competence, as was established in the National Emergency Law operative at that time and which the present government has maintained (La Gaceta, 2006). In 2002, 48% of municipalities – 31 cantons of the total of 81 – were complying with the financing of this activity, although not all of them had carried it out at that time (Romero, L., Brenes, A., 2002). The amount contained in the fund depends on the capacity and budget of the municipality in each case, but at least this enables the authorities to attend partially to local emergencies, making clear the difference between local responsibilities and those of the nation and the community, and attributing to the municipalities a necessary function which hopefully will be translated into political will and real options for undertaking local risk management.
- d) Other initiatives that have been in operation for several years include the creation of administrative instances within the government system: the Sectorial Agricultural Program for Risk Management (PSAGR) created in 2000 and placed under the aegis of the Technical Secretary for Sectorial Agricultural Planning (SEPSA) and the Office for Disaster Prevention and Attention (OPAD) set up in the Municipality of San José in 1997. The first of these promotes the training of sectorial officials in the subject of risk management and in facing events which harmfully affect national agricultural activity, as well as stimulating research with technical aims, and represents the agricultural sector in the COE, as well as fulfilling other tasks. The second case is a body that aims to identify the more problematic areas in the San José canton and the kind of events that are most frequent, with a view to collaborating in mitigating them and reducing the unfortunate consequences which contribute to present risk in this area, as well as trying to reduce these in the long term, having recourse to inter-institutional support with strategic planning (Romero, L., Brenes, A., 2002).
- e) The **Canton Regulation Plans**, created by the Urban Planning Law, are instruments that have significantly transformed the management of territory in the cantons and the municipal criteria for administration. Although it has been pointed out that these plans contain certain technical deficiencies

cies, more and more cantons are achieving a more responsible management in their municipalities thanks to their application. Besides, these documents attempt to include threats identified with each canton, and that means imposing legal restrictions on the way soil is used (Romero, L., Brenes, A., 2002). An effort in this direction has already been made by publishing the Atlas of Natural Threats (CNE, 2001) which, although general and synthetic, does constitute a first level of work and provides guidelines for deepening one's knowledge of local problems, a step which can be taken either by local governments or private or institutional interests who wish to carry out research.

As statistics have shown, harmful events of a hydro meteorological kind are the most frequent and the damages can be significant, whether they be caused by large-scale disasters or by neighborhood gales. Both for these and for events associated with other types of threat, the new administrative and legal regulations have contributed to creating a scenario for risk management in Costa Rica, the fruits of which in the medium term could contribute to orienting present conditions along the right path. Nevertheless, we need to do much more, as all those know who are involved in the task of reducing risks, given that, in order to be effective, this requires sustained and lasting commitment on a national scale. In this case, the key is to work from the communities upwards if we are finally going to achieve such conditions.

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Manifestations of ENSO in Ecuador⁷⁵

In Ecuador, disaster typologies indicate that floods, landslides and alluviums are the events that cause the greatest impact.

Environmental degradation in the upper regions of river basins and inadequate infrastructure in the lower parts combine to increase risk conditions. This leads to the spatial expansion of those disasters which occur.

Even so, risk management is still oriented mainly towards attention in cases of emergency. And, the lack of sectoral level work makes it hard to articulate integrated risk management actions. At the same time we note signs of a learning process on the part of the private sector which has begun to develop tools for self-financed management.

In Ecuador, since the 1982-1983 Niño event greater attention has been paid to the ENSO phenomenon as a potential cause of disasters. The 1997-98 ENSO event, the second most intense during the 20th century, caused almost four times as much loss as the earlier one and unleashed a growing concern and a widely-felt need to study the problem.

DISASTERS ARE IN FACT INCREASINGLY LINKED TO CLIMATIC VARIABILITY

The DESINVENTAR data base for the period January 1970 to December 2003 registers a total of 3,589 disasters; on average, more than 105 disasters per year, of which 1,375 are of anthropogenic origin (accidents, fires, explosions, etc.), 101 of geo-dynamic origin (volcanic eruptions, earthquakes, tremors, tsunamis, etc.) and 2,114 linked to climatic variability (CV) or hydro meteorological origins⁷⁶, representing 58.9% of the total.

Between 1970 and the last months of 2000, disasters of hydro meteorological origin increased by between 15.8% and 67.1%, and of these the number of floods and landslides was highly significant. Anthropologically induced disasters (accidents and fires) were the most frequent in the seventies, whereas in the nineties hydro meteorological events (floods and landslides) assumed this dominant position.

It is worth mentioning here that due to anthropogenic intervention in the natural environment, both at the global (the hothouse effect, climatic changes) and local levels (induced by urbanization processes, the expansion of the agricultural frontier, the impact of highways and other transport infrastructure, hydroelectric plants, industrial plants, etc.), hydro meteorological hazards are increasingly of socio-natural origin and not due solely to natural causes.

THE MAGNITUDE OF DISASTERS

The methodology used by La Red to construct the DesInventar data base, by contrast with other data bases, considers a disaster to be “the combined effects on human lives and economic infrastructure produced by an event (whether natural or not) registered at a maximum scale of territorial resolution”, without any need to stipulate a minimum number of dead, wounded, or affected persons or the need to declare an emergency or solicit international aid, as is required in the definition given by the Research Center on the Epidemiology of Disasters at the University of Louvain (CRED).

DesInventar’s definition enables one to define large-scale events – such as the 1997-98 El Niño phenomenon, or the 1985 Coca earthquake, or the eruption of Reventador in 2002 – as the sum of diverse events and effects distributed in di-

⁷⁵ Summary of the study “RIESGO ASOCIADO A ENSO Y VARIABILIDAD CLIMÁTICA EN ECUADOR – Patrones y Procesos de Configuración; Una visión Interpretativa a partir de Tres Décadas de Registro de Desastres” por Othón Zevallos Moreno (Co-PL Ecuador).

⁷⁶ Although these are not all strictly hydro meteorological events, we give that name to those that are thought to be associated with (or sparked off by) ENSO phenomena and by climate variability. These are: floods, landslides, sudden storms, heavy rainfall, gales, high tides, hurricanes, sedimentation, frosts, hailstorms, droughts, alluviums, avalanches, forest fires, epidemics, plagues, electric storms, snow, heat waves (Lavell *et al.*, 2001).

fferent geographic units over a given period of time. This allows us to sum and compare the local effects of these extraordinary events with the "normality" of the small, frequent, and recurrent small scale events that lay no claim to international, or even national, attention, but which when taken together may turn out to have as serious accumulative impacts as the major disasters.

Analysis of the magnitude of disaster events in Ecuador was undertaken using the methodology proposed by the Argentine research team. The magnitude scale goes from zero (no impact) to 30 (maximum impact). This Magnitude Index is based on a quantification of the effects on material goods and services, the impact on persons and the duration of the event. In accordance with this work, out of 1,322 disasters of hydro meteorological origin, 1,043 are classified as small, 272 as medium-sized and only 7 as large. The small and medium-sized disasters caused the greatest impact, which corroborates the hypothesis that the basic problem is not confined to the effects of large-scale disasters.

At the national level, Guayas, Pichincha and Manabí were the provinces most affected. These provinces, in order, are also the most populous in Ecuador. The greatest number of disasters reported is on the coast, with 58.3% of the total number of records in the data base, followed by the Sierra and the East with 33.9% and 7.8% respectively.

On the coast, floods (606), landslides (161) and epidemics (128) are the more important events. As for the Sierra region, the most frequent disasters relate to landslides (258), floods (150) and heavy rainfall (99). In the Amazon region, the most frequent are landslides, floods and, to a lesser degree, heavy rain.

At the municipal level, the greatest number of disasters are located around the Gulf of Guayaquil, in Manabí and in the province of Esmeraldas on the coast, and in Quito and Cuenca in the Sierra (or high Andean) area. Due to the coastal area's heavy rainfall, cantons with above average disaster levels are located at the foot of the western ranges, and municipalities with low disaster levels are located in the inter-Andean region and in the Amazon.

The study indicates that the number of disasters has increased noticeably over the last 34 years. An analysis taking samples every five years shows that the number of disasters due to hydro meteorological causes has risen from an average of two (2) events per year in the five-year period 1970-1974, to a maximum of 116

during the 1995-1999 period. There is an especially noticeable increase during those five-year periods in which large-scale ENSO events have occurred, as in the case of 1980-1984 (ENSO '82-'83) and particularly 1995-1999 (ENSO '97-'98).

Apart from the increase in numbers of disasters of a hydro meteorological origin during ENSO periods, there is also an increase in non ENSO periods (neutral periods, or periods of the La Niña phenomenon, according to the Trenberth classification, 1997). That is to say, a "normality" of disaster occurrences exists provoked by underlying socioeconomic processes which give rise to the vulnerability of certain populations in the face of normal hydro meteorological events associated with "normal" climate variability. The number of events occurring during extraordinary ENSO periods (1982-83 and 1997-98) equals the number of events that occurred during the following 13.5 years.

A more detailed analysis, summing disasters during NOAA nominated Niño, Niña or Neutral periods (see the chapter on Argentina) shows that 51% of all hydro meteorological disasters and 56% of floods have occurred during the 110 El Niño months. This demonstrates once again that in the warm phases of ENSO in Ecuador, hydro meteorological disasters increase, especially those associated with flooding and landslides. However, if one excludes the two extraordinary ENSO periods (May 1982-June 1983 and May 1997-April 1998), when the number of events is significantly greater, during the remaining periods, whether we are dealing with weak or moderately strong Niño periods, or with La Niña or Neutral periods, ENSO and general climate variability related disasters also occur. In fact, 33% of all disasters, including floods, have occurred during the 162 months deemed to be Neutral periods.

On the other hand, La Niña periods are less significant in terms of the occurrence of hydro meteorological disasters. Thus, during the 119 Niña catalogued months, 15% of the total number of disasters and only 6% of droughts occurred. The occurrence of drought is clearly associated with Neutral periods (75% of the total).

Thus, one can conclude that, from the viewpoint of preparing for, mitigating and forecasting the occurrence of ENSO related events, extraordinary events during the warm ENSO phase are at least as important as the Neutral or Niño occurrences, and to a lesser extent those of La Niña, whether the latter be weak, moderate or strong (that is, normal climate va-

riability) since in all periods and in all regions one or another significant number of disasters occur.

Floods

Although it is not always possible to characterize floods, 40% of those reported occur in rural areas, affecting agricultural land and small groups of population located in isolated small communities, receiving little or no support from authorities, and some 33% occurred in urban areas. An additional 10% affect highways, bridges and transport in general, while 3% of coastal areas are flooded and 5% affect both urban and rural zones simultaneously. In the case of 9% of occurrences it is impossible to determine the characteristics of flooding. Rural and urban floods occur with greater frequency along the coast.

In the case of urban areas, 40% of floods are caused by rivers breaking their banks, and 60% to a lack of capacity or deterioration of the sewage system, or to blocked drains along roads on the urban periphery.

Landslides

Landslides constitute the second most recurrent event and also the second most important in terms of the number of people affected. 476 landslides occurred throughout the 34 study period. 51.9% of these occurred in the Sierra, 33.8% on the coast (including the Galapagos Islands) and 14.3% in the Amazon region.

The greater occurrence of landslides in the in the Sierra, is a result of steep slopes and the geological instability of the Andes. This is aggravated by inadequate cuttings through the mountains or the removal of soil as roads are opened up. Quito and Cuenca – municipalities in the central Andean area – are the most affected.

Basically, when landslides occur in the cities these are due to unplanned urbanization, usually on hillsides and steep slopes. In rural areas, landslides occur basically because of the advance of the agricultural frontier and the destabilization of agricultural lands.

On the coast, the most affected municipalities are those located along the foothills of the western mountain range or on the Chongón range. An interesting fact is that the majority of landslides reported in Zamora are due to the exploitation of mines.

The recent 1997-1998 El Niño showed that landslides are now also a big problem along the coast. During this Niño event, coastal

areas reported 57% of all landslides, more than in the Sierra. Manabí was the province where most landslides occurred (44), followed by Pichincha (23), Guayas (17) and Esmeraldas (14). On the coast, typical clay formations, degraded by deforestation, inadequate agricultural methods, etc., have provided conditions that lend themselves to landslides.

In all reported cases, intense and continuous downpours of rain have sparked off or aggravated landslides. This factor is the principal cause of landslides. Another factor to bear in mind is the search for cost cutting, slope destabilizing construction of roads on mountain slopes. In Ecuador, some thirty existing river basins have unstable slopes.

In the Amazon region large-scale landslides have also occurred, such as that on the Guarumales-Mendez road in the province of Morona Santiago in 2002. The site of this landslide was declared a Holy Sanctuary due to the large number of people who were buried under the avalanche. The landslide was attributed to unusually heavy rainfall.

Another indirect consequence of the 1997-1998 El Niño was a malaria epidemic⁷⁷ which occurred, according to CAF, due to the mobilization of large number of people due to the large number of local disasters that occurred. These people spread the disease from the northern coastal areas throughout the whole coastal region.

Temporal and geographic variation

The occurrence of disasters of hydro meteorological origin has been increasing constantly over the past three decades. This may be related amongst other factors to the spread of population throughout the country and mainly towards coastal and central and southern Sierra municipalities. In the seventies, disasters were mainly reported in Quito and Guayaquil. In the eighties, however, due mainly to the 1982-1983 ENSO event, this spectrum broadened to include a greater number of coastal, central Sierra and Amazon region municipalities.

