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Climate Change, Vulnerability and Adaptation in Latin America

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Preface

It is now widely agreed that we are facing a climate change with the main features being global warming and the universal deterioration of natural habitats and livelihoods. These side-effects also extend to sea-level rise, change of weather, decrease on the freshwater supplies, impacts on farming and health. Latin America plays a key role itself. We only have to think about the Amazon tropical forest, its biodiversity but at the same time the deforestation that takes place and the fact that 35 percent of the worlds freshwater is found in the region. Furthermore, the impacts on the people's livelihoods are substantial, considering for example that 30-40 percent of the working population is employed in farming and bearing in mind the fact that Latin America is a continent with a high degree of poverty and therefore vulnerability. At the same time, there are various efforts towards adaptation taking place, focusing mainly on alternative sources of energy such as for example the use of bio-fuels in Brazil and the micro-hydro system in Peru. The aim of this dissertation is to present, discuss and analyze climate change and the issues of vulnerability and adaptation in the Latin American region.

Chapter 4

Chapter 5

List of Abbreviations

AIACC	Assessments of Impacts and Adaptations to Climate Change
AF	Adaptation Fund
CARICOM	Caribbean Community
CEPAL	Comisión Económica para America Latina y el Caribe
CH_4	Methane
CO_2	Carbon dioxide
CRRH	Comite Regional de Recursos Hidraulicos
DFID	Department for International Development
ECLAC	United Nations Economic Commission for Latin America and the Caribbean
ENSO	El Niño-Southern Oscillation
EU	European Union
GCM	General Circulation Model
GEF	Global Environmental Facility
GFDL	Geophysical Fluid Dynamics Laboratory
GHG	Greenhouse Gas
GISS	Goddard Institute of Space Studies
IIED	International Institute for Environment and Development
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter-tropical Convergence Zone
LDCF	Least Developed Countries Fund
NCAR	National Center for Atmospheric Research

NGO	Non-Governmental Organization
N_2O	Nitrous oxide
OSU	Oregon State University
PPMV	Parts Per Million by Volume
SACZ	South Atlantic Convergence Zone
SD	Sustainable Development
SPAF	Strategic Priority on Adaptation Fund
SPCCF	Special Climate Change Fund
TOGA	Tropical Ocean-Global Atmosphere
UKMO	UK Meteorological Office
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USD	United States Dollars
WHO	World Health Organization
WMO	World Meteorological Organization
WWF	Worldwide Fund for Nature

1 Introduction

1.1 Background

The environment today, seems to be at the centre of worldwide interest. News concerning natural habitats, deforestation, species extinctions, and extreme weather events are making headlines.

Despite the fact that modern environmentalism can be traced back to the middle of the 19th century, the environmentalist movement did not grow significantly until the final quarter of the Twentieth Century. Today, it could be said, that environmentalism and ecology have become a trend, something that everyone is supposed to be interested in and moreover a measurement of each person's ethics and sensitivity. As a result the number of environment-oriented state, market and civil society institutions has been expanding rapidly.

Probably the biggest issue, and arguably one of the main factors that have contributed to growing environmental concern, is global climate change. Climate change seems to be everywhere: in television commercials that advertise environmentally friendly products, on electricity and telephone bills urging customers to go paper-free, in the supermarkets, clothing shops, cars, buses, movies, basically throughout our everyday life.

At the same time there also seems to be a growing state concern. Governments are led to take environmentally friendly measures and decisions while nature and its significance seem to be gaining a bigger part in their discussions.

A good example of growing environmental concern is illustrated by the fact that the 2007 Nobel Prize for Peace was awarded jointly to Al Gore, mainly due to the movie 'An Inconvenient Truth' where he describes climate change, and to the Intergovernmental Panel on Climate Change (IPCC), thus making a strong statement as a revered international institution about the importance of the issue.

While the above are happening in the developed countries, in the developing and least developed countries, the people are more concerned about the effects and consequences of natural disasters, especially extreme weather events.

Latin America, which is the focus of this dissertation, is a continent characterized geographically by its natural reserves and resources. Its physical regions contain from mountain and highland regions, to river basins and coastal plains, while its climate varies from tropical in the north part to polar in the southern. Worldwide interest has been mainly focused to the Amazon basin that has been characterized as "the lungs of the earth".

Moreover, the continent is comprised almost totally by emerging and developing countries (classification by the IMF and the UN), which are basically characterized by poverty and inequality. According to the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), Latin America, is the most unequal continent in the world (ECLAC,2008) while, according to the World Bank, nearly 25% of its population lives on less than two United States Dollars (USD) a day (World Bank, 2008).

1.2 Research Questions and Methodology

The questions that will guide this research are:

- What is climate change and how will Latin America be affected by it?

- What are the regional vulnerabilities

- What adaptation programs or measures, are taking place in the continent and to what degree of success.

- What is the role of the Latin American countries in the negotiations over global climate change agreements and whether they represent an example of the claimed inequality in matters of vulnerability and adaptation

In order to respond to these questions there is going to be an analytical literature review of the different subject areas. In the matter of the scientific facts the paper is mainly based on IPCC reports, while for matters of North and South politics and equality in vulnerability and adaptation, the recent works of Roberts and Parks (2007) "A Climate of Injustice" and of Adger *et al.* (2006) "Fairness in Adaptation to Climate Change", will be key sources of secondary data. Additional information and perspective on the issues of concern will be drawn from relevant publications of Latin American governments, international NGOs such as the Worldwide Fund for Nature (WWF), and suprastate institutions such the UN Environment Program, the International Institute for Environment and Development (IIED) and the Department for International Development (DFID).

1.3 The Structure of this Dissertation

For the purpose of this dissertation, the climate change phenomenon will be examined, focusing on the Latin American continent. The second chapter describes a brief overview of climate change itself looking at the history, the causes and the facts of this problem. The third chapter will be comprised by an environmental and social description of Latin America, so that the importance and the grounds are set to move in the forth and fifth chapter where a discussion of the vulnerability and adaptation in the continent will take place respectively.

It is also important to add that lately, a big interest in the North and South politics has developed along with a discussion on the equality issue with regard to matters of vulnerability and adaptation, between the poor nations of the south and the rich nations of the north. For that reason a brief discussion will be made in the forth and fifth chapter as mentioned before.

Before moving on to these though, climate change will be described and analyzed in the next chapter.

2 What is Climate Change?

2.1 The Climatic System

Climate change, as mentioned before, is one of the most important current issues. In order to understand it better, it is useful to start from the beginning by describing the climatic system.