In the nineties, this process accelerated, with disasters being reported in 67 municipalities, a great number of them in the province of Manabí and in the middle and upper basin of the river Guayas.

Thus we are witness to a process affecting a growing number of areas and associated and explained by increasing conditions of exposure and vulnerability, since one can reasonably suppose that there have been no significant

⁷⁷ And other illnesses which attack numerous individuals in the same area during brief periods of time (days, weeks, months at most) such as cholera, typhoid fever, bubolic plague, etc. In Ecuador most epidemics occur in coastal areas.

climatic changes experienced in the affected geographical area.

This growth can be partly explained by Ecuador's accelerated rate of urbanization since the seventies, which was given impetus by petroleum exports. In fact, according to the preliminary results of the most recent census taken in November 2001, the country's urban population is now much larger than the rural population. The urban-rural relationship has changed from 58.2-41.8% in 1990 to 60.98-39.02% in 2001. During this decade urban areas grew 3.6% annually, while rural areas showed a negative 0.07% rate. This is manifested in rural-urban migration.

Population growth is undoubtedly another significant factor. Despite the continual decrease in population growth rates (from 2.9% annually between 1980 and 1990, to 2.1% during the decade 1990-2000), the country's population grew from 9.6 million in 1990 to 12.1 million in 2001.

Effects on people and infrastructure

The loss of human lives, the destruction of houses, the number of ill and, wounded and, in general, material and economic losses in sectors such as highways and transport, agricultural activity and public services, are the major effects of disasters.

By analyzing recorded disaster occurrences one may conclude that:

- 36% were associated with some level of death.
- 29% registered cases of destroyed homes.
- 20% affected roadways, and 13% affected the agricultural sector.
- Landslides are responsible for most deaths, followed by epidemics and floods.
- Floods, because of their number and extent, destroy most homes and affect the largest number of people.
- Landslides are the second most important cause of destroyed houses, because dwellings are often located on steep slopes alongside streams, rivers and so forth.

Index of materialized hydro meteorological risk

The occurrence of disasters and their effects can both be employed as Indicators of Materialized Risk (IMR). The simplest index is the number of disasters recorded during the period under study. If one constructs a series of independent values made up of the number of years in which hydro meteorological events occurred and assuming that the series behaves homogeneously, if this series is then divided by the

total number of years for which records were kept, one obtains a relative frequency of events, in other words, an approximation to the probability of their occurrence, with values between 0.0 and 1.0. This type of analysis can be made for all types of hydro meteorological event, or for particular types of event, although in this case the number of events is obviously less.

Applying such an analysis to places in Ecuador, Quito, Guayaquil and especially Cuenca present the highest indexes during the period analyzed. In the case of Cuenca, this is due to the Josefina landslide in 1993, which caused a great number of deaths and a huge amount of damage. In the case of Zamora, the high IMR is explained by the occurrence of a landslide at Nambija.

In general, those municipalities that correspond to Provincial capital cities are those that show the highest IMR values, due to the fact that many of these have large populations and highly-exposed infrastructure. However, others such as Quevedo, Pujilí and Baquerizo Moreno also present high indexes of materialized risk.

These factors of vulnerability are contributing to the creation of risk:

- *Vulnerability due to lack of access to resources* (VAR) is defined with reference to Basic Needs Met, a quality of life index, an infrastructure (services) index and overcrowding. This mainly occurs in impoverished areas along the coast such as Esmeraldas, southern Manabí and the north of Guayas, the provinces of the central and southern Sierra (such as Chimborazo, Azuay and Loja) and in Morona Santiago, Pastaza and Napo in the Amazon region. In the provincial capitals and large cities, vulnerability indexes due to lack of access to resources are lower.
- *Socioeconomic vulnerability*, defined with reference to the number of inhabitants, level of schooling and the number of economically active persons, is prevalent in urban centers with a large concentration of population and denser levels of infrastructure, such as in the Sierra: Quito, Ambato, Riobamba, Guamate, Cuenca, Loja and on the coast: Guayaquil, Santo Domingo, Portoviejo, Esmeraldas⁷⁸.
- *Demographic and population-related vulnerability* is present fundamentally in the municipalities of the Sierra, followed by municipalities in the province of Manabí. This is due mainly to poverty and migration.

⁷⁸ The apparent contradiction that exists in the fact that greater vulnerability due to lack of access to resources (SAR) is presented in the impoverished areas of the coast, whereas the greatest socioeconomic vulnerability is recorded in urban centers of largest population concentration, is due to the difference in the indicators employed to measure each of these "vulnerabilities".

- *The area most vulnerable to hydro meteorological hazards* is the inter-Andean corridor, although it is not the most exposed area. On the coast, the provinces of Esmeraldas, Manabí and Guayas are the most vulnerable, in that order. This vulnerability, combined with greater exposure to ENSO threats and climate variability in the coastal provinces, leads to the widely recognized fact that this region is the more highly affected.

Risk and vulnerability in smaller populations

Rural-urban migration processes are expressions of survival needs on the part of rural sectors. According to Vásquez (in Zevallos *et al.*, 1996, p. 290), the benefits of development in Ecuador are centered on Quito, Guayaquil and, to a lesser extent, Cuenca. Urban centralization is a common vice in the country, in the regions and municipalities, with the capital city dominating urban structures. The process becomes more blatantly visible as one moves away from the more developed poles. Smaller centres attempt to extract from even smaller centres what was lost to higher level centres. Rural villages and communities are the last link in this chain and groan under the weight of all kinds of injustice and are condemned to having a much lower capacity for resistance.

In general, according to DESINVENTAR data, the larger a population the more liable it is to suffer the effects of a disaster. If we divide the index of the number of disasters and their effects in each municipality by the number of inhabitants, this gives us an indirect indicator of the state of vulnerability in relation to the hydro meteorological hazard. Here we find that in small municipalities, although they are less populous and have fewer goods exposed, they are hit by relatively more events and suffer a greater number of deaths. This is the case, for example, if we divide the number of deaths due to disasters of hydro meteorological origin in each province by the population. The number of deaths per 100,000 inhabitants is greater in the provinces of the Amazon region, and also on the coast.

Something similar occurs if we carry out this same exercise for the number of disasters of hydro meteorological origin or if we divide the IMR by the number of inhabitants. By this means we can observe another dimension to the problem, closer to the vulnerability of each population group. Again in these cases, the provinces of the Amazon and coastal regions (and not the large cities) present greater per capita values for the IMR.

This suggests that small municipalities with less inhabitants and infrastructure are relatively more vulnerable when compared with

larger cities. Of course these data imply that more significant hydro meteorological hazards occur in the coastal region, especially during ENSO periods.

Does this fact contradict the direct relationship found between urban growth and increased vulnerability?

No, given that to the extent the urbanization process is one of the factors that most increases vulnerability (since it implies that more people and a greater number of goods will be exposed), the urban process-vulnerability formula still stands. There will be a more manifest risk index, more disasters and more destructive effects associated with them. However, a closer look shows us that in proportion to the number of inhabitants and the quantity of goods exposed, smaller population centers (rural areas, more dispersed human groups, the poorest and those most distant from the centers of power) suffer relatively more deaths and greater ecological and material losses as a result of disasters.

Manifestations of ENSO

According to the World Meteorological Organization (WMO, 1998), the 1997-1998 ENSO phenomenon was one of the strongest on record, with sea surface temperature anomalies (TSM) of between 2 and 5 degrees Celsius above their normal value. During the 1982-1983 and 1997-1998 events, the most intense maximum rainfall levels for a 24 period were recorded in various places along the Ecuadorian coast, and extraordinary specific volumes of water were registered. As for the hydrological aspects, during the 1997-1998 ENSO record river stream flow statistics were recorded in various places (Heredia-Calderón, 1998), close to a world maximum.

During the cold ENSO phase (Niña events), positive rainfall anomalies sometimes occur. Such was the case during the 1988-1999 Niña event when anomalies occurred at various parts of the coast (Heredia and Galárraga, 1999). Extraordinarily intense local events are also possible even though they may not be associated with. Such is the case with the Manabí region during the rainy periods associated with the 1999-2001 Niña, and in the extraordinary event recorded in March 2001 at Portoviejo (Zevallos, 2002).

ENSO and climate variability: Normal and Abnormal

To understand in greater detail what is normal and what is abnormal as regards annual rainfall and its relation to ENSO events, we analyzed pluvi-metric anomalies at the Manta,

Chone and Portoviejo stations. From this analysis we may conclude that the presence of a warm ENSO period (El Niño) signifies the likelihood of lower rainfall. However, only very strong ENSO events, such as those of 1982-1983 and 1997-1997, produce clearly pronounced anomalies in the matter of precipitation (usually with major deviations above 1). The remaining occurrences during neutral, moderate Niña and even heavy Niño, periods, can be considered part of normal climate variability (anomalies with a positive or negative standard deviation of above 1). Due to the semi-arid climate on Ecuador's central coast, the absence of El Niño events implies a major risk of drought.

PROCESSES OF RISK CONFIGURATION

Spatial analysis: From the national and regional to the local levels

The Province of Manabí, mainly its central region, was chosen for study.

This area is the locus of the province's major cities, with a total of around 600,000 inhabitants. Information was culled from the local newspaper with a view to constructing a more complete and detailed data base for the period 1960 to 2003 than was available through the national DESINVENTAR data base. During this period, episodes of drought and very severe floods were experienced.

Socioeconomic indicators for Manabí

Social Development, Housing and Poverty Gap indicators for Manabí Province are average in relation to the rest of the country (economic vulnerability). The Municipal Management Index is low and barely reaches 29.4% (institutional vulnerability). The largest and most populous municipalities, such as the provincial capital, Portoviejo, have greater indexes of relative development. At the same time, poverty and the lack of development are more evident in the rural areas than in the cities. An example: in Portoviejo municipality the city's Social Development Index is 69.3% and only 48.1% in the countryside. For the Santa Ana municipality, the housing index is 66.7% in the city and 46.5% in the countryside. In terms of municipal management there is a similar degree of achievement in the lower ranges. As for gender differences, indicators of illiteracy, for example, are greater among women (16.3%) than among men (14.7%), although this difference is becoming less marked (educational vulnerability).

Due to rural poverty, rural-urban migration has become a spontaneous strategy to mitigate po-

verty. Since the seventies, rural areas have suffered a decrease in relative and even absolute population levels and numerous marginal shanty towns have sprung up around the two largest cities as a result of this (Manta and Portoviejo). The population of Manta municipality grew 44.8% between 1990 and 2001, while in others such as Santa Ana, Olmedo, 24 de Mayo and Bolívar (fundamentally rural municipalities) population decreased (economic vulnerability).

The 1968-1969 and 1979-1982 droughts were particularly severe. During the former, it did not rain for 20 months, most of the rivers dried up and water had to be supplied from wells excavated in the river beds. The drought led to whole families of farmers leaving the land, as was reported in April 1968 in the *Diario Manabita* (Card No. 177). The availability of water from a limited number of sources, such as La Guayaba, led at times to mass brawls, as was reported in the press in March 1969 (Card No. 35)⁷⁹.

As for floods, those that occurred during the 1997-1998 Niño were the most severe. 3,850 mm of rainfall were recorded in Chone in practically 24 consecutive months of rain. In March 1998, 10 homes were reported destroyed in Olmeda municipality, while another 200 were affected by the rise of the Puca river. In November 1997, patients at the Calceta Hospital had to be evacuated because the Carrizal river flooded. In June 1998, a month when it usually does not rain, several neighbourhoods in the city of Chone were flooded by upto 1.5 meters of water. In October 1997, the parish of Novillo del Cantó Flavio Alfaro was completely isolated due to rain (Card No. 982).

PROCESSES OF RISK CONFIGURATION: THE CASE OF THE RÍO PORTOVIEJO BASIN

Environmental analysis

A diagnosis of environmental problems carried out by Zevallos (2000) for a Technical Assistance in Environmental Management project revealed that contamination by sewage and rubbish, the blocking of the river flow due to waste matter left on its banks, the lack of hydro capacity and sedimentation were the most serious environmental problems suffered. With regard to the river basin, environmental degradation due to deforestation and the burning of vegetation, the conversion of woodlands into pastures on steep hillsides and, unplanned urban settlement on hills and slopes, lead to erosion, loss of fertility, lower productivity of the soil and the impoverishment of the *campesinos* living in the area⁸⁰.

⁷⁹ This refers to index cards on which data has been collected using the DesInventar method.

⁸⁰ Vulnerabilities that lead to the ecosystems' losing their resistance capacity and their resilience, which in turn leads to threats for the communities which interact with them. (Note by Wilches-Chaux).

In another study carried out by Valencia (2001), under the direction of Zevallos, the following causes of flooding were revealed:

- Mismanagement of natural resources, fundamentally in the upper and middle river basin.
- The inadequate implementation of infrastructure, mainly in the lower river basin.

The major negative index concerns the upper basin (located to the south of the main basin) which corresponds to the sub-basin of the Lodama river. This region is also the poorest and has very serious problems of erosion due to environmental degradation, aggravated by the 1997-1998 El Niño. The change in land use and the conversion of woodlands into pastures, as has occurred in the sub-basin of the Chico river (the central eastern part of the basin), has brought about erosive processes on the hillsides⁸¹.