In general terms, the climatic system consists of the following physical components:

- The atmosphere, which comprises the earth's gaseous envelope, is the most variable part of the system and has a characteristic response or thermal response time of the order of a month
- The hydrosphere, which comprises the liquid water distributed over the surface of the earth, including groundwater and subterranean water
- The cryosphere, which comprises the world's ice masses and snow deposits and includes the continental ice sheets, mountain glaciers, sea ice, surface snow cover and lake and river ice
- The lithosphere, which consists of the land masses over the surface of the earth, includes the mountains and ocean basins, together with the surface rock, sediments and soil
- Finally the biosphere that includes the plant covers on land and in the ocean and the animals of the air, sea and land, including people.

(US Committee for the Global Atmospheric Research Program, 1975, 13-16)

The climate at any particular time represents the average of the various elements of the weather, along with the state of the other components of the system.

According to Ratchford (1996: 89) "natural variations in the earth's climate have been quite large. Alternating ice ages and interglacials are one indication for this". For example during the Eemian interglacial, temperatures were on average 2°C higher than at present. Only in the last 10.000 years, which constitute the present interglacial, have temperatures been relatively stable.

2.2 Causes of Change in the Climate

From the above it is obvious that there are a lot of factors that can contribute to changes in the climate. In the next part there is going to be a short description of these causes based around Burroughs (2001) book 'Climate Change a Multidisciplinary Approach'.

First there are the atmosphere-ocean interactions. According to Burroughs they represent a classic example of the 'chicken and the egg' since there are no starting points in analyzing the circular nature of the processes involved. "So it can be argued that the capacity of the atmosphere to sustain circulation patterns, which can produce changes in ocean temperatures which then reinforce these anomalous patterns, means that the atmosphere is in the driving seat. Conversely it is the massive thermal inertia of the ocean that suppresses the wilder fluctuations of the atmosphere and so dictates how the climate behaves over periods of a year or more" (Burroughs, 2001: 204). An example of these interactions is the "El Niño" phenomenon (Burroughs, 2001).

Then there are the ocean currents, such as the Humbolt that brings cold water to the west coast of South America, which play a major role in the transport of energy in higher and lower latitudes meaning that any changes in these patterns could have substantial climatic implications.

Volcanoes and volcanic eruptions play their own role since they can inject vast amounts of particulate matter and, more significantly, sulphur dioxide into the upper atmosphere where this gas is converted into sulphuric acid aerosols. However there is considerable doubt about how big and long lasting their impact on climate is.

Sunspots and solar activity can also have an impact on climate. Solar radiance with wavelengths between 200 and 300nm are absorbed high in the stratosphere by oxygen and ozone molecules, thus initiating photochemical reactions that influence the weather at lower levels.

In addition changes in atmospheric composition play an important role and are more relevant with today's climate debate. As Burroughs argues, "the changing level of greenhouse gases (GHG) in the atmosphere has been an important part of climate change during the Earth's history" (2001: 220). What has now been called the 'greenhouse effect' is the result of the presence in the atmosphere of gases which absorb terrestrial radiation while permitting incoming solar radiation to pass through the atmosphere relatively unhindered. Major GHGs are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). According to Adger *et al*. CO_2 "is currently increasing at 0.5 percent per annum and now constitutes approximately 355 parts per million by volume (ppmv) compared to 280 ppmv in pre-industrial times" (1994:5).

So the final and arguably most important factor regarding change in climate; is human activities. The IPCC in its Second Assessment in 1995 states that "human

activities, including the burning of fossil fuels, land use change and agriculture, are increasing the atmospheric concentrations of GHG (which tend to warm the atmosphere) and, in some regions, aerosols (which tend to cool the atmosphere). These changes taken together are projected to change regional and global climate and climate-related parameters such as temperature, precipitation, soil moisture and sea-level" (IPCC, 1995: 1).

Additionally, according to Mintzer and Leonard, "during the past century the greenhouse effect became the greenhouse problem as human activities enhanced the natural greenhouse effect through the release to the atmosphere of billions of tons of CO_2 and other GHGs. These GHG emissions have caused a continuing atmospheric buildup of CO_2 and similar gases, amplifying the background greenhouse effect" (1994: 7). Or elsewhere, "if current trends in anthropogenic emissions continue, the combined radiative effects of this group of gases will equal, by the middle of the next century, the warming effect that could be expected from raising the concentration of CO_2 alone to twice its pre-industrial level" (1994: 9).

2.3 Climate Change

Thus the term "climate change" that today seems to be in everyone's vocabulary. Before analyzing further the phenomenon it is important to mention that climate change has caused a lot of dispute and even today is still not fully recognized. Despite the fact that there is now an agreement that global warming and climate change are happening, there is no universal agreement on the causes. For example, the Lavoisier Group published in February 2006 a paper with the title "Nine Lies about Global Warming" while the Royal Society (2007) has published "A Simple Guide to

Climate Change Controversies". Moreover, often newspapers host articles such as "Scientists threatened for 'climate denial'" (Daily Telegraph, 11 March 2007), or "Greenhouse effect is a myth, say scientists" (Daily Mail, 5 March 2007). Finally, on the internet you can even find a website called Climate Change Fraud (2008) with articles such as "Global Warming Fears Fueled by False Science".

This dissertation however will focus on the research and the reports of the IPCC. The IPCC is an intergovernmental scientific body set up by the World Meteorological Organization (WMO) and by the United Nations Environment Program (UNEP) that was "established in 1988 to provide the decision-makers and others interested in climate change with an objective source of information about climate change" (IPCC 2008).

According to the IPCC's Fourth Assessment Report (2007), "climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use" (2007a, 943).

Moreover, according to The United Nations Framework Convention on Climate Change (UNFCCC), which is an international environmental treaty produced at the United Nations Conference on Environment and Development (UNCED), informally known as the Earth Summit, held in Rio de Janeiro from 3 to 14 June 1992, climate change is "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in

addition to natural climate variability observed over comparable time periods" (UNFCCC, Article 1).

It is important to highlight the fact that the UNFCCC makes a clear distinction between climate change attributed to human activity and that which results from natural internal processes and external forcings, both of which are included in the IPCC definition.

2.4 History of Climate Change

The relative role of changing CO_2 and particle loading as factors in climate change was assessed by Mitchell in 1973. He noted that these variable atmospheric constituents are not necessarily external parameters of the climatic system but may also be internal variables. The now famous atmospheric concentrations recorded at Mauna Loa, Hawaii, showed a steady increase in the annual average amounting to about 4 percent rise in total CO_2 between 1958 and 1972 (US Committee for the global atmospheric research program, 1975: 43).

According to Cline, "public concern about the greenhouse effect exploded in the late 1980s primarily for three reasons. First it was becoming evident that the decade was the warmest on record. Second, numerous calculations by climatologists using general circulation models (GCM) had become available and third there was increasing awareness among scientists that other GHGs were adding substantially to the impact of CO_2" (1992: 14).

In this context the United Nations (UN) and other nations agreed to establish the IPCC in 1988. Furthermore, on April 1990 the Bush administration hosted the

White House Conference on Science and Economic Research to Global Change and on December 1988 the UN General Assembly approved resolution 44-248, which called for a global summit on environment and development issues, scheduled to take place in Rio de Janeiro in June 1992.

As mentioned before, the result of the Rio summit was the creation of the UNFCCC with its ultimate objective to achieve "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (UNFCCC, Article 2). In this manner it paved the way for the Kyoto Protocol that was adopted on 11th of September 1997 and came into force on the 16th of February 2005. With this "ministers and other high-level officials from 160 countries reached an agreement on a legally binding Protocol under which industrialized countries will reduce their collective emissions of greenhouse gases by 5.2%. The agreement aims to lower overall emissions from a group of six greenhouse gases by 2008-12, calculated as an average over these five years. Cuts in the three most important gases - CO_2, CH_4, and N_20- will be measured against a base year of 1990" (UNFCCC, 2008).

Up to now, over 180 countries have ratified the protocol. Of these, 36 developed countries are required to reduce greenhouse gas emissions to the levels specified for each of them in the treaty. One hundred and thirty-seven developing countries have ratified the protocol, but have no obligation beyond monitoring and reporting emissions. Latin American countries are included in the latter while it has to be mentioned that the United States has yet to ratify this treaty to date.

2.5 The Work of IPCC and its Observed Changes

In the meantime the IPCC has produced four assessment reports since its creation. These were published in 1990, 1995, 2001 and 2007. The IPCC also produces Special Reports; Methodology Reports; Technical Papers; and Supporting Material, often in response to requests from the Conference of the Parties to the UNFCCC, or from other environmental Conventions. The findings of the first IPCC Assessment Report of 1990 played a decisive role in leading to the UNFCCC, which was opened for signature at the Rio de Janeiro Summit in 1992. "It provided the overall policy framework for addressing the climate change issue. The IPCC Second Assessment Report of 1995 provided key input for the negotiations of the Kyoto Protocol in 1997 and the Third Assessment Report of 2001 as well as Special and Methodology Reports provided further information relevant for the development of the UNFCCC and the Kyoto Protocol" (IPCC, 2008).

Having discussed the creation and activities of the IPCC, there follows an overview of the observed changes in climate and their effects as included in the IPCC Fourth Assessment Report of 2007. According to this, eleven of the last twelve years (1995-2005) rank among the twelve warmest years in the instrumental record of global surface temperature (since 1850). The temperature increase is widespread throughout the globe, and is greater at higher northern latitudes. Land regions have warmed faster than the oceans. Rising sea levels are consistent with warming. Global average sea level has risen since 1961 at an average of 1.8 mm/yr. The projections from the 1997 report on temperature and sea level rise were that the annual global surface temperature would increase by 1-3.5°C by 2100, while the sea level will rise by 15-95 cm.

Moreover, satellite data since 1978 show that the annual average cover of Arctic sea ice has shrunk 2.7% per decade. Mountain glaciers and snow cover on average have declined in both hemispheres. From 1900 to 2005, precipitation increased significantly in eastern parts of North and South America, northern Europe and northern and central Asia but declined in Mediterranean, southern Africa and parts of southern Asia. Globally, the area affected by drought has likely increased since the 1970s.

Furthermore, these long-term, large-scale, human induced changes will interact with natural variability in time scales of days to decades and thus influence social and economic well-being.

2.6 Global Circulation Models (GCMs)

Before closing this chapter, it is important to make a reference to methods used in order to calculate, model and predict climate change.

The obvious starting point would be the numerical weather predictions which provide our daily forecasts, but as Burroughs argues "weather forecasting is a problem in mathematical physics, having to incorporate the principles of conservation of momentum, mass, energy and water in all its phases, and also to include parameters including the size, rotation, geography and topography of the Earth, the incoming solar radiation, vegetation, snow and ice cover and a lot more" (2001: 240).

So despite the fact that they have shown significant improvements in the last twenty years, such models only provide useful forecasts up until around six days

ahead. The most complex climate models that are the more widely used in studies for climate change are the three-dimensional GCMs.

According to Goodess *et al*. "their aim is to simulate the full three-dimensional character of the climate by solving the primitive equations that describe the movement of energy and momentum, and the conservation of mass and water vapor thus making them the most sophisticated existing models of the atmosphere" (1992: 77).

Most of the published literature relates to five specific GCMs, each of which is known by the name of the group responsible for its development: the UK Meteorological Office (UKMO); Goddard Institute of Space Studies (GISS); National Center for Atmospheric Research (NCAR); Geophysical Fluid Dynamics Laboratory (GFDL); and Oregon State University (OSU) (Goodess et al, 1992: 78). The performance of the best GCMs was assessed in the 1995 IPCC report. In this the sixteen most developed models were considered.

However, as both Burroughs and Goodess *et al*. agree there are some fundamental problems related to the validity of the model results themselves. As the latter argues "doubts still remain concerning the representation of feedback effects. Until substantial advances in modeling occur, none of the available GCMs can provide reliable high-resolution scenarios suitable for use in quantitative regional impact studies" (Goodess *et al*., 1992: 98).

Despite that, GCMs are still considered to offer the greatest potential for developing regional scenarios of climate change for use in impact studies, given the condition that their limitations are fully considered.

This chapter has provided a brief review of climate change, of the climatic system along with a reference to the IPCC and the GCMs. Moving on from the scientific facts, the climate change effects and predicted consequences are going to be discussed, focusing on the Latin American region. In order to do that though, it is important to have an overview of the continent. This will take place in the following Chapter 3.

3 Latin America

3.1 History

In this chapter, there is going to be a description of Latin America, starting with a review of its history and moving to today's geographic, demographic and social characteristics.

For many, Latin America's history starts with its discovery by Christopher Columbus in 1492. Of course this is far from the truth since it could be said that what Columbus found was a new 'old world'. According to Miller (2007) the American population in 1492 ranged from 40 to 70 million, while Kirby (2003) sets the number at 50 to 90 million, at a time when the population of Europe was less than 60 million. Mexico and Central America combined may have held some 24 million; South America about the same number while the Caribbean islands alone held 3-7 million.

These numbers were quickly reduced; both through the brutality of the conquerors and the diseases they brought with them. "In 50 years the population of the island of Hispaniola (today's Haiti and Dominican Republic) was reduced from one million to 500, while the population of Mexico fell from 20 million to one after the first century after the conquest" (Kirby, 2003: 17). In 1650 all humans of all origins could only muster ten percent of the 1492 population.

"As a result, soils, forests, waters and wildlife that had been mined, logged, dammed and hunted for millennia, under constant indigenous pressures, got a sudden reprieve" (Miller, 2007:57). For the immigrants who came a century later, the "New World" was a place with immeasurable forests, rich wildlife and few people. This was

to change though, due to both the new immigrants' mentality and the new technologies that they brought with them.