Effect of infrastructure on flooding

Ill-conceived roads, designed and built on flood plains without taking into account hydraulics and environment, lead to the damming of floodwaters. Moreover, roads built with insufficient lateral drainage or using narrow bridges act as funnels which cause rivers to dam up, producing sedimentation in the valley and contributing to the likelihood of floods.

The building of thirteen bridges, twelve of them too narrow or too low, has led to the blocking of the river's course, causing increased flooding in several sectors. The most obvious example is that of the Cruz Verde road (Ceibal) to Rocafuerte which cuts across the valley of the Portoviejo river. The bridge is no more than 20 meters wide and the river has a capacity at this point of only 66 cubic meters, whereas the volume of water can reach 600 cubic meters. One can imagine the consequences.

The building of seven dams with heights of between 2.5 and 3.0 meters, meant the elevation of the river bed and hence, water levels too. This has made flooding more likely and has also increased the sedimentation problems with serious consequences for agriculture,

for the life of the local farmers and for the ecosystems.

Behind all disasters there is invariably a lack of awareness of risk, and also a lack of alternatives due to poverty. Solutions are patchy or demagogic, people react as if it had been impossible to foresee what was going to occur, irresponsibility and often corruption are also present. In the end it is clear that the disaster was not of a natural order. It was political, technical and environmental. In the end the real disaster is the sort of society that we have constructed⁸².

It has also been shown that the increase in risks associated with ENSO and with climate variability in general can partially be explained by the greater magnitude and frequency of a natural phenomenon, namely rain, as well as by population growth and the level of infrastructure exposed to hazards. However, as has also been demonstrated, in the face of events of like magnitude, the greatest impacts are due fundamentally to an increase in social vulnerability. The deterioration of the national economy, growing poverty and inequality, processes of urbanization and environmental degradation are the causes of an increase in the number of hazards and in the ever increasing vulnerability of the population, infrastructure and ecosystems. This, of course, leads to greater risk conditions.

Last minute, emergency actions designed to prevent or mitigate disasters, have little or no effect when it comes to significantly reducing the risk of disasters in the communities. Nor do they prevent floods and landslides from occurring, nor diminish the number of deaths, people affected or infrastructure lost. We cannot resolve in a few days what we have been deteriorating over decades, least of all considering the scanty resources at our command. Emergency works, which almost all governments feel obliged to implement in order to help assuage social and collective pressures, are not designed to solve the real fundamental problems. Rather, they are implemented in order to deal with small and isolated cases where there is a particular, passing hazard. But this kind of activity has little impact on the larger and wider problems of a whole region.

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⁸¹ The deterioration of ecosystems reflects a deterioration in people's quality of life, and viceversa (Comment by Wilches-Chaux)

⁸² In short, the disaster is a territory's inability to provide its inhabitants with integral security. (Comment by Wilches-Chaux).

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Manifestations of ENSO in Florida, USA⁸³

Este estudio, el único de este proyecto que se realiza en un país del “primer mundo”, revela de qué manera los cambios en el uso del suelo, el crecimiento urbano, las brechas existentes entre ricos y pobres y la evolución de la economía durante los últimos 50 años, generan los escenarios propicios para que fenómenos de carácter natural, como los huracanes, los tornados, las tormentas eléctricas, las inundaciones, las sequías, los incendios forestales y las heladas, produzcan graves desastres en las comunidades que habitan en territorios que han perdido la capacidad de convivir sin traumatismos con los efectos de esos fenómenos, cuya ocurrencia no es inusual en esas zonas.

En los días en que este libro se preparaba para entrar en prensa (febrero 2 y 3 de 2007) en una noche se registraron tres tornados que azotaron la zona central de la Florida y dejaron cerca de 20 víctimas mortales, además de una enorme destrucción física y ecológica y enormes pérdidas económicas.

RISKS IN FLORIDA

Assessing Florida’s degree of vulnerability when faced with natural disasters is a task which ought to be carried out in the context of changing social, economic and environmental patterns and processes that have characterized the State’s development in the 20th century.

Patterns of local risk and vulnerability are generated by underlying social, political, territorial and economic patterns that function with regionally specific results. The majority of risks associated with ENSO are more likely to be of a socio-natural kind rather than a simply natural one. Human interventions through deforestation, infrastructure projects, intensive grazing, mining and the exploitation of waterways contribute to producing hazards such as flooding, forest fires and droughts. At the same time, urbanization, migration and economic development projects generate complex patterns of vulnerability in the face of hurricanes, tornadoes and other such storms. Thus the evolution of disaster risk cannot be explained without reference to development models and practices that are operating in the region. In order to reduce risk in the future, and in a sustainable fashion, such considerations ought to be broken down into social and economic terms and must take into account territorial development.

HALF A CENTURY OF ACCELERATED CHANGE (1950-2000)

The second half of the 20th century was a period of enormous change in Florida. Especially over the past thirty years, powerful forces such as immigration, emigration, climatic change, infrastructure and economic development have profoundly altered the social and physical identity of Florida and its citizens. In these years, the State has experienced a period of significant population and urban growth, as well as economic and environmental change.

Florida is the fourth most densely populated State in the US, with over seventeen million inhabitants. Its present growth rate is twice that of the nation as a whole. For example, in mid-twentieth century, from 1950 to 2000, Florida’s population was doubled four times over, increasing from 2.7 million in 1950 to 15.9 million in 2000. In the nineties, the growth rate was in the region of 23.5%, whereas the national rate was 13.1%. This population increase has certain particular traits. Florida overall, and particularly cities like Miami, have populations with a high percentage of elderly folk, often people who have come to the State to retire. Miami and Southern Florida in general are also remarkable for the large number of residents who were born of foreign parents. The population is distributed in such a way that there is a large percentage of senior citizens in the

⁸³ Summary of PATRONES Y PROCESOS DE VULNERABILIDAD ANTE AMENAZAS EN LA FLORIDA by Anthony Oliver-Smith, Christopher Berry, Sarah Cervone, Amanda Holmes, Byron Real, Joanna Reilly-Brown and Astrid Wigidal.

peninsula's coastal area, where development has been mainly urban and suburban. At the beginning of the 21st century, the percentage of urban residents in the State has grown by 75% since 1950 (Mormino, 2005; 19).

The nature of urban growth also presents particular characteristics. At present Florida is indisputably an urban State, where there are only a few hundred thousand residents living on the outskirts of metropolitan areas (Mormino, 2005; 20). However, in this urban pattern more people live in areas not incorporated than in incorporated municipalities. The fact that millions of inhabitants have decided to live in areas remote from urban centers reflects the impact of the automobile, urban design and planning. The result of these impacts is that Florida's cities tend to decentralize, exhibiting low levels of population density (Mormino, 2005; 31). Another significant aspect of this tendency has been excessive difficulty in regulating growth. Consequently, Florida's cities tend to be "marginal", characterized by uneven urbanization. Many attribute the deterioration of city centers to the loss of arable land and to this haphazard urbanization.

Another pattern of urbanization, mostly a result of Florida's economy, based on tourism and as a place for retirement, is the development of coastal areas. Towards the end of the 20th century, 25 of the 30 largest cities in the State were located either on the Gulf or the Atlantic coast. The areas between the cities, along the beachfront, were affected by unregulated development, so that many non incorporated areas and small towns are characterized by an uninterrupted line of large buildings and condominiums stretching along the narrow strip of coast. On the Atlantic coast, this thin line, which is densely populated, is located on the islands between the coastal road and the ocean itself. Between 1950 and 2000, the coastal population increased by 609 per cent, from two million people to over twelve million. By contrast, the residents of non coastal areas increased by an impressive 493 per cent. However, in absolute terms the change from 750,000 to 3.7 million was merely a slight increase when compared with that of the population growth along the coast.

By mid-twentieth century the State's economy was based on agriculture and tourism, although it did also possess a manufacturing sector, relatively small when compared with States in the north of the US. The following fifty years brought to Florida, along with an enormous increase in population and urban development, successive periods of bonanza and of crises, generating an economy with strongly marked contrasts. In Florida there is enormous

wealth alongside critical conditions of poverty. In 2000 the average income in the State was lower than the national level. As Mormino has pointed out, construction, space and defense industries, expanding agro-business in citric fruits, winter vegetables, cattle raising and an increase in tourism have not succeeded in elevating the economies among the lower strata of society in the United States. Florida depends excessively on two very vulnerable industries: tourism and agriculture. The State's labor structure has been characterized by marked increases in the sector which receives the lowest pay and on the agrarian sector. Manufacture represents only five per cent (5%) of the State's gross product. Despite the massive wealth accumulated in certain sectors, especially in the tourist industry, building and agriculture, Florida's economy is characterized by much disparity between low incomes and great wealth among the population in general.

Both the enormous population increase and the particular patterns of urban development have had serious implications for the fragile environment. In fact, as has happened in the majority of environments, Man has transformed this region. However, in Florida's case, the changes have been extreme. People have seriously modified the State's terrain, altering its hydro resources and its temperature, and changing the chemical composition of the air. Technological innovations in pesticides, air conditioning and mass transport have made Florida habitable and accessible to millions of people (Mormino, 2005; 231). Stimulated by massive investment in tourism, building and agriculture, growth and development have devastated large areas of Florida, undermining key ecological characteristics and processes such as the patterns of rainfall and drainage for one third of the State's area in the south. Rivers have been channelled, wetlands drained, reclaimed for building and covered over with housing estates. Forests and natural reserves have been destroyed. Dunes and beaches have been eroded or destroyed to make way for building sites. Bio-toxins, industrial chemicals and fertilizers have entered the ecosystem in great quantities. All these costs of growth and development have led to the destruction of the environment, endangering life itself in the State.

There are numerous implications behind such social, demographic, economic and environmental processes as regards vulnerability in the face of hazards. A few examples will serve to illustrate how patterns of vulnerability are linked to processes of development in Florida. From a demographic perspective, population density presents a problem in situations where there arises a need for rapid evacuation. A successful evacuation depends on how densely

populated (or otherwise) the area is, and also on the quality of the roads and the duration of the early alert system. Population density along the coast exposes a lot of people to storms and tidal variations. Psychologically the high percentage of senior citizens who have retired from other regions means that the population has far less experience of the kind of threat which is typical of Florida and therefore may have much greater difficulty in responding to an alert or in dealing with post-disaster conditions. The high percentage of residents born of foreign parents and who are not native English speakers may also lead to problems of communication when alert signals are given by the authorities. Economic growth in sectors like the services and agriculture has meant that many people earn low salaries. Such people may have little access to communication systems or may live in inadequate housing conditions. Old houses, mobile homes and dwellings built before certain building codes had been established often prove to be inadequate during hurricane seasons. Unplanned development has led to vulnerable systems of services such as water and electricity supply, and this causes a hazard and has a negative effect on the quality of drinking water. The management of residual waters, including sewage, may be suspended, and inadequate draining could easily lead to contamination of surface waters, placing human populations in danger, as well as fish and the general stability of the fishing and lobster industry.

ENSO AND HAZARDS OF A NATURAL ORDER IN FLORIDA

As has been observed over recent decades, the exceptionally humid and then, conversely, the excessively dry conditions caused by El Niño and La Niña respectively, are precursors of flooding and drought. An example of this occurred during the early stages of ENSO between 1997 and 1998 when, with the pattern of teleconnection, El Niño generated dry conditions in the north west and wet conditions in the south east. This caused excessive precipitation in Florida, reaching, in 1997, a figure twenty percent (20%) higher than was normal for the months of October to December. In marked contrast, shortly after El Niño, the Niña phenomenon occurred ushering in the driest and hottest period Florida had experience in over a century. This occurred between April and June 1998. This season was recorded as one of the driest in one hundred and four years (Laing *et al*, 2000)

When understanding the probabilities of variations in the conditions of weather and the pa-

terns of teleconnection in both phases of ENSO, it seems reasonable to link the phenomenon with a number of associated events. Jones, Shriver and O'Brien have shown that ENSO has an influence on Florida's precipitation rate, as it does in other parts of the world also. They explain how heavy rain in the Galapagos Islands during the autumn season is often followed by winter rain in the southern States of the US. Floods which occurred in the autumn of 1997 and in early spring 1998, are clearly associated with this oscillation.

The effects of ENSO on forest fires are even more evident. According to Goodrick and Brenner (2000), over the past decade of interaction of ENSO in Florida there have been many forest fires. Swetman (2000) confirms the influence of ENSO in creating conditions for fires of this kind. Employing an analysis of tree rings from 1600 up to the present time, Swetman points out that ENSO has had a significant influence on available firewood and potential forest fires, especially during times of extreme occurrences. An episode of a more humid Niño phenomenon is usually associated with an increase in exuberant seasonal vegetation, especially certain kinds of grass, which become inflammable during the dry season. That is why the confluence of an especially wet El Niño period followed by an unusually dry Niña creates an enormous potential for the propagation of forest fires.

Morehouse (2000) explains that such a convergence occurred during the 1997-1998 ENSO period when interaction between Niño and Niña increased the potential for the most destructive forest fires in the history of Florida. Morehouse (2000) and Goodrick and Brenner (2000) state that when wet conditions suddenly change into dry conditions (a rapid passage from Niño to Niña) there is a greatly increased likelihood of forest fires, which are sparked off by social or natural detonators.

As a global event, the ENSO effect produces climatic anomalies in different parts of the world, teleconnecting regions of the planet which are widely separated from one another (Glantz, 1994). As has already been pointed out, these teleconnections function with similar (or opposite) effects in areas like the South East and the North West of the United States, or in areas such as the Galapagos Islands. Such anomalies may also make themselves manifest in the form of severe drought, floods or hurricanes. Records in Florida do not necessarily reflect a relationship between ENSO earlier than the nineties, and this is due to the high instability of its occurrence, since it only produces joint climatic conditions that are similar (or opposite) in widely separate regions, and that only

after a period of many decades. Therefore the analysis of an area or of a particular weather sample may easily confuse researchers who are unable to perceive the importance of an analysis of the local conditions that are generated by ENSO. Nonetheless, by broadening the scope of the analysis, both in space and in time, researchers obtain surprising results on how ENSO functions in different parts of the world and on its different patterns of similitude and lack of similitude. This understanding of how the mechanics of ENSO work notably improves our knowledge of the role this macro event plays in spreading social risk and vulnerability, in combination with the spread of anthropologically-generated conditions such as urbanization, the production of goods and the use and extraction of natural resources around the world.

HAZARDS OF A NATURAL ORDER IN FLORIDA

Hurricanes

Due to Florida's geographic location, it is often the first place in the US to be hit by hurricanes. Historically this State has been one of the most affected by this kind of hazard and has necessarily had to adopt measures to minimize the effects of such happenings. Florida's subtropical environment and its closeness to the Atlantic Ocean and the Gulf of Mexico make it vulnerable to tornadoes, storms and hurricanes. The communities that are most vulnerable to the impact of hurricanes are located along the State's coastal areas, many of which depend on coastal resources to sustain economies based on tourism. The impact of hurricanes may severely affect tourist activities of the said coastal communities, and likewise their local economies.

Between 1970 and 2001, Florida was affected by hurricanes that caused economic damage and social instability over eleven years. According to Florida's Data Base for *DesInventar*, on which this chapter is based, during the period 1970-2001 hurricanes were responsible for fifty-eight deaths, the destruction of over 250,000 houses and economic loss amounting to over twenty-nine billion dollars.

Except for Hurricane Andrew, which caused forty-four deaths, the number of victims due to hurricanes over the past thirty years is minimal if we compare them to previous decades. However, economic damage caused by this kind of occurrence is enormous. Hurricane Andrew is the one that has caused most damage during the period under study. According to *DesInventar*, total losses amount to

US\$ 29.578'329.175, of which twenty-five billion dollars correspond to Hurricane Andrew. This was the most destructive hurricane in the history of the United States. Andrew damaged or destroyed 125,000 dwellings and left 250,000 people homeless. (This article was written before Katrina)*.

Patterns of vulnerability among Florida's communities can be seen in the effects of Hurricane Opal, in Okaloosa County, where twenty-four miles of coast on which the tourist industry has been developed were severely affected. Opal reached land as a Category 4 storm at 6 p.m. on 4 October 1995 and produced destruction valued at three billion dollars. Up until 2004, Opal was the third most costly hurricane in its impact on the United States, after Andrew (1992) and Hugo (1989). Over 100,000 people were evacuated before the storm hit, and approximately 40,000 residents were temporarily installed in Red Cross refuge camps. The intense storms leveled the sand dunes and deposited three to five feet of sand in front of houses and shops facing the beach. Hundreds of boats were destroyed in the marina. Sewage and drainage systems were damaged, roadways eroded and electric and telephone cables were also affected. By contrast with other major disasters, in this case residents and those in charge of attending to the emergency did receive warning from the National Hurricane Center about when and where a hurricane was likely to strike a particular area. However, it is a known fact that hurricanes undergo sudden unexpected changes in their course and intensity at the moment of making contact with the land. Immediately before Opal hit the beaches, its force increased from Category 2 to Category 4, and its speed accelerated from 8 mph to 21 mph, which meant that it hit the shore a day before it had been expected.

In many of Florida's counties, tourism is an integral component of the economy, as it was in Okaloosa. The tourist industry is highly susceptible to the negative impacts of events of extreme climatic change. Many coastal communities depend on the quality of their beaches and of their services in order to attract visitors and make earnings out of tourist activity. Coastal destruction caused by Opal had a significant impact on tourist trade for well over a year. A year after the hurricane hit, 70,000 less people had visited the county than was normal. Before Opal, there were 10,000 rented dwellings; after it, only 2,000 of these remained habitable. Motels and condominiums had to be built and available housing was occupied by contractors, insurance inspectors, people in charge of attending to the emergency and displaced proprietors. A year after Opal occurred, the overall earnings from tourism were merely

* ... struck the Gulf of Mexico in 2005. Katrina losses are calculated in 100 billion dollars, and some sources calculate about twice that figure.

18% of what they had been before. A year after the disaster, one million dollars were spent on announcing to the rest of the nation that Florida's Northwest had recovered from Opal.

Tornadoes

Florida leads national statistics in terms of the annual total of tornadoes reported for every 10,000 square miles, and is third in terms of the total number of tornadoes per year (FEMA). Nevertheless, most tornadoes in Florida are relatively small, do not last long and rarely result in deaths. While the greatest number of tornadoes occur in June, July and August, more lethal tornadoes are likely to hit early in the Spring - in February, March and April. Winter and Spring tornadoes are more powerful due to air currents which move across the Gulf of Mexico at these times.

In the rest of the country, the most violent tornadoes occur in the afternoon or at nightfall, due to an increase of heat during the day. However, Florida's most violent tornadoes may occur at any time, day or night. This time factor increases residents' vulnerability, since a lot of people already retire to bed after midnight and do not hear the alert signals transmitted by radio or television. Nonetheless, Florida's tornadoes are neither so mild nor so brief as not to merit a timely warning by the State's Meteorological Service. For example, during the night of 22-23 February 1998 there were at least seven tornadoes. Four of these caused the loss of human lives. At 12,40 a.m. on 23 February, there occurred a tornado in the county of Osceola that was traveling at 56 kph before arising, an hour later, over Orange County. This was the most catastrophic of the seven that occurred that night. It caused 25 deaths and around 150 wounded in the city of Kissimmee and its environs in Osceola County. Numerous demographic, economic, environmental and socio-cultural processes, including patterns of human settlement, the basis of the community's economy, patterns of conservation and the use of soil and institutional structure activated or increased people's vulnerability due to the above-mentioned events.

Osceola is located in the wider metropolitan area of Orlando, and is one the counties with especially rapid growth. The total population was 172,000 in 2000, of whom 77% were white, 7% colored and 29% Latins (a category that the Census Office classifies as a "separate racial category" and that would seem to be included under the general category of "white"). Research carried out on the racial characteristics of the victims in the county revealed that over 90% were white, while there were only two Hispanics or Afro Americans. As was pointed

out by Schmidlin *et al.*, this could be a phenomenon that has more to do with the route the tornado followed than with any special risk associated with racial types, since the majority of victims were living in caravans and mobile homes in parking areas. All victims of the tornado were people from mobile homes, recreation vehicles or automobiles; on the other hand, the tornado hit the Hispanic subdivision of the Buenaventura Lakes, which consists mainly of vacant lots, so that the risk of serious bodily harm to individuals was greatly reduced.

Given that the county is located south of Orlando, a highly developed tourist resort, the basis of the economy depends on that activity, while citric fruits and cattle ranching play supplementary roles. Whereas the percentage of people living below the poverty line is slightly lower than in the State taken as a whole, the average per capita income, US\$17,022 is below the State average (US\$21,577). The low incomes of the majority of those employed in tourism and agriculture means that less is spent on housing, and this means that more people live in mobile homes in the Kissimmee area than elsewhere. Additionally, the economy based on tourism invites people to spend their vacations in recreational vehicles for months at a time in this same area. This concentration of a population economically formed by this lifestyle leads to greater vulnerability in the face of events such as tornadoes when they take place in the area, simply due to the number of residents who are also potential victims. High levels of population concentrated in the North West of Osceola County, combined with the fact that many people live in mobile homes or recreational vehicles, makes them extremely vulnerable. Also the fact that there are two lakes nearby contributes to a large concentration of people in this already vulnerable area.

Electric storms

According to the National Agricultural Safety Database, a greater number of electric storms occur in Florida and therefore there is a greater impact due to lightning than in any other State. Electric storms are produced when masses of air charged with humidity are swept upwards due to temperature and, forming cumulus clouds, they darken as further humidity accumulates. The upper sections of the clouds generate a positive charge, while the lower ones generate a negative charge. This causes a flow of energy downwards towards the earth. The positive charges try to get as close as possible to the cloud, normally in the highest objects nearby, and lightning occurs when the difference between positive and negative charges is sufficiently great to overcome resistance and

create a route between them through which it can pass. Apart from lightning strikes, other very common phenomena are air blasts from above that can reach speeds of over 100 mph. These are known as “vertical explosions” and can cause considerable damage to infrastructure and the environment.

On average, some ten people are killed annually and about thirty are wounded in Florida as a result of electric storms. Approximately 50% of accidents occur in recreational centers, and of these about 40% are related to recreational activities associated with water, such as sailing, surfing and swimming (Becker DATE) Our database at *DesInventar* shows that remunerated activities, such as those related to building and maintenance, also partly explain accidents that occur as a result of lightning strikes. Electric storms and their effects also cause drastic economic impacts, costing the State thousands of millions of dollars over the past thirty years according to the ENSO database. This database reveals that every county in Florida has reported at least US\$ 100,000 in losses due to electric storms in the period from 1970 to 2000.

In accordance with Florida’s Division of Emergency Management (FDEM), the interior areas at the heart of the State are hit by the greatest number of storms, with a total of over 100 days per year. Storms are frequent too in coastal areas, occurring on an average during 80 or 90 days in the year. *DesInventar* reveals that two areas, in the counties of Gilchrist/Marion and Pinellas/Hillsborough Park have reported the highest figures of loss due to electric storms during the past thirty years. Pinellas and Hillsborough are also places where there is the greatest number of people killed or wounded by electric storms.

The impact of electric storms is related to the fact that both regions are located in the State’s coastal area, which receives storms during 80 or 90 days every year. High figures of loss reported in Gilchrist and Marion can be related to agricultural activity in those areas. Whereas Pinellas and Hillsborough are highly urbanized and are therefore more exposed to structural damage caused by high winds. The county of Polk has a high level of agricultural activity and thus is exposed to losses caused by storms. Recreational activities have significant importance when it comes to examining the number of deaths caused by lightning in Florida. These are more numerous in Pinellas and Hillsborough than in other affected areas. The fact that these two counties in the Gulf area are more affected could be explained by the great quantity of recreational activities, as well as by their accelerated urban growth,

which means that laborers are often obliged to work out of doors, despite the threat of electric storms.

Floods

Floods occur as a result of the way natural factors such as the duration and intensity of rainfalls, the permeability of the soil and its drainage capacities are combined with cultural factors such as physical infrastructure (asphalt, sewage and gutters). Floods are produced when soil becomes saturated by a storm with such rapidity that it is unable to absorb the quantity of water received. The flow of water transports surface layers of water that flow swiftly due to gravity. As a result, everything that is in the way of these surface currents is dragged towards draining systems, river basins and nearby waterways. In urban zones, floods may exacerbate their behavior when faced with blockage or inefficient drainage systems and extensive surfaces covered with asphalt. This facilitates the rapid flow of great volumes of water that in other conditions would be absorbed by the soil (Marchman, 2000). Of course floods are phenomena that can occur in any place where the capacity of a river bed, for example, is at its maximum level. Along the coast, storms can temporarily flood the lower regions, many of which, once the storm has passed, will remain flooded indefinitely.

Dade County, followed by Pinellas, Volusia and Alachua, are where most floods are recorded, and they also happen to be the counties with some of the highest population density in Florida. From this we can deduce that there exists a direct relation between urbanization/infrastructure and increased damage caused by floods. Although floods can occur anywhere in the State, the danger is greater in those areas that are not equipped to handle periods of intense rainfall (Alpalachicola Regional Planning Council, 2004). Both in urban and in rural areas, the impact of flooding varies. The combination of certain economic and political conditions, plus municipal infrastructure, create conditions that cause territories to be affected to a greater or lesser degree. For example, Alachua County reports a higher incidence of heavy rainfall that many other counties along the coast that tend to suffer from tropical storms. Hypothetically this could be due to population density, which would make them more susceptible to structural damage, such as falling trees and damage to roofs.

Despite the high incidence of damage reported due to flooding in urban areas, the most severe and recurring damage is experienced in rural areas. For example, in the case of Franklin County, the factor which generated most floods

was the succession of tropical storms (Beryl and Alberto)⁸⁴. In less urbanized areas, the lack of adequate systems of sewage may retard the rate of absorption, as will occur also where housing conditions are deficient.

It is certainly quite clear that coastal areas are susceptible to being affected by floods. Many such areas record damage estimated in millions of dollars. Low lying areas and highly urbanized ones along the coast are definitely those that are likely to be most damaged as a result of floods. Both areas suffer structural damage (flooding of roads, houses and shops) although urban areas do seem better equipped when it comes to recovering, or from preventing a certain amount of damage from occurring. Many counties are highly dependent on agricultural activities, and therefore a flood in the area of crops may have a greater impact on rural areas than on urban counties (Livingstone, 2003). The destruction of a crop produced more collateral harmful effects. At the same time, the seriousness of floods in urban areas ought not to be underestimated. Coastal areas are among those in which real estate values are high and where large buildings are constructed in the center of urban areas (for example, St. Augustine and St. Petersburg). This is why the proximity to large expanses of water increases the population's vulnerability to floods. The network of damage, both immediate and tangible, which is caused by flooding in urban zones is notorious according to the records kept by *DesConsultor*. This kind of damage can be analyzed and classified. However, the resilience of crops and herds may be diminished under sustained flooding conditions. Situations in which the appearance and dissemination of diseases that develop in aquatic environments could easily lead to a setback in crops and cattle. Likewise, an increase in the turbulence and muddiness of water (quantities of sediment, for example) have an incredible effect on aquaculture and therefore on tourism and fishing, which are the pillars of the local economy for many coastal communities (Agency for Environmental Protection, 1994).