According to Roberts and Thanos (2003) what shaped Latin America's society forever was this "pillage" mentality. Plantations and mines were introduced that provided products for an overseas market, while new towns were created thus generating a new demand for textiles, tea, firearms and luxuries. Through their words, "from the beginning of the conquest, Latin America's mining and plantation agriculture were directly linked to the world economy. This new economic system sent out waves of influences, that eventually reshaped local economies, societies and ecosystems" (Roberts and Thanos, 2003: 12).

Sugar was one of the most important plantation crops, that helped first Brazil and then the islands of the Caribbean, become a colonial success. Sugar though, is one of agricultures' most ravenous activities, for in addition to burning forests for fields and depleting soils of their fertility, it also results in the destruction of forests well beyond the plantation due to the need for immense quantities of firewood. The result was that the Atlantic forest, a treasure of unique plant and animal species, experiences the first incursions of a violence that would intensify over the next centuries.

In the same mentality the extraction of silver had direct environmental impacts around the highland mining zones. "Even by 1660, Spain had received 16 million kilograms of silver, three times Europe's entire former reserves" (Miller, 2007: 87).

All the aforementioned authors (Miller, Roberts and Thanos, Kirby) agree that Latin America's main role since colonial times has been to supply raw materials to the industrialized countries. This role has continued after Latin American independence, when these countries realized that they were in no position to compete in the

production of industrial goods, despite the efforts towards industrialization between the 1930s and the 1970s.

3.2 Latin America Today (geography, demography)

Latin America's geography is characterized by its diversity. The Andes Mountains, running down the west coast of South America for 2,500 miles from Venezuela, until they form the border between Chile and Argentina, are the world's second highest mountain range. Mexico is divided by the three ranges of the Sierra Madre, while Central America is divided by volcanic ranges.

East of the Andes, lays the world's largest extension of tropical forests and the three extensive river systems- the Amazon, the Orinoco and the River Plate. The Amazon basin supports 20 percent of the world's vascular plant species and 2500-3000 fish species, while some 20 to 30 percent of the earth's available water flows through the basin (Padua, 1997). The rainforest includes vegetation zones ranging from dense forest areas to areas with sandy soils and sparse vegetation (Bennett, 1992). The diversity is high, including about 250 species of plants per hectare. Moreover, the forest holds some 50 billion tons of carbon (or 90-140 billion tons according to Nepstad, 2007), an element that if released into the atmosphere would cause a greenhouse effect of unimaginable proportions.

Moreover, Latin America's climate is highly heterogeneous. A large portion of the region is located in the tropics, showing a climate dominated by convergence zones such as the Inter-tropical Convergence Zone (ITCZ), and the South Atlantic Convergence Zone (SACZ). The summer circulation in tropical and sub-tropical

Latin America is dominated by the North American Monsoon System, which affects Mexico and Central America, and the South American Monsoon System, which affects tropical and sub-tropical South America east of the Andes (IPCC, 2007a: 584-585).

Its population is also characterized by diversity. Apart from the indigenous and the first Europeans who came from Spain, Portugal, the United Kingdom, France and the Netherlands, the continent witnessed the arrival of some 8.5 million Africans during the slavery period, and later from countries such as Lebanon and Syria, Japan and India. This racial diversity finds expression in terms such as *mestizo* (those of Spanish and indigenous parentage) and *mulatto* (of Spanish and Black parentage).

The region's population, 507 million, is continuing to grow and is expected to be 50 percent larger than in 2000 by the year 2050. Its annual population growth rate has decreased and is expected to reach a value of 0.89 percent by 2015, which is considerably less than 1.9 percent the average rate for the 1975 to 2002 period (IPCC, 2007a: 595).

Furthermore, Latin America is the most urbanized part of the developing world, with 380 million out of its 507 million residents, living in urban zones. "There are 52 cities in the region with population over one million, while four of them are characterized as megacities (with population of more than 10 million), with the biggest being Mexico City with 25.6 million" (Roberts and Thanos, 2003: 99).

3.3 Society

As Roberts and Thanos argue, an important tradition that in varying forms was passed on from pre-Columbian and European societies is a system of authoritarian governance. Even more, "after the conquest, these Latin American authoritarian (nondemocratic) regimes were aided by foreign militaries and military aid, first from Spain and later from the United States" (Roberts and Thanos, 2003: 11).

In this way an elite class was created in every Latin American country, which benefited from this relationship with the foreign powers. These elites, adapted quickly to the World Order without, on the whole, much consideration for their fellow countrymen. They profited from the sale of state goods, while at the same time they were imitating the habits of the European and US upper classes. "In many ways, the Latin American elite held on to policies that kept their nations underdeveloped" (Roberts and Thanos, 2003: 16).

As a result, Latin American societies are characterized by inequality and the poverty that comes along with this. This situation deteriorated further, after the 1980s, which has been named the 'lost decade'. During these years the region faced a great debt crisis, which forced the countries to implement rigorous economic measures in order to liberate their economies and meet the conditions of imposed by IMF structural adjustment loans. "Gross national income per capita fell by more than 14 percent from 1981 to 1991 in every Latin American country, and 21 percent for the Caribbean "(Jonas and McCaughan, 1994: 1). According to the IPCC: "deterioration of economic and social conditions, unemployment, extension of the informal economy and poverty characterized this decade" (IPCC, 2007a: 591).

Debt remains a threat to Latin America's economic and social conditions even today. The collective debt now exceeds $800 billion or roughly 40 percent of its total gross product (Roberts and Thanos, 2003). At the same time, despite the fact that the percentage of households in poverty has declined, it still remained at 35.3 percent (41.3 million) in 1999, while the percentage of persons in poverty, in the same period was 43.8 percent (211.4 million) (Kirby, 2003).

Inequality worsened over the 1990s, thus giving Latin America the distinction of being the region with the highest levels of inequality in the world. "The wealthiest 10 percent of its population claims between 40 and 47 percent of the national income, while the poorest 20 percent has only 2 to 4 percent" (IPCC, 2007a: 591).

As a result, some environmental implications appear evident. Civilian pressure for the protection of the environment is difficult to be applied, when there is a lack of democracy itself. Also, when the countries are facing severe economic crisis, environmental enforcement by governments could be considered a luxury. After all, as Miller argues, "developing nations were too busy trying to bake an economic pie large enough to feed everyone to worry about the vile mess they were making in the kitchen" (Miller, 2007: 206).

But interestingly, as Miller and Roberts and Thanos argue, today environmentalism is present across Latin America in nearly all forms of media and makes up a significant part of public and private education. According to two surveys, discussed by Roberts and Thanos (Dunlap's Gallop Institute survey and the World Values Survey), "approval of the environmental movement and concern about the environment reach levels that are in some places even higher than in wealthier countries" (Roberts and Thanos, 2003: 105-106). Miller offers an explanation for that:

"For rich nations, environmentalism is driven in part by the fact that modernization and development have alienated us from nature. For the poor, environmentalism is motivated by the knowledge, now lost in developed nations, that people are entirely dependent on nature for livelihoods and cultural survival"(Miller, 2007: 214).