Floods in coastal areas may be a recurring phenomenon. Some of the most visible and immediately recognizable effects of flooding are coastal erosion, flooding of low lying land and damage caused, both to structures and to crops. Independent of the kind of flood which has occurred, floods can affect the quality of the water and thus do harm to local communities and industries (MMWR Weekly, 1995). This series of effects do not appear until some time after the flood has occurred and may last for long periods of time. Therefore the chain effects may finish up causing much greater damage than was originally estimated.

What happened in the Apalachicola estuary in Franklin County in the early nineties, and went on up to the year 2000, provides a useful illustration of this. The health of the ecosystem in the Apalachicola bay constitutes a clear example of how one can detect matters such as regional politics, micro regional weaknesses in infrastructure, economic susceptibility and environmental degradation. The National Reserve of Estuary Investigation in Apalachicola is the largest of its kind in North America and one of the largest in the western hemisphere. The reserve is located in a major river basin nourished by the upper waters of Georgia and Alabama. Intense urban growth in Atlanta during the mid-nineties, and right up to the end of that decade, led to worries about irrigation rights and the purity of the water resources. This inter-State discussion about water illustrates the systemic nature of a local problem. The health of Apalachicola ecosystems works as an indicator of emerging crises due to their importance for the economies of a lot of fishermen, oyster and sea fish gatherers in the region who work in the estuary and in the bay area. Their livelihood is not only conditioned by the fact that water is being degraded due to vectors of dispersed source, contamination of water upstream and tourists (who throw rubbish out of passing boats), but they are also susceptible to cyclic climate change, such as periodic tropical storms and droughts that accompany the Niño and Niña systems. These two factors converge with urban growth to generate conditions of economic and environmental susceptibility. For example, development practices that remove the covering of high land and estuaries permit the direct infiltration of contaminated water. This situation is exacerbated by the coincidence of extreme meteorological conditions with inadequate drainage and sewage systems. This can be seen during storms that occurred in the context of the El Niño phenomenon in the nineties, especially in the tropical storm known as Alberto. This latter storm saturated the drains and deactivated pump stations, freeing dangerous quantities of contaminated water which flowed into the local aquatic systems. The consequent closing down of the bay devastated the fishing industry and activated multiple programs of emergency aid at a local level, as well as State and National support. Despite all this, the St George Island and other coastal regions were subsequently developed in a way that took no account of this specific incident and opted for installing a large number of septic tanks, which in the conditions we have just described meant high levels of infiltration.

The recent upsurge of development is paradoxical when one considers that one of the main factors that make the region attractive is the

⁸⁴ Florida Severe Storm, Flooding, Tropical Storm Alberto Declared July 10, 1994

fishing industry. The irony of the matter is that the tourist “boom” and subsequent wave of development contribute to the deterioration of fishing as an activity. The rent obtained from taxes on the use of public lands in the Reserve has been displaced by the private sector which has taken over these properties. Such is the case of the St. Joe Paper Company, which now uses its former plantation terrain as a site for urban development and commerce.

Drought

Before the wave of development, Florida’s central area consisted of approximately 8.9 million acres of marshland that made up the main part of the landscape at that time. One of the essential traits of the natural terrain is a system for handling water. The absorption of a highly variable precipitation and extended hydro (or flood) periods are essential components of the environment of the wetlands and a factor which lessens vulnerability during dry spells and droughts, since it allows a great quantity of water to be stored and transported. Environmental characteristics are made up of a graded surface elevation, a certain quantity of vegetation and layers of turf.

Precipitation in southern Florida is highly variable. The area receives almost 55 inches of rain in a year of normal precipitation. Variations lead to floods or droughts. Floods can be induced by hurricanes and are more frequent than droughts, which happen only once every ten years or so. Variability of precipitation is very noticeable, with about 75% of precipitation occurring in the rainy period which goes from May to October. The natural hydrological cycle may change due to alterations in water consumption. Consumers of this resource are Nature, agricultural practices and urban populations. Water consumption has been stable. However population growth and its practices, including more intensive agriculture, have increased the amount of fresh water required.

The natural hydrological cycle is made up of evaporizing-transpiration, precipitation, underground water and surface draining. The natural threat of drought, a regular deviation from the normal hydrological cycle, is capable of generating a reduction in the volume of water in certain parts. Therefore drought has been defined as either meteorological, agricultural, hydrological or socioeconomic, in which order it also appears and is experienced by the human population. Meteorological drought refers to a reduction in precipitation when compared with the quantity of rainfall in a “normal” year. Agricultural drought is generated when circumstances do not reach the humidity of the soil required for the growth of a particular spe-

cies. Hydrological drought consists of a reduction in the volume of water in surface bodies and in subterranean ones such as streams, lakes and canals. Socioeconomic droughts occur when their effects begin to affect human communities.

The arrival of development in Florida implied a severe and continuous intervention in the hydrological cycle by means of the construction of canals and dykes. Such alterations changed the area’s territory, which before spent a good part of the year under inches of water, turning it into an area habitable by a great number of people.

The wetlands in Florida’s southern and central regions have been drained. Control of the hydro periods of flooding has been achieved by discharging massive volumes of water through a system of canals or by artificial damming by means of dykes. Two important characteristics of wetlands have been lost: the ability to store important quantities of water, and the ability to face up to and resolve the problem of great irregularity of rainfalls. These changes in the natural system have made wetlands much more susceptible in the face of deviations. Through this process, the risk of flooding (or of hydro periods) has increased and, at the same time, the system has become more vulnerable to meteorological droughts and to the dry season itself.

Due to the wetlands’ lack of capacity for water storage, Lake Okeechobee, the second largest lake in the United States with a capacity of 1.05 trillion gallons, has become the main object of a project for controlling floods, creating reservoirs for agricultural and urban use in southern Florida. The lake provides control of flooding, meeting the needs of agricultural and urban use and the prevention of salt accumulation in the coastal wetlands due to low levels caused by over exploitation. This is also a recreational area and a source of water for the remaining environmental elements in the area. The system’s fragility increased with the high demand for urban focuses in the coastal zones and the demand for water for agriculture, which led to unusually low levels of water in dry periods. To meet these multiple demands, levels of water in the lake were kept artificially high, even though this seriously compromised ecosystems and, as a result, the recreational potential on which many of the surrounding communities depend. Thus, in times of “normal” precipitation there arises a conflict of interests over the use of water. As can be expected, such conflicts increase in periods of meteorological drought.

For example, Glades County, one of the rural counties flanking Lake Okeechobee on its wes-

tern side, has based its economic development on activities which are highly dependent on the availability and quality of fresh water. The county's economic basis consists of prime matter (fishing, vegetable gardens and agriculture) and of tourism based on fresh-water activities along the lake shore. The lake's ecological degradation is affecting various species of animals which are tourist attractions for a lot of visitors, mainly due to the high levels of water pollution and a lowering of water levels, as happened during the 1980-1982 drought that noticeably affected the economic sector. Likewise the agricultural sector depends on various irrigation systems which are also seriously affected in times of scarcity.

As distinct from the coastal communities which have benefited from (and been protected by) the lake's capacity for water storage, Glades County has not known either the growth nor the prosperity of the region in general. In 1999, the per capita income was US\$ 18.905 dollars, about US\$ 10.000 dollars below the State average, placing it at number 48 on the State's overall register. Counties such as Collier, Palm Beach and Martin occupy the first three positions in the State, with annual incomes of over US\$ 40.000 on average. Historically, unemployment has also been high in the region by comparison with the State average, running at between 8 per cent and nine per cent during the nineties. Apart from its economic dependence and its growing vulnerability to economic change due to unemployment and low incomes, the population has increased at a much slower rate and, with no more than ten thousand inhabitants in the year 2000, this means that one per cent of the population receives benefits from the use that is given to the lake.

Drought, or the events that lead to water shortage, can have either natural or social causes. In the period 2000-2001, southern Florida and Glades County experienced a hydrological drought as well as a socioeconomic one caused by human factors such as changes in the natural environment, water consumption and a lowering of water levels. These simultaneous factors led to the lowering of the lake's water level and consequently to a restriction imposed on all users (both rural and urban), generating disastrous impacts especially in the economic sector which had based its activities on resources coming from the lake.

Forest Fires

According to the definition given by the Florida Department for Community Affairs (FDCA), a forest fire is "an undesired event occurring in the natural environment" (FDCA 2004: 16). These

events occur some five thousand times every year, and although there are 13 such occurrences every day in the State, the social risk when faced with this threat has not been carefully studied⁸⁵. Climatic conditions and human behavior are two of the main causes of forest fires in Florida. Social vulnerability to the fires is located somewhere between natural conditions and the increase of population and urbanization.

In Florida, forest fires are highly influenced by global climatic conditions, particularly by ENSO. According to Moorhouse (2000), ENSO embraces climate change and weather conditions, underlining the following patterns in the United States:

- The El Niño phenomenon occurs because of significant warming on the sea's surface in the Eastern Pacific. As a result, the south east and south west tend to be more humid than in normal conditions during the mid-year winter season, while in the North West Pacific, conditions tend to be drier than normal.
- La Niña is generated due to a significant cooling of the sea's surface in the Eastern Pacific. This generally leads to abnormally dry conditions in the South East and South West, but more humid conditions than normal in the North West Pacific.

These patterns suggest that during the La Niña period there is greater danger than usual of forest fires. During the period 1981 - 1998, the tendency was towards fewer forest fires during the El Niño episodes, and a highly significant increase in times of La Niña. One example of this pattern can be seen in the forest fires that occurred in 1998, when vast tracts of woodland were burned. This happened after a sudden change from a El Niño wet period (the Spring of 1997 and the Spring of 1998, when Florida experienced heavier rainfalls than normal) followed by a La Niña dry spell between April and June 1998, which was the State's driest and hottest period in over a century.

A sudden change from wet to dry conditions is extremely dangerous in terms of the probable occurrence of forest fires, as has been pointed out earlier. The wet season generally leads to the rapid growth of pasture lands, which, in the dry season, are converted into highly inflammable material for the fires to thrive on. This same pattern is repeated when, after hurricanes and storms, which normally cause trees to fall and leave branches and suchlike vegetation lying about. During the dry season, the fallen tree trunks become

⁸⁵ Data on forest fires in Florida are fragmentary. The FDCA began making periodic records in 1981. Data on places, areas burned and the causes of this scourge have been recorded, but there are no references to economic loss or to the loss of human lives. NOAA began to document forest fires in 1996, with periodic records on the number of dead and wounded, as well as damage to property and crops.

highly dangerous as potential fuel for fires (USA TODAY, 2005).

Another element that contributes to vulnerability to forest fires in Florida is the urbanization of what were formerly urban-woodland spaces. According to data provided by FDCA (from their Data Base on Forest Fires, Florida 2)⁸⁶, over 75 per cent of such fires between 1981 and 2001 were due to human causes. Among the more significant modes of human behavior which can lead to forest fires is urbanization in ecosystems adapted to fire and a resulting increase in the number of people who inhabit such areas. According to FDCA (2004), population growth in Florida over the past decade was near to three million inhabitants, and that fomented the massive urbanization of an area known as the urban-woodland interphase. Settlements around these wooded areas increased the probability of forest fires due to human activity, such as the lighting of fires in general, as well as contamination. There is a clear relationship between population growth and the harm caused by forest fires.

During the 1998 fires, the area most affected was the central-eastern coast. Communities located along the 1.95 freeway between St. Augustine and Cocoa Beach (in the counties of Flagler, Volusia and Brevard) were particularly affected by these devastating fires (Minshew and Towle, 1999). According to the Data Base of *Desinventar Florida 1*, Brevard and Volusia represented 87 per cent of economic losses during the 1998 and 1999 fires. In Brevard the total amount of economic damage was estimated at US\$ 200,082,500, and in Volusia at US\$ 150,276,000, which signify, respectively, fifty and thirty-five per cent of damage caused by forest fires in Florida during those two years. Finally, it is important to underline the fact that forest fires have serious implications with regard to the population's health. According to Sorensen *et al.*, (1999), in 1997 and 1998, visits to emergency wards increased substantially due to attacks of asthma (91%), serious bronchitis (132%) and chest pains (37%).

Frosts

Frosts generally occur during the months of January and December, when temperatures drop to below 32 degrees Fahrenheit. They last for periods of between several hours and, at times, many days. However, according to *Desinventar*, frosts as a phenomenon have not occurred annually between the years 1970 and 2001. Frosts have been experienced in the State in a total of twelve years out of the thirty-one years recorded in the data base.

People are put on alert when weather forecasts predict temperatures of 32 degrees Fahrenheit or less over a period of more than 24 hours. A severe frost alarm occurs when temperatures drop to below 29 degrees F for at least three hours. This kind of frost occurs in rural areas, in inland southern Florida, approximately once every ten years and are even less frequent in metropolitan areas near the coast.

According to *Desinventar* data from 1970 to 2001, 273 frosts were reported (that is, 2.9% of the total number of recorded disasters). Hillsborough and Collier have experienced frosts during eleven out of the twelve years in which the phenomenon was recorded in Florida.

On the other hand, *Desinventar* records show that, between 1970 and 2001, in Florida, frosts have occurred in the months of December and January in twelve different years. The lowest temperatures recorded in that period were localized in the county of Marion during the 1998 frost (15 degrees) and in 1971 (16 degrees). Zierden and O'Brien indicate that the record for the lowest temperature was in 1899, when Tallahassee experienced temperatures of minus 2 degrees Fahrenheit.

The main social problems derived from frosts have been a number of deaths and unemployment in agriculture. According to the data base, Florida's frosts have caused eight deaths between 1983 and 2001. However, the National Meteorological Service refers to a study that reported a broader picture, in which there were 124 deaths due to frosts between 1979 and 1999. Especially significant are the 26 cases of people who died from Hypothermia in 1989⁸⁷.

Unemployment, particularly in agriculture, is another of the negative impacts of frosts, especially given that Florida's agroindustry is extremely sensitive to dramatic changes in the weather. According to the Agency for Innovation in the Labor Force (the AWI), 8,330 workers were temporarily unemployed in 2001. Of these, 8,242 had been engaged in vegetable production, and the remainder in artesian fishing. Losses were valued at around US\$11.2 billion.

Frosts produced the greatest economic losses in the field of agriculture. Besides generating unemployment, they also affected production stability. Thousands of acres of citric fruit were lost, and in some counties the damage even affected soil conditions.

According to *Desinventar*, in 1983, 1985 and 1997, significant losses rose to over US\$40 million dollars per county. The year 1999 saw a fall in damage per county caused by frosts; that

⁸⁶ The Project on Risk and Disaster Management ENSO Latin America at Florida University has compiled two data bases for the State of Florida: *Desinventar Florida 1*, which contains all the natural and humanly-induced happenings that have caused the loss of lives and material damage between 1970 and 2001, and *Desinventar Florida 2, Forest Fires Database*, which contains all the forest fires reported to FDCA that occurred from 1981 to 2001. This study is based on both of these data bases.

⁸⁷ National Weather Service Forecast: Florida Division of Emergency Management.

year, such losses were estimated at around US\$ 130,000. Also, during 2001, a report highlights the fact that Florida farmers suffered considerable losses in the areas of sugar cane, citric fruits, ferns and the tropical fish industry. These losses were estimated at US\$ 179 million (information which has not, however, been recorded on the data base)⁸⁸.

To sum up, throughout any year Florida provides the tourist and the agricultural sector with conditions of a subtropical paradise. Nonetheless, when the weather fluctuates unexpectedly and generates frost, the social and economic costs are high. Why are some areas more vulnerable than others?

Disasters in Florida seem to spark off economic and socio-demographic processes. However, as a cause of disasters in Florida, frosts may be unique in that they spark off change through devastation but without renewing anything. Many inhabitants suffered personal loss from the drastic socio-demographic, economic and environmental harm caused by frost in the eighties. "Yes, I remember it well. It was on Christmas Eve in 1983," says Bruce Day, a regional planner. Frosts alone destroyed the citric industry in Marion County.

Since 1800, frosts have been the determining factor in establishing where citric fruits and other vegetables can be grown in Florida. White Springs, in Hamilton County, was dominated

by citric plantations up until 1895, when the great frost occurred⁸⁹. After that, producers were forced to move to Marion, where there were three main centers: McIntosh (1000 acres), Citra (2000 acres) and Weisdale (between six thousand and seven thousand acres)⁹⁰. Citric fruit production did not occupy most of the county's terrain, but the county did house the main centers of that industry.

Frosts do more harm to agriculture in Florida than to any other industry. They particularly affect orange plantations. "Frosts cause havoc to citric fruits, while they do little harm to pastures for grazing cattle and horses"⁹¹. The area's local economy used to be based on citric fruits. Even so, many producers moved south, attempting to ensure the industry's viability. Most went broke, others retired. Some planted pine trees in order to be able to carry on as farmers. In 1985, 9,600 small farmers re-classified their holdings. A few paid a high price to have fencing made and turned their properties into cattle ranches. However, the Orlando region was undergoing a population boom and housing estates began to spring up. The beautiful hills and lakes of the old orange plantations were converted into real estate. However these particular sources of income did not become future dividends for the county's people in general. Many sold out to urban developers. "People planted rooftops like it was their next crop" (Bruce Day).

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⁸⁹ Bruce Day (Regional Planning Council at Withlacoochee).

⁹⁰ Bill Phillips (Orange producer since 1986 and ex director of the IFAS Extension Service during the frosts of 1983 and 1985).

⁹¹ Lee Ulsberger (Agricultural Assessor of Properties in Marion County).

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Manifestations of ENSO in Mexico⁹²

For methodological purposes, a distinction was made between manifestations, effects and impacts.

There is no really clear sign of the manifestations (and therefore of the effects) of ENSO in the communities.

The scope of the analysis was centered on river basins located in Guerrero, Veracruz, the Tehuantepec Isthmus and Oaxaca.

In the Tijuana river basin one can clearly discern the relationship between ENSO and natural manifestations. It is precisely in this case that vulnerability has increased due to uncontrolled urban growth.

Among other processes of risk construction, deforestation is mentioned, as are contrasts between the rural and urban environments, erosion and contamination of drainage systems and of gutters clogged up with rubbish, which leads to greater flooding.

The most outstanding lessons to be learned when the project came to an end were centered on the fact that, with or without ENSO, climatic variability is greater and, besides that, the role of field work is fundamental when it comes to understanding, especially at a local level, the cultural ecology of risk management.

Can one associate certain disasters of a meteorological origin with the ENSO phenomenon in Mexico? Its manifestations, effects and impacts have been identified more clearly, up to now, in countries like Ecuador and Peru, whereas in Mexico it is less evident that there exists a relationship between the intensity and/or frequency of ENSO climatic variability, which occurs every two years, and the increase in hydro meteorological events that contribute to threatening disasters becoming concrete realities.

The results which we present in what follows would seem to indicate that an increase in the impact of hydro meteorological phenomena in Mexico is not so much associated with manifestations of the ENSO phenomenon in itself, but rather with a growing social-risk construct which has led to a great number of floods. Nevertheless, the presence of the ENSO phenomenon and the effects associated with it, especially flooding, acts as a detonator of disasters when these phenomena occur in local or regional contexts that are particularly vulnerable. Which disaster processes have materialized in events with greater impact? And which can one directly attribute (and/or relate) to the ENSO phenomenon?

[...]

There is no overall consensus with regard to ENSO's direct impact in Mexico, even though we have data to indicate its incidence and regu-

larity. But some key elements enable us to explore semantic and territorial patterns linked to a constant and growing construction of disaster risks.

ENSO IN MEXICO AND THE SOCIAL CONSTRUCTION OF RISK

As in many other parts of the world climatic anomalies and particularly the effects of El Niño have begun to arouse great interest amongst governments, national and international organizations since the occurrence of what has become known as the Great Niño of 1997-98.

It has been recognized that the only real novelty of this phenomenon is its name, (although in fact it was first baptized in Peru more than one hundred years ago). It is a global phenomenon whose associations with abnormal climatic changes derive from its so-called "teleconnections" (Glantz, 1998). The effects and impacts of this phenomenon have given rise to an impressive number of research projects on the phenomenon itself, recognizing that it is one of the factors that affects both climate and climate's annual variations. However, little progress has been made in studying disaster risk levels deriving from its presence and the specific context in which it occurs. That is to say, between the factors that control weather

⁹² A summary of MANIFESTATIONS, EFFECTS AND IMPACTS OF ENSO IN MEXICO (PATTERNS OF RISK) Study Director: Virginia García Acosta (PI) The project's students: Fercia Angulo Fernández, Fernando Briones Gamboa, Leticia González Álvarez, José Alfonso Hernández Gómez, Myriam de la Parra Arellano, Juan Manuel Rodríguez Esteves.

and climate and the degree of accumulated vulnerability in societies affected by the particular hazards associated with El Niño (especially floods and droughts).

The concept “social construction of risk” (García Acosta, 2005 and Lavell, s/f) attempts to respond to the need for deeper social analysis of risk causation promoting diachronic study of the ways in which society constructs insecure or fragile contexts, with increased levels of vulnerability (Wilches-Chaux, 1993; Cardona, 2001). The lack of adaptation to the physical environment this implies on occasions, signifies that the physical environment itself becomes a hazard and may even become a factor in generating risk. To understand these processes, we must begin, therefore, by adopting a holistic approach to the relationship between natural and social processes, also examining the ways in which these two process influence one another dialectically (Cardona, 2001; Lavell)

According to specialists in this matter, El Niño in Mexico provokes increased rainfall in winter and a serious lack of rainfall in summer; that is, its presence is intimately linked with the availability of water. Winter rains become heavier during El Niño years in the northwest and northeast of Mexico, whereas they fall off in the south. El Niño winters, on the other hand, are colder in almost all parts of the country, whereas El Niño summers are drier and hotter than La Niña summers. and sometimes even lead to severe drought. The lowering of humidity levels in the soil very often leads to the loss of thousands of hectares of woodlands due to forest fires. It is however a recognized fact that the effects and impacts of El Niño in Mexico are not always the same, due in part to the different spatial and temporal characteristics of rainfall and temperature anomalies from one El Niño year to the next.

A decrease in rainfall in Mexico during El Niño years, mainly in the northwest, seems to be associated with a decrease in the number of hurricanes in the Caribbean and the Gulf of Mexico. Therefore the relationship between El Niño and the Atlantic hurricanes would seem to be significant. On the other hand, it is not clear whether the occurrence of El Niño affects the number of hurricanes in Mexico’s Pacific region or in the northeastern Pacific. One of the regions most affected in terms of availability of water is the northern Pacific region where, in El Niño years a rather weak monsoon and lower ground water discharge levels occur. In fact, during the summer of 1997, there was one of the worst droughts ever experienced in Mexico, with almost fifty per cent (50%) less rain than normal. This affected the whole country and was an immense setback for the Spring-

Summer agricultural harvest that is fundamental for national food production. This period of drought was also accompanied by a large number of forest fires in the Spring of ’98, triggering off some the most severe ecological and social catastrophes in the country’s history. Meanwhile, in the winter, towards the end of ’97 and in early ’98, rainfall was well above the usual parameters in Mexico’s northwest (Baja California) and in the Yucatan peninsula, contrary to all forecasts.

As far as La Niña is concerned, in general, knowledge of climatic variability related to the phenomenon is way behind our knowledge of its counterpart⁹³. A lack of clarity exists regarding the effects and impacts of La Niña, and there is uncertainty as to whether or not these are a kind of “tail” product of the most recent El Niño. Certain scientists identify all non-Niño years as Niña years, due perhaps to the fact that there is no great climatic difference between a Niña year and a “normal” one, at least when compared with the dimensions of impacts felt during a Niño episode⁹⁴.

EL NIÑO IN DESINVENTAR MEXICO

Amongst water related disasters (excess or scarcity) registered in DesInventar over the past thirty-four years, floods and forest fires dominate, the former being over twice as numerous (1.901) as the latter (707). Among the different events associated with an abundance of water, floods are followed, in descending order, by rainfall (608), frosts (623) and storms (417). Taken together, these sum (1648) to almost as many events as floods (1.901). Something similar, but with different proportions, occurs with reports on events deriving from a scarcity of water where forest fires (707) constitute about sixty per cent (60%) of the total when compared with others such as droughts (384) and heat waves (179).

TODAY AND YESTERDAY: EL NIÑO IN MEXICAN HISTORY

In the context of The present project a specific piece of research was carried out in order to identify the presence of ENSO in Mexico’s history. This research was based on a series of studies carried out in Mexico on the subject of historical droughts⁹⁵, and on a well-documented data base including over 500 years of information on the manifestations, effects and impacts of hydro meteorological phenomena (referred to generically as “agricultural disasters”)⁹⁶.

⁹³ Cornejo-Grunaur, 2002 and Glantz, 2002, among others. A very good brief summary on what this is, how it makes itself manifest and what impact the La Niña phenomenon has is the article by Quintana on Chile (Quintana, 2000).

⁹⁴ Donoso, 2003

⁹⁵ We refer especially to the studies of Florescano (1980-1995)

⁹⁶ Studies carried out by CIESAS and recently published: García Acosta *et al*, 2003 and Escobar, 2004).

The semantic and territorial patterns of ENSO in Mexico were identified⁹⁷, employing studies of contemporary specialists, data available in DesInventar Mexico, historical data and existing chronological histories of the presence of ENSO, especially in South America (Quinn and Neal, 1992: Quinn, Neal and Antúnez, 1986 and Orliab, 2000). From this analysis we were able to conclude very interestingly that out of twenty-seven “strong” or “very strong” Niño years identified for Peru and Chile, only eight of these were manifest in Mexican territory⁹⁸.

This finding was of particular interest, since it confirmed that the floods and droughts that have occurred in Mexico’s history in general, and particularly those with the greatest impact and that can be catalogued as “disasters”, have not necessarily been related to ENSO. Furthermore, historical data show that impacts associated with floods and droughts, whether or not derived from ENSO, have been increasing in Mexico over the years. Has it been ENSO, then, or other factors, that have led to hydro meteorological disasters in Mexico?