This chapter has provided an overview of the continent's history, geography and demography along with a short description of its society and the main problems that it faces. The above were portrayed in a way that they relate with Latin America's environment and its problems. But, what are today's environmental conditions in the region and how have, or will they be affected by climate change? Furthermore, how are the aforementioned social problems connected with the region's vulnerability to climate change? These questions are going to be considered in the next chapter.

4 Vulnerability in Latin America

This chapter is going to examine Latin America's vulnerability to climate change. Before moving on to that though, it is necessary to define what 'vulnerability' is. For the purpose of this dissertation, the IPCC's definition will be used. This states that: "Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity" (IPCC, 2007a: 883).

4.1 Climate Change Vulnerabilities

4.1.1 An overview

Past climatic variations have had impacts on the Earth, its species and humans themselves. According to Burroughs (2001) climatic factors are to blame for the fall or decline of various ancient civilizations. For example, the collapse of the Harrapan culture which thrived in the Indus Valley between 2.500 and 1.500 BC, as well as the fall of the Mycenae, Ugarit and Hittite Empires. Moreover the decline of the Maya civilization is attributed to the drought period from 750 to 900 AD. But let's consider these factors analytically.

First of all there are the geological consequences. It is evident that climatic events like the waning of ice sheets or the drying up of oceans have major impacts on the geology of large parts of the earth. But as Burroughs argues (2001: 116-118) the real question is whether these were the 'cause' or the 'effect'. According to him, as yet there is no agreement.

Glaciers, ice caps, ice sheets and sea levels are also affected by climatic variations. The melting of glaciers and ice caps leads to sea level rise, while oceanic thermal expansion is the result of global warming. Coastal areas, that are of course mainly affected, are amongst the most densely populated areas in the world, and support several important ecosystems. "According to one study, that assumes protection levels rise in line with GDP per capita, between 7-70 million and 20-300 million additional people will be flooded each year by 3 to 4°C of warming causing 20-80 cm of sea level rise" (Stern, 2007: 90).

Moreover, climate change can have significant consequences on the flora and fauna of the planet. The changing temperature can exert powerful control over the development and distribution of species. For many species, the rate of warming can be too rapid to withstand while others will have to migrate to distant landscapes in order to stay within their "climate envelope".

Of course, this can lead to mass extinction of many species. According to Stern (2007), a 1°C warming can lead to the extinction of at least ten percent of land species; while with a 3°C warming 20 to 50 percent can face extinction. Burroughs offers the Late Permian extinction example, when 60 percent of all families of species were wiped out, with possibly as many as 96 percent of all species disappearing, with the mortality being higher on land than in water (Burroughs, 2001).

In the same way, it is easy to suppose that agriculture will be affected too. "Agriculture today accounts for 24 percent of world economic output, employs 22 percent of the global population, occupies 40 percent of the land area while 75 percent of the poorest people of the world (who live on less than $1 a day) live in rural areas and rely on agriculture for their livelihood" (Stern, 2007: 74). While low levels of

warming in mid to high latitudes may improve the conditions for crop growth, in tropical regions it will lead to declines in yield and therefore to the likelihood of leaving hundreds of millions without the ability to purchase or produce food. According to Stern, rises of 2°C to 3°C will increase the people at risk of hunger potentially by 30 to 200 million, while an increase of more than 3°C will lead to 250 to 550 million at risk.

Health as well is one of the most important areas that are affected by climatic variations. Despite the fact that the health of the world population has improved substantially over the past decades there are still parts of it that are susceptible. Poor people especially, living in slums in urban areas are particularly exposed to disease, are suffering from poor air quality and have limited access to clean water. The World Health Organization (WHO) estimates that climate change since the 1970s is responsible for over 150,000 deaths each year, through increasing incidence of malaria, malnutrition and diarrhea, predominantly in developing regions (WHO, 2008).

Finally, there are severe economic impacts due to the more frequent extreme weather events such as droughts, heat waves, hurricanes and winter storms. These, can cause damage to infrastructure and lead to changes in soil conditions that influence building's stability. For example, the Gulf and East Coasts of the US suffer an average of nearly $5 billion hurricane damage per year, thus leading Burroughs to argue that extreme weather events represent the most immediate threat of climate change.

4.1.2 Vulnerability in Latin America

Over the past three decades, Latin America has been subjected to climate related impacts of increased 'El Niño'[1] occurrences. According to CEPAL "between 1972 and 1999 natural disasters caused 108,000 deaths and directly affected over 12 million people, while damages were estimated at US$50 billion" (CEPAL, 2000: 10-11).

The Latin American tropical forests, and especially those of Amazonia, "are increasingly susceptible to increased 'El Niño'-related droughts and to land-use change such as deforestation and forest fragmentation" (IPCC, 2007a: 586). According to Case, the projected changes of warmer temperatures and decreased precipitation "could lead to devastating impacts, including; increased erosion, degradation of freshwater systems, loss of ecologically and agriculturally valuable soils, loss of biodiversity, decreased agricultural yields. Increased insect infestation and spread of infectious diseases" (2008: 3). Moreover, according to the IPCC, "by mid century tropical forest in Amazonia will be gradually replaced by savanna while semi-arid vegetation will tend to be replaced by arid-land vegetation" (IPCC, 2007b: 10).

Furthermore, in agriculture, findings indicate high/low wheat yields during 'El Niño'/ 'La Niña' in Mexico, shortening of cotton and mango growing seasons in Peru and increases in incidents of plant diseases in Argentina and Brazil. As the IPCC's

[1] El Niño is a global coupled ocean-atmosphere phenomenon and is the most prominent known source of inter-annual variability in weather and climate around the world (about 3 to 8 years). The intensity and frequency of El Niño events are known to have varied in recent decades. "These changes appear to be connected to shifts in climate, raising the possibility that ENSO might undergo discernible changes in response to anthropogenically driven warming" (Merryfield, 2006: 4009).

summary for policymakers argues, “These effects can have adverse consequences for food security, while the number of people at risk of hunger is projected to increase” (IPCC, 2007b: 10).

Water availability is another area that is predicted to be affected. Despite the fact that the region is recognized as having large freshwater resources, the spatial distribution affects their availability and quality. For example droughts related to ‘El Niño’ impacts are causing a 30 percent reduction in the Colombia Andean region while droughts related to ‘La Niña’ create severe restrictions for water supply in central western Argentina and central Chile. At the same time “vulnerability to flooding events is high in almost 70 percent of the area represented by Latin American countries” (IPCC, 2007a: 586).