SOCIAL CONSTRUCTION OF RISK AND ENSO IN MEXICO

In the Mexican regions we have selected for study, is El Niño something really “abnormal”? Is it “abnormal” in those communities we selected within the given regions? Is it “abnormal” at an urban or rural level? Is it seen by the people as something different? Does the El Niño phenomenon disrupt daily life in the places we studied? Or is it seen as just one more event among the many that affect the marginalized or excluded on a daily basis?

Additionally we may pose other questions:

How can we tell the difference between those effects related to the social construct of risk that are clearly associated with ENSO from those that are not? How can we distinguish between those that are identified with the three processes and those that have identified the social construction of risk with ENSO? Desertification/desertization, deforestation and erosion? How does one discriminate the elements of vulnerability that are directly related to ENSO from those that are not?

We know that the impact of natural hazards and disastrous events on regional and local economies is increasing. This impact is progressively more unequally distributed, both territorially and socially. This is due, to a large extent, to economic processes that have occurred in Latin America over the past twenty-

five years, a period which includes two of the century’s most intense Niño experiences: 1982-1983 and 1997-1998. These processes have led to risk scenarios and vulnerability becoming more and more heterogeneous and variable.

When we attempt to define more precisely the territorial patterns of impacts, we take those two major ENSO phenomena as a point of reference. The 1997-98 event is associated with a considerable increase in impacts which are not concomitant with a similar increase in hazard factors characteristic of the phenomenon itself. This leads us to hypothesize that an increase in exposure and vulnerability were responsible for the increased risk and impacts associated with excess rainfall events -floods in particular.

The study methodology led us to select three river basins located in the States of Guerrero, Veracruz and Baja California for detailed analysis. These river basins present a “centripetal system of hillsides and streams” which converge on a major river⁹⁹: the river Omitlán (Guerrero)¹⁰⁰, Papaloapan (Veracruz) and Tijuana (Baja California). In the State of Oaxaca, due to available *ad hoc* studies on the coastal areas¹⁰¹ and thanks to the possibilities the area offered for more in-depth study, we selected the Gulf of Tehuantepec area.

THE TIJUANA RIVER BASIN IN BAJA CALIFORNIA¹⁰²

The Tijuana river basin is located in Mexico’s extreme northeastern region and covers 4.481 km², two thirds of which are in Mexican territory and the remaining portion in the US state of California. The area has a Mediterranean-type climate, with the rainy season during winter. Average annual rainfall between 1926 and 2000 was 239 mm. However, during the last ENSO period (1997-1998) annual precipitation rose to as much as 495mm. In other words, it was 207% higher than in a “normal” year.

Floods are the type of event most frequently associated with ENSO. This is particularly true in the city of Tijuana (1.400.000 inhabitants in the year 2000) which is located in the lower river basin close to where the river Tijuana flows into the sea. Floods occurred for several reasons. Deficient or non-existent urban infrastructure, a lack of effective urban planning, and construction in the zones of influence of the rivers (that is on plains liable to flooding or on the banks of creeks and streams) are amongst the urban and socioeconomic causes.

⁹⁷ It was not so easy to identify weather patterns, mainly due to the more qualitative nature of the information being used.

⁹⁸ The resulting study was presented as a thesis for “*licenciatura*” in Archeology by Leticia González Álvarez (2004).

⁹⁹ Lugo, 1989; 58 and Soto y Fuentes, 1966; 74.

¹⁰⁰ In this case it is a sub-basin derived from a larger basin, that of the Costa Chica- Río Verde, which in turn subdivides into minor basins, one of which is that of the Papagayo river, whose tributaries flow into the Omitlán river.

¹⁰¹ Magaña, 1999.

¹⁰² Based on the work of Juan Manuel Rodríguez Esteves.

Then come the natural factors directly related to the surface of the tributaries that flow into the Tijuana river. In this case, the sub-basins referred to can sometimes cover dozens of square kilometers, and this leads to a rapid overflowing of streams that normally lie low in their river beds. Likewise, the area's pluvial regime is characterized by irregular downpours, since these vary considerably from one year to the next, especially when ENSO conditions prevail.

The city of Tecate (60,000 inhabitants), located 50 kms east of Tijuana, also suffers from intense rainfall. However in this case the main factors are the constant overflowing of the Tecate river, which cuts across the city from east to west, leaving most of the urban area divided into two parts. Finally, the Valle de las Palmas, a valley dedicated to irrigated agriculture, is an alluvial area and is therefore the site of the most important accumulation of sediments from the Tijuana river basin. El Valle de las Palmas (with its population of 1,500 inhabitants in the year 2000) was inundated by overflows from the Las Palmas river, a tributary of river Tijuana, during the ENSO events of 1983 and 1993. This led to a number of farm houses being left without communication for days on end.

Tidal waves affect only the city of Tijuana, since it is located on the Pacific coast. The city has been hit by tidal waves on the Delegation Beaches of Tijuana, to the west, where there were approximately 25,000 inhabitants in the year 2000. The area's main risk is that the sea-front may be destroyed as well as some buildings close to the shore (mainly hotels and restaurants).

Landslides have occurred mainly in Tijuana City where fifty-seven per cent (57%) of the terrain is on sloping ground with an inclination of fifteen per cent (15%) or more. The problem is that many constructions are built on hillsides or beside streams so that, when cuttings are made, the terrain becomes unstable, especially when it has been raining. Finally, gales have occurred in the area under study, leading to problems such as the falling of trees, billboards and electric cables.

A relevant fact regarding the Tijuana river basin, especially for Tijuana City, occurred in a non-ENSO year (1980) when heavy downpours caused the waters of the Abelardo L. Rodríguez reservoir, on one occasion, to rise above the dam's safety level. At this time the locks' sluice-gates had to be opened to avoid danger to the infrastructure, and this led to the flooding of the river basin below and to severe damage to colonies located along both river banks.

[...]

Based on DesInventar Mexico data, we find that out of the 45 hydro meteorological occurrences that were recorded between 1973 and 1998, 89% happened in the city of Tijuana, whereas only 7% and 4% affected the Tecate and Valle de las Palmas areas respectively. Thus, in the years 1973, 1978, 1980, 1983, 1993 and 1998, the 45 hydro meteorological occurrences related to ENSO (except for those in 1978 and 1980) which took place in the Tijuana river basin were related to flooding (31), tidal waves (6), landslides (6) and gales (2), the majority of which affected Tijuana City.

Heavy flooding in Tijuana City may indicate that it is precisely the fact that there is population density (compared with other localities) and that land not apt for urban development (such as wetlands) have been occupied by inhabitants, and this would explain why there have been more floods. However, one must also consider the way newspapers report this kind of event, since news of flooding is more likely to appear when the floods occur in the cities that when they occur in more remote and less populated areas.

THE LOWER BASIN OF PAPALOAPAN, VERACRUZ¹⁰³

Veracruz is one of the States "possibly" affected by manifestations of El Niño. It is located in the central part of the Gulf of Mexico and its population in the year 2000 was of 6,908,975 inhabitants on a surface area of 72,815 km² divided into 210 municipalities. Veracruz, along with Chiapas, Guerrero and Oaxaca is one of the States with the highest indexes of marginality.¹⁰⁴ Over 1,600,000 of the inhabitants are located in the area of influence of hydro meteorological phenomena (24.3 % in all, according to CONAPO, 2001) and more than half the population lives in cities exposed to cyclones, the chief effect of which is flooding. However, the medium and low marginal localities are the ones most exposed to these occurrences and also the worst hit. Due to their location, therefore, in an area of tropical rainfall, their topographical characteristics as well as their degree of vulnerability understood as "the degree on the basis of which groups, classes, regions or countries are differentiated with regard to risk in terms of social, economic and political conditions" (García Acosta, 1997: 11). Added to the above, marginality conditions in one section of the Veracruz population become potentially prone to the manifestations and effects of certain natural phenomena, which can turn into genuine disasters.

¹⁰³ Based on the work of Fercia Angulo Fernández

¹⁰⁴ According to data from the National Population Council, index of marginality in the State of Veracruz is 1.13, just above the entities we mentioned earlier (www.conapo.gob.mx consulted in August, 2002)

[...]

In order to carry out more precise research, only two municipalities were studied carefully. The first was Tlacotalpan, and in particular its municipal township, given the fact that it had certain traits which we will mention further on. The second was Cosamaloapan.

Tlacotalpan, besides being located on the shores of the Papaloapan river, presented peculiar characteristics that would seem to respond to certain adaptation strategies which were culturally built up and which, nonetheless, may not have been developed in the same way in other communities located on those same shores. Tlacotalpan seems to have adapted its landscape to the natural environment surrounding it. For example, houses built by the river's edge are constructed on so-called "tapancos", which enable people to continue to live in them even when frequent flooding occurs due to the Papaloapan river breaking its banks.

As regards the second municipality studied, it was chosen especially as a result of what was discovered by the Veracruz DesInventar program. By contrast with Tlacotalpan, this municipality had a greater number of reports associated with abundance and scarcity of water in one of the El Niño periods surveyed; that is, 1982-1983 and 1997-1998, which were the two Niño periods considered to be those of greatest impact.

The municipality of Cosamaloapan turned out to be the third hardest hit municipality in the State, above all due to flooding. It is worth mentioning that, along with Tlacotalpan, these are the two municipalities to be found in the course of the Papaloapan's lower river basin. Nonetheless, it is a notorious fact that neither DesInventar Mexico nor DesInventar Veracruz contain a single report on Tlacotalpan, whereas for Cosamaloapan the period 1997-1998 figures as the second most affected region in the State.

On the other hand, one of the results of field work showed that Cosamaloapan, with some of its public services and its infrastructure, attends to the needs of neighboring municipalities. That implies that every kind of event is recorded for this municipality, not just its own explicit ones. Cosamaloapan has a low index of marginality (CONAPO 2001) and Tlacotalpan, a high index. The former enjoys an economy sustained by sugar cane. The latter's economy depends rather on cattle grazing, fishing and to some extent on tourism. The place was declared Cultural Patrimony of Humanity by UNESCO in 1998.

THE SUB-BASIN OF THE OMITLÁN RIVER, GUERRERO¹⁰⁵

The State of Guerrero is located in the southern part of the Republic of Mexico, between 16° 18' and 18° 48' latitude north and 98°03' and 102°12' longitude west. Due to its geographic location, the State is directly within the tropical zone and has a hot climate with rainy periods during the steamy middle months of the year from May to the end of October.

Guerrero is made up of three main river basins: Balsas, Costa Grande and Costa Chica-Río Grande, the last named subdivided into smaller basins, one of which is that of the Papagayo river which runs into the Omitlán. The subbasin of this river is made up of six tributaries: the Omitlán (La Venta-Chapala), the Omitlán (Chapalla- Llano Grande), the Unión (Xochitpec-Azul) the Azul or Huacapa and the Chapala river.

Geographically the Colotlipa community (municipality of Quechultenango) is located in a valley surrounded by low hills. The nucleus of the population is located between the Azingo, Blanco and Azul rivers, this last being a continuation of the Huacapa river which runs down from the capital Chilpancingo. A large number of people live along the banks of the Azingo and Blanco rivers, a population settled in the Manila quarter on the banks of the Azul river, which makes the inhabitants susceptible to floods when the river overflows its banks, as it does regularly, either in the rainy season or when sudden storms occur. Tixtla in Guerrero is located in a closed valley where there is a lake which, through a series of grottoes and subterranean rivers, flows towards the Quechultenango municipality where Colotlipa lies. The Tixtla lake is about 1,300 meters long and measures 800 meters at its widest point; it is 2 meters deep and has an underground draining system known as *El Resumidero*, which is located on its eastern side. However, the location has suffered as a result of constant rises in the water level, which have affected the inhabitants of Cantaranas and El Santuario during the months of July and October. In the case of Chilpancingo, flooding occurs whenever there is a rainy season, and this affects the inhabitants who have settled on the banks of streams such as the Jalahuatzingo and Apatzingo.

The Omitlán sub-basin in Guerrero State has a high degree of marginality (CONAPO, 1990-1995 and 2000). There were reports of hydro meteorological occurrences on the part of the Omitlán in the El Niño years of 1882-1883 and 1997-1998, causing damage to the population in the municipalities of which it consists. Localities

¹⁰⁵ Based on the work of José Alfonso Hernández Gómez.

analyzed here are: Chilpancingo de los Bravos (two cliffs, urban context), Tixtla of Guerrero (urban semi-rural), Colotlipa (rural). These localities show signs of particular vulnerability and possess human settlements beside the lake, the streams and the river.

THE ISTHMUS OF TEHUANTEPEC, OAXACA¹⁰⁶

On the isthmus of Tehuantepec there are two recurring climatic phenomena: wind and rain. The relation between the ENSO phenomenon and the strong winds which can be observed in the region is represented because the number of "norths" increases during the El Niño years by comparison with the Niña years. Schultz *et al.* (1998) discovered that there are more cold frontal spells in the south of Mexico during El Niño winters than in the Niña ones. (Romero-Centeno *et al.*, 2003; 2637). These winds are popularly known as "tehuanos" and in winter they produce a phenomenon called "north" which is characterized by dry strong winds (anti-cyclone whirlwinds), as distinct from Veracruz where they are accompanied by rainfall. The "tehuanos" are masses of polar air that cross the Gulf of Mexico towards the Pacific, passing through the isthmus of Tehuantepec through a break in the mountain range just where the southern Sierra Madre is separated from the Central American range at a place called Paso de Chivela. According to Bourassa and O'Brien (s/f), "these winds make a great impact on the surface temperatures of local seas (...) and also increase the productivity of fishing, since they attract nutritious and fertile territorial waters to the surface".