The low-lying coasts of several countries of the region (e.g., Argentina, Belize, Colombia, Costa Rica, Guyana, El Salvador, Venezuela) and large cities including Buenos Aires and Rio de Janeiro are among the most vulnerable to climate variability and extreme hydrometeorological events such as rain, windstorms and hurricanes. While sea-level rise is not yet a major problem, evidence of an acceleration of sea-level rise suggests an increase in the vulnerability of the aforementioned areas, leading to loss of coastal land, infrastructure and bio-diversity, as well as the intrusion of contaminating saltwater.

Finally, important consequences are taking place in the human health area. The 2001 IPCC report was predicting that the geographical distribution would expand poleward and to higher elevations, while exposures to diseases such as malaria, dengue fever and cholera would increase. The 2007 IPCC report states the risk of epidemic malaria in Colombia and Venezuela, epidemics in Colombia and Guyana,

dengue fever in Honduras and Nicaragua, leptospirosis in Brazil and dermatological diseases in Peru. At the same time, hyperthermia related to heat waves is responsible for ten percent of summer deaths in Buenos Aires, while in Sao Paolo, an increase of 2.6 percent in all-cause morbidity in the elderly per °C increase in temperature above 25°C is reported.

4.2 Vulnerability Due to Latin American Special Characteristics/ North-South Inequality

So far, a discussion regarding the general, natural vulnerabilities of Latin America has been made. But up to what extent do the region's special socioeconomic characteristics (see Chapter Two) affect these vulnerabilities?

Ulrich Beck, in his influential work 'Risk Society' argued that "poverty is hierarchic, smog is democratic" suggesting that we all suffer equally from environmental degradation (Beck, 1992: 36). On the other hand, various authors (Roberts and Parks (2007), Kirby (2003), Adger *et al.* (2006), Adger *et al.* (2001), Painter and Durham (1995), IPCC (2001, 2007), DFID (2004)) believe that climate change vulnerability is not democratic and equal, but as Kirby argues, "the level of impact that natural disasters have on people, their communities and their livelihoods results from the social conditions in which people live" (Kirby, 2003: 117). This dissertation is going to argue that the regional characteristics along with global inequality are increasing the continent's vulnerability.

4.2.1 Emissions Inequality

In this part the following will be discussed: global inequality in reference to current and past emissions and North-South politics in reference to negotiations.

As Roberts and Parks argue "global warming is all about inequality, not only in who will suffer its effects most, but also in who created the problem in the first place" (2007: 135). The numbers are revealing: the US, with only four percent of the world's population is responsible for over 20 percent of all global emissions. "That can be compared with 136 developing countries that together are responsible for only 24 percent of global emissions. Overall the richest 20 percent of the world's population is responsible for over 60 percent of its current emissions of GHGs" (Roberts and Parks, 2007: 10).

Furthermore, according to Sachs, "countries are not affected according to their share of responsibility for the climate change. Taking CO_2 as the predominant GHG, the average per capita consumption in 1985 in the industrialized countries was almost ten times as high as in the Third World" (1993: 81).

Latin America, accounts for only about six percent of global emissions of GHGs. Furthermore most of the region's economies are less CO_2-intensive than the US, and several are less intensive than Japan or the EU. "On a per capita basis, the population is a modest contributor to the problem and this is not likely to change significantly in the future" (Vergara, 2007: 9).

4.2.2 North-South Politics

Together with the described inequality in matters of emissions and responsibility, there is an ongoing discussion concerning equity in North-South cooperation in dealing with climate change. The IPCC states that "to be effective and to promote cooperation, agreements must be regarded as legitimate, and equity is an important element in gaining legitimacy" (1995: 6.1). Also it recognizes that "appropriate measures to enable developing countries Parties to participate effectively in negotiations increase the prospects for achieving effective, lasting and equitable agreements on how best to address the threat of climate change" (IPCC, 1995: 6.2). In practice though, this doesn't seem to be happening.

As Roberts and Parks argue, "global inequality promotes a social distribution of economic benefits and environmental burdens that advantages rich countries and disadvantages poor countries and thus creates political conflicts of an intrinsically structural nature" (2007: 31). Consequently, this creates "conditions of generalized mistrust and weak reciprocity, which in turn makes developing countries more inclined to take self-damaging actions for their emotional satisfaction" (Roberts and Parks, 2007: 27).

Generally, the developing countries due to their weak technical, administrative, negotiating and financial abilities are thought to have a negative impact on cooperation. At the same time, such nations lay emphasis on the North's "environmental colonialism": "When the rich chopped down our forests, built their poison-belching factories and scoured the world for cheap resources, the poor said nothing. Now the rich claim a right to regulate the development of poor countries.

And yet any suggestion that the rich compensate the poor adequately is regarded as outrageous" (Mahathir Mohamad cited in Roberts and Parks, 2007: 38).

On the whole, as Roberts and Parks argue, there are three widely held perceptions that obstruct North-South efforts to protect the climate: "the fact that climate change is primarily an issue of profligate Northern consumption; that a nation's ability to implement meaningful environmental reform depends upon its position in the international division of labor; and that the North is using environmental issues as a ruse to thwart the economic development of poor nations" (2007: 36).

Section 4.2.1 demonstrated that the developed countries of the North are responsible for most past and current emissions and therefore are the ones mainly responsible for today's environmental condition. Despite this, there is no equity and no social considerations within climate change negotiations, thus leading to non-cooperation and as a result to an increase in developing countries' vulnerability.

4.2.3 Vulnerability Due to Regional Characteristics

Having examined how North-South politics promote vulnerability the focus will now be turned to Latin America itself and to how the regional characteristics affect the region's susceptibility to climate change.

First of all, as Stern argues, "developing countries are especially vulnerable to the physical impacts of climate change because of their exposure to an already fragile environment, an economic structure that is highly sensitive to an adverse and changing climate, and low incomes that constrain their ability to adapt" (2007, 106).

In Simms and Reid's' words "developing countries are the most susceptible to climate change. Their economies are heavily dependent on sectors vulnerable to the climate, such as agriculture, forestry and hydropower, not to mention public sectors such as the health service and water utilities" (2006: 6).

As was previously described, Latin America is characterized by mass poverty. As CEPAL says "the poor live in zones of high risk, use cultivation techniques which damage the environment or work in marginal areas, and have less access to information, to basic services and to pre- and post-disaster protection" (2000, 2). The result is a further weakening of the environment with further disasters thus resulting in a vicious circle, aggravating social and environmental vulnerability. Furthermore, according to DFID, "the poor are already finding it difficult to cope with the effects of 'El Niño' and hurricanes. Their ability to deal with the climate is being eroded by economic changes, increasing urbanization, increased population densities along coasts, and environmental destruction" (2004: 4).