The influence of the ENSO phenomenon could be represented by an increase in the frequency and intensity of hurricanes and tropical storms. The coastal region of Oaxaca is exposed to these meteors, especially towards the end of the rainy season; that is, in September and November. DesInventar shows us that the majority of disasters reported are related to hydro meteorological phenomena, in particular to excess of water, which would suggest that the warm phases (rain increase) tend to increase risk, as against normal periods when serious damage is not reported. In many localities in the region, floods are recurrent towards the end of the rainy season. Likewise, gales and landslides occur due to hurricanes and tropical storm.

[...]

It is hard to associate the frequency and regularity of ENSO manifestations with disasters. During our field work, some fishermen of the Huave ethnic group (or the "mero ikooc") referred to cycles of five years of good climate

and five years of bad. The dry and wet seasons are well identified in the Huave cosmogony and by the urban *zapotecas* of Juchitan and Tehuantepec. Climatic variability is constantly mentioned by them and they offer numerous examples of droughts and intense rainfall, but without linking them to ENSO or to particular time sequences. The most representative reference was the event of the Paulina and Rick hurricanes in 1997.

[...]

DesInventar shows that reports on hydro meteorological events are concentrated in the urban center of Salina Cruz and in municipalities with high levels of poverty and marginality. The tendency in the increase of disaster reports coincides with demographic increase and growing levels of poverty.

Isthmus society has a strong cultural heritage which is expressed in claiming its identity, its tradition of resistance throughout history and its relative political independence. These traits have been factors in social movements and political conflict that have, in fact, led to increasing their vulnerability.

Among the most obvious consequences of recent years have been political confrontations in the sixties and eighties which led to invasions and land takeovers as a strategy for protest and proselytism employed by both forces in conflict: the PRI¹⁰⁷ and the COCEI¹⁰⁸. The motivations of these movements was linked both to ancestral problems of land ownership and to the effects of large regional development projects being carried out: the building of an Inter-oceanic railway connecting Santa Cruz and Coatzacoacos, the Benito Juárez reservoir in Jalapa del Marqués, the Irrigation District No. 19 and the PEMEX oil refinery at Salina Cruz. These projects led to expropriation of terrain which in turn led to resentment on the part of those affected.

Over the past fifty years, the Oaxaca Isthmus has undergone a process of industrialization which has altered the whole territory and has favored rapid demographic growth. The economic corridor formed by cities like Juchitan, Santo Domingo, Tehuantepec and Salina Cruz has its origin in the geo-strategic nature of the region. The installing of the PEMEX refinery in Salina Cruz (1974) created a labor focus which implied the formation of surrounding colonies that have no adequate public services. They represent poverty levels and topographic features which renders them highly vulnerable. During our field work, many inhabitants of these areas that have been flooded commented that they installed themselves in these places for three main reasons:

¹⁰⁶ Based on the work of Fernando Briones Gamboa

¹⁰⁷ Partido Revolucionario Institucional. In power for over five decades with practices such as clientelism and paternalism.

¹⁰⁸ Coordinadora Obrero Campesina Estudiantil del Istmo. This left-wing political movement allied to the United Socialist Party of Mexico won municipal elections in 1981 in Juchitan but were ousted by their rivals of the PRI who sparked off a conflict in which people were killed, political demonstrations were held and a social fragmentation occurred which can still be observed among militants of both fronts.

- a) the possibility of obtaining their own property (they were working on ranches or in isolated towns). They acquired terrain as a gift or by buying it from their particular political party.
- b) The need to live near their source of work (such as the PEMEX refinery).
- c) In order to follow families who had already gone to live there ahead of them, something which also illustrates the importance of the nuclear family in the territory's organizational structure.

It is clear that of the three most important cities in the region, Juchitan and Salina Cruz are the ones that most suffer from flooding (in Tehuantepec a dyke has been built to protect the city). Floods occur mainly towards the end of the rainy season (September-October). Curiously, some of the names of the colonies most liable to flooding suggest the recurrence of these events. For example, Barrio Cheguigo is a *Zapoteca* term meaning "the other side of the river" and refers to the COCEI militants who built their homes on the lower part of the river basin. In Salina Cruz the barrio called Cantarranas bears that name because, during the rainy season, water becomes stagnant and as a result there is a proliferation of frogs (*ranas* in Spanish).

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ENSO manifestations in Peru¹⁰⁹

Throughout Peru's history, there has always been interest in El Niño. Every society, in its own proper historical context, pays attention to this matter, some more than others. We have evidence of the presence of El Niño in Peru right from the era of the Formative Horizon in the valley of Cupisnique. At that time El Niño caused changes in patterns of subsistence and also in methods of storage¹¹⁰.

[...]

El Niño in itself is not the problem. The problem lies in the lack of social contextualization of the El Niño phenomenon. El Niño is part of a great scheme of things, and therefore should be looked at in its totality and not reduced to a matter of simple geographic or sectional impact, which is what frequently happens. El Niño's influence will be ineluctably linked to every sector in the country. Each one of these, to a greater or lesser degree, will be affected by El Niño's specific and weather-related climatic conditions. And that brings in its train a sequel full of multiple upsets which enable us to perceive all kinds of different problems (social, economic, demographic and political ones, among many others).

In this sense, El Niño acts as a sort of sparring partner who lets us understand the degree of development that the country has achieved as we take account of the way society and the State respond. That is why any talk of El Niño means talking about what we have done and what we

have failed to do in the matter of risk management.

Episodes motivated by the El Niño phenomenon are always accompanied by a series of changes and renovations. Every time the phenomenon reappears, there is a new opportunity for us to improve and make use of what we have learned in the past. El Niño not only brings with it catastrophes. It has also served to promote and motivate Peruvian people, practically under duress, to introduce new models that imply greater adaptability to our natural surroundings. El Niño could (and maybe should) be seen as a fundamental axis of substantial change in Peruvian society. It could produce modifications to our patterns of subsistence, it could serve to reorient demographic concerns, leading us to changes in colonization and the settling of territories, and it could even become the axis around which we might give expression to a new kind of local idiosyncrasy.

[...]

It is estimated that the 1982-1983 El Niño produced two thousand million dollars worth of losses for Peru as a result of intense rain along the northern coastline and droughts that affected the southern plateau (...). Damage caused by El Niño at that time was enormous; in Tumbes, 85 % (eighty-five per cent) of agricultural production was written off; that is, about nine thousand hectares of land were affected. Those hardest hit were the small farmers, who

¹⁰⁹ Summary of a study headed by Eduardo Franco and made up of the following team: Juan Carlos Gil H., Gustavo Girmaldo M. Arturo Maldonado N. and Max Watanabe R., Proyecto ENSO IAI-LA RED (Lima, December 2001): It's also based on research by Lenkisa Angulo.
¹¹⁰ Manzanilla, Linda, *Indicadores Arqueológicos de Desastres: Mesoamérica, Los Andes y otros casos*, in García Acosta V., "Historia y Desastres en América Latina", 1997 LA RED, Vol. II.

lost not only their crops but also their homes and their domestic animals.

As well as Tumbes and Piura, several departments in Peru suffered the consequences of El Niño. However, we are all aware of the fact that this kind of occurrence will happen from time to time and more intensely in the northern departments. It is alarming that the effects of the disaster were greater, on that occasion, than the damage caused by phenomena of a similar magnitude in earlier times, and it is even more alarming when one recalls that, in the period under study, the government had no additional budget to cover losses. The central government had not foreseen this kind of happening and was not at all ready to deal with the consequences of such a crisis.

Paradoxically, events such as this one have been repeated for years over and over again. Written sources tell us of the presence of El Niño in northern Peru since the year 1578 when “the town of Saña was damaged, but this was overlooked and buildings were constructed again in the same place, despite the fact that the site was known to be dangerous”¹¹¹.
[...]

THE IMPORTANCE OF MEMORY

We know that El Niño is a phenomenon that is never the same twice. We ought not to forget that it is a complex problem, and we should be able to distinguish one El Niño from another. One way of doing this is to take each Niño happening as an “episode”; that is, something arbitrary that has been established for its usefulness. Also we ought to bear in mind that particular El Niño events affect each section of society in a different way.

It is impossible to measure the real impact of El Niño in a certain period of time, since this is a relative matter. El Niño brings with it a follow-up which affects several aspects of social, economic and structural organization in the region, something like what happens when there are droughts in the high Bolivian valleys, where several years are needed to achieve the solid recovery of agriculture.

Apart from the losses directly due to the El Niño impact, which can be measured as soon as the happening has occurred – by means of numbers based on the direct physical impact or on inventories –, there exist also multiple factors which, in a circumstantial or deliberate manner, combine to increase the economic impact of such an event.

Finally we ought to understand that El Niño is a natural part of our ecosystem, with all the benefits and disadvantages that a natural phenomenon can offer us. Therefore we must learn how to make maximum use of the gains and reduce to a minimum those losses which the event brings with it.

[...]

From remote times, El Niño has formed part of the practical common sense of fisher folk and coastal dwellers in general, since the cold waters that are rich in nutrients are displaced and alterations occur in the normal patterns of precipitation. Although this is a recurring event, it does not happen at regular intervals, nor is it always of equal magnitude.

The task of understanding El Niño increasingly engages the attention of climatologists and meteorologists, since it supplies an important key to revealing the mysteries of patterns of meteorological conditions and tropical climates and, to a different degree, its impact outside the topical areas. As knowledge increases on the subject of “teleconnections”, forecasts become more reliable and a “useful science” is developed, as well as the need to educate the public, and above all the politicians, and to reinforce in the latter a marked interest in identifying the social and environmental consequences of El Niño.

Atmospheric processes are complex. The same can be said of oceanic processes. El Niño is the result of a complex interaction between the atmosphere and the ocean. From which we can conclude that a complete understanding of the phenomenon cannot really be attained, or rather that to do so requires a great deal of time and resources. In any case, the challenge to those of us who are not natural scientists consists in trying to find a way to decide which discoveries are relevant to society; that is, which are able to make an impact on decision-making in society.

WORK HYPOSTHESIS

General hypotheses

- Risks connected to disasters are on the increase.
- Every year we see a greater number of events that make some degree of impact, especially those events related to ENSO. Because of this, risks when faced with possible disasters have also increased. In accordance with a growing number of events which cause a considerable impact, one should expect also an increase in the probability of disaster risks.

¹¹¹ Rostworowski, María, *El Diluvio de 1578* in “*Desastres y Sociedad*”, 1994, No. 3, La Red.

- Disasters bring with them elevated costs in social and economic terms.
- The vulnerability of populations is on the increase. This increase is due, on the one hand, to social and economic conditions of the population (uncontrolled demographic growth, unplanned occupying of territories, etc.) and on the other, to the inadequate management of risks in order to prevent disasters (the use of inadequate technologies for controlling floods, etc.).
- No two El Niño phenomena are the same.
- El Niño, as such, is not a disaster.

Particular hypotheses in the case of Peru

- ENSO events mainly affect the northern coastal areas.
- The main events associated with ENSO are of a hydro meteorological kind.
- During ENSO periods, the majority of events are related to rainfall measurement.
- ENSO events are predicted with a certain degree of anticipation, but even so damage is not lessened. Systems of forecast have advanced to such an extent that it is possible to predict an El Niño phenomenon several months ahead of time. Nonetheless, this has not led to adequate measures being taken to manage the risk factor, and therefore damage has not decreased. On the contrary, it has increased.
- The majority of events associated with ENSO are concentrated in the early months of the year. The greatest concentration of these is during the Summer; that is in January, February and March.
- The effects of El Niño are varied and may change in each cycle where the phenomenon occurs.
- El Niño produces effects in the various sectors of society in different ways and to a

varying degree in each of the sectors involved.

Analysis of results with respect to the hypotheses already indicated

As a result of the study already carried out, one can determine a slight tendency with regard to the hypothesis that disaster risks are on the increase. However, this tendency is quite moderate. And that fact can become a little more tangible if we take ENSO events into account. The succession of events every year tends to be irregular. Certain significant peaks can be clearly observed in the El Niño phenomena of 1972-1973, 1982-1983 and 1997-1998.

With regard to these peaks, one observes a representative increase in the impact of events that generate disasters. As for the 1970 ENSO, we may note the presence of a peak which is attributed to the earthquake and the landslides that occurred in Ancash. Something similar happened in 1994. From a reading of the graphs we can see that, during that particular year, the El Niño phenomenon was quite moderate. The existing peak is attributed to heavy rainfall in the Peruvian Andes, and those rains were not necessarily the result of the El Niño phenomenon.

Likewise, on the major impact of ENSO in Peru's northern coastal area, the hypothesis has been demonstrated: Tumbes and Piura are the two departments that received the greatest number of negative effects of ENSO occurrences over the thirty-year period we took into account for this study.

[...]

As for the hypothesis on a greater concentration of ENSO occurrences during the first months of the year in Peru, this has been positively shown to be a fact: there is an important number of events of this kind in the Summer months in Peru, and this is also true of events not related to ENSO. During the three decades studied, one can clearly observe a very large number of events concentrated in the first months of the year (in January, 2,900 disasters; in February, 2,800 disasters; and in March, more than 3,000 disasters).

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