"Inequality affects vulnerability directly through constraining the options of households and individuals when faced with external shock; and indirectly through its links with poverty and other factors" (Adger *et al.*, 2001: 23). According to the IPCC's report "the combination of low economic growth and high levels of inequality can make large parts of the region's population very vulnerable to economic and natural stressors, which would not necessarily have to be very large in order to cause great social damage" (2007a: 591).

Roberts and Parks also focus on "unique structural constraints such as the "feeble postcolonial government institutions that limit the countries' ability to implement good environmental policies" (2007: 192). Also they are referring to

"states beholden to narrow groups of 'export elites' that tend to have ineffective and corrupt bureaucracies and therefore little capacity to deliver public goods, like environmental protection" (2007: 193). Lastly they place emphasis on the historical legacy of a country's incorporation into the global economy, claiming that "we expect that a colonial insertion into the global economy (reliance on the export of a few, barely processed raw materials) will negatively influence a nation's environmental policy" (2007: 198).

This chapter provided an examination of Latin America's vulnerability to climate change. From the above, it was made evident that "there is an uneven distribution of climate change impacts leaving the hotter, poorer nations- the countries that have lower adaptive capacity- more vulnerable"(Schneider and Lane, 2006: 28). Consequently these countries are more in need of adaptation. The level, the programmes and a discussion of global inequality in adaptation will be discussed in the next chapter.

5 Adaptation in Latin America

5.1 Overview

As discussed in the previous chapter, the countries that have contributed the most to global GHG emissions are likely to cope better with the effects of climate change. On the other hand, less developed countries tend to have lower adaptive capacities, due to their higher vulnerability affected by financial and governmental constraints. According to the IPCC 2001 report "adaptive capacity of human systems in Latin America is low, particularly with respect to extreme climate events, and vulnerability is high" (2001: 15).

But what exactly is 'adaptation' and 'adaptive capacity'? This dissertation is going to use the IPCC definition which states that adaptation is the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (2007a: 869). Adaptation can be distinguished as anticipatory (or proactive), autonomous (or spontaneous), and planned. On the other hand 'adaptive capacity' is "the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences" (IPCC, 2007a: 869).

5.2 Current Adaptation

This part is going to examine Latin America's current adaptation, and is based on the findings of the 2007 IPCC report on Latin America (2007a, 581-583). After the

1982/83 ‘EL Niño’ an international effort to understand and predict this ocean-atmosphere phenomenon started under the Tropical Ocean-Global Atmosphere (TOGA) programme. The result was the emergence of increasingly reliable seasonal climate forecasts for many parts of the world and especially for Latin America. A number of applications rose starting in the late 1980s for fisheries in the Eastern Pacific and crops in Peru, subsistence agriculture in north-east Brazil, prevention of vegetation fires in tropical South America, streamflow predictions for hydropower in the Uruguay river, dengue epidemics in Brazil and malaria control and hydropower generation in Colombia.

“Agriculture is a key sector in Latin America since it represents 19 percent of the land area, and employs 30 to 40 percent of the population” (Simms and Reid, 2006: 22). Climate forecasts have been used, especially in Brazil since the early 1990s, for planning production strategies. Moreover, some adaptive measures, such as changes in land use, sustainable management, insurance mechanisms, irrigation, adapted genotypes and changes in agronomic crop management are used to cope with climatic variability. For example; farmers located on the US-Mexico border that have been able to continue farming through changes in irrigation technology and smallholders in Nicaragua who were able to cope better with the impacts of Hurricane Mitch through sustainable land management.

In the area of natural ecosystems, ecological corridors between protected areas have been planned for the maintenance of biodiversity, such as the Mesoamerican Biological Corridor. Important projects are those for natural corridors in the Amazon and Atlantic forests and the Villcambaba-Amboró biological corridor in Peru and Bolivia. Other positive practices are orientated towards maintaining and restoring native ecosystems and protecting and enhancing ecosystem services such as carbon

sequestration in the *Noel Kempff Mercado* Climate Action Project in Bolivia. Furthermore, mountainous forest conservation programmes are taking place in Costa Rica and Brazil.

A further major important area of interest is water resources. Some communities and cities, such as in the Paraná river basin of Argentina, have organized themselves in disaster prevention, while programmes for rainwater cropping and storage systems are taking place in Brazil. However, according to the IPCC, "there is lack of adequate adaptation strategies to cope with the hazards of floods and droughts due to low GDP, the increase of the population settling in vulnerable areas and the absence of appropriate political, institutional and technological framework" (2007a: 592).

On the other hand, several Latin American countries (e.g, Argentina, Colombia, Costa Rica, Uruguay and Venezuela) have planned and developed autonomous adaptation measures in response to climate variability impacts on their coasts. Most of them are focusing on integrated coastal management and plans for adaptation and development of appropriate capacities.

In the area of human health, the IPCC reports that adaptation measures should be considered as isolated initiatives. Isolated measures can be identified in Colombia on dengue and malaria surveillance control systems and in Bolivia on vector control and medical surveillance.

As has previously been described, Latin America is also characterized by urbanization particularly in low-lying areas, such as north-east Brazil, Guyana and Venezuela. According to Satterthwaite *et al.* (2008) though, little attention has been given to cities' adaptation with the exception of Buenos Aires where a World Bank

programme is underway to address flooding and the PRODEL programme in Nicaragua focusing on upgrading slums and squatter settlements.

5.2.1 Other Projects and Efforts

At the same time many universities, climate research institutions and NGOs are organizing projects in an effort to promote regional climate modeling and climate scenarios.

Some examples are:

- The CPTEC in Brazil that is a leading research center for climate system analysis, climate modeling and climate prediction.
- The CATHALAC Project that works as a data warehouse, and helps in the assessment of adaptive capacity in Central America, Mexico and Cuba.

The MACC project, which is funded by the Global Environmental Facility (GEF), is a regional project being implemented in twelve CARICOM countries. "Its main objective is to build further capacity in the Small Island Developing and low lying coastal States of the Caribbean for increasing their resilience to climate change risks through the identification and implementation of feasible adaptive options" (AIACC, 2004: 4-3).

In Central America, the *Comite Regional de Recursos Hidraulicos* (CRRH) is an intergovernmental centre with expertise in meteorology, climate and water resources and also provides training in these areas. Furthermore universities in Brazil, Argentina, Chile, Costa Rica and other countries of the region offer high quality

meteorology programmes and are centers of research that can contribute to improve understanding of climate risks and adaptation.

Finally, several other smaller projects are taking place in the region. Simms and Reid's 2006 report makes reference to some of them including:

- The training of technical leaders, or *Kamayoq*, in Peru that help smallholder farmers in higher lands with their crops and animals.
- The introduction of small-scale hydro electricity in the mountains of Bolivia
- The *Jepirachi* wind power project in Colombia.
- The *Plantar Project* in the state of Minas Gerais in Brazil to substitute coke/coal production with eucalyptus plantations.
- The programme for electricity generation from waste incineration in Brazil.

5.3 Sustainable Development and Climate Change

Sustainable development (SD) is a very broad concept encompassing issues related to development, environment and equity. For the purpose of this dissertation, the Brundland Commission definition is going to be used stating that SD is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission, 1987: 8).

According to the IPCC "SD can reduce vulnerability to climate change by enhancing adaptive capacity and increasing resilience, and climate change could impede nations' abilities to achieve SD pathways" (2007c: 19).

However Halsnaes argues that studies addressing how the broad agenda of SD policy objectives can be integrated in climate change studies have not been identified. Nevertheless, there are studies that make a first attempt at integrating important indicators. "These studies include ancillary benefit studies and studies that have assessed climate change mitigation projects in relation to selected SD impact indicators representing development, environmental, social, and in some cases, technology implementation dimensions of SD" (2002: 69).

The above is also recognized by the IPCC: "at present, few plans for promoting sustainability have explicitly included either adapting to climate change impacts, or promoting adaptive capacity" (2007c: 19).

Specifically for Latin America, Dore refers to two problems with the sustainable development approach: "first, while tropical forests, especially Amazonia, monopolize the attention and funds of advocates of SD, the vast majority of Latin Americans live in areas that attract minimal interest. Second, the notion that economic growth causes ecological destruction, prevents ecologists and policymakers from exploring the connections between property relations, political power and environmental destruction" (1996: 9).

5.4 Biofuels

Another proposed solution to the problem of climate change is biofuels. As has already been described, the main driver of global warming is the emission of GHGs. The magnitude of the problem becomes even clearer, if the earth's growing population and the increase of per capita energy demand are considered. Moreover,

over the past ten years, transport has shown the highest rates of growth in GHG emissions in any sector. By 2030, according to The Royal Society (2008), energy use and carbon emissions from transport are predicted to be 80% higher than current levels.

Today the world's primary source of energy for transport is oil. At a time though when availability is becoming geographically restricted and the prices are getting higher biofuels seem to be the answer. There are three main biofuels: ethanol, biodiesel and methanol. Biofuels are currently produced from the products of conventional food crops such as the starch, sugar and oil feedstock from crops that include wheat, maize, sugar cane, palm oil and oilseed rape. Brazil is a leading producer and exporter of biofuels, mainly ethanol, derived from sugarcane.

According to Gallagher, biofuels have the:

• Potential for GHG savings in relation to fossil fuels;

• Capacity to diversify the supply of transport fuels and provide additional fuel security benefits; and

• Ability to create new agricultural markets and rural development opportunities.

(Gallagher, 2008: 17).

For example ethanol from sugarcane in Brazil has "the potential to reduce total life-cycle GHG emissions by up to 90% compared with the consumption of an equivalent amount of gasoline" (Doornbosch and Steenblik 2007: 18).

However there are some very important side effects. Due to the growing biofuels demand, a displacement of existing agricultural production is taking place,

while at the same time farm commodity prices are increasing as demand rises for grains, oilseeds and sugar. The result is a rise in food prices which according to Doornbosch and Steenblik are expected to rise between 20 percent and 50 percent over the next decade. “This projection seems to be consistent with the development of food prices in recent years that have gone up sharply in reaction to increased biofuels production in Brazil (the world’s largest sugar exporter)” (Doornbosch and Steenblik, 2007: 33).

Furthermore, production of biofuels can have impacts on biodiversity. According to the Royal Society report “Characteristics that make them appealing for crop use, such as fast/vegetative growth and high yield, may also enable them to become invasive under the right environmental conditions” (2008: 47). In addition, if crops spread into surrounding habitats, particularly natural ecosystems they may also displace local biodiversity and disrupt ecosystem processes.

Water can also be affected in two ways. First, the increased usage of biofuels will raise the demand, which could, in turn, negatively impact on water availability for other uses. Second, water quality can be affected through the use of fertilizers and pesticides.

5.5 Equality in Adaptation

As discussed in Chapter 4, the impacts of climate change are being felt disproportionally by developing countries and the poor within these countries. This fact exacerbates the already existing inequalities in access to food, health and other resources, while poverty creates conditions of low adaptive capacity.

This fact is recognized by the IPCC which acknowledges that "adaptive capacity is intimately connected to social and economic development but is unevenly distributed across and within societies" (2007b: 14). In addition, "a range of barriers limit both the implementation and effectiveness of adaptive measures. The capacity to adapt is dynamic and is influenced by a society's productive base including: human capital and institutions, governance, national income, health and technology" (IPCC, 2007b: 14).

Furthermore, according to the UNFCCC "The developed country Parties shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects". (2007: Article 4.4).

Several financial mechanisms have been created for this purpose, under the management of the GEF. These are:

- the Least Developed Countries Fund (LDCF)
- the Special Climate Change Fund (SCCF)
- the Adaptation Fund (AF)
- and the Strategic Priority on Adaptation Fund (SPAF)

According to Mace though, "the trajectory of the negotiations on the SCCF and LDCF underscores the challenges developing countries face in negotiations. It is clear that the achievement of favorable substantive outcomes depends upon

bargaining power and negotiations ability that developing countries often lack" (2006: 66).

Moreover, according to the IIED, "at present the international funding pledged for supporting adaptation in low- and middle-income nations is dwarfed by the investments being made for adaptations in high-income nations. For example, UK which has so far pledged $38 million to international adaptation funds, is investing $347 million in new climate-cooling systems for the London Underground" (2007: 89).

Especially for Latin America, as the World Bank argues, "adaptation measures are limited by a number of factors. These include financial limitations imposed by the GEF and other sources of funding, and the budgetary resources available in nations with many competing needs" (2005: 19).

Therefore, it can be concluded that inequality exists also in terms of adaptation. It is evident that available funding is inadequate at a time when the costs of adaptation are high. Additionally, as the World Bank says, while those "should be ideally borne by those most responsible for the increase of trace gases into the atmosphere they are being borne by all nations, and will be particularly onerous for Latin America" (2005: 19-21).

This chapter has examined the extent of adaptation in Latin America and identified various programmes taking place. Those along with SD and bio-fuels were discussed in terms of their capacity to constitute a solution in the climate change problem. Finally the question of equality on adaptation, between developed and developing countries, was discussed in the last part.

Conclusion

Climate change is one of, or maybe the, most important challenges that the world faces today. Global warming is now an acknowledged problem, despite the existence of theories that dispute the causes and especially the role of human activities in aggravating the problem.

The facts are indisputable:

- The five warmest years on historical record were 2005, 1998, 2002, 2003 and 2004.
- The number of major natural catastrophes was four times larger, and cost the world's economies eight times more during the 1990s that in the 1960s.
- Ninety percent of natural disaster fatalities during the 1990s were the result of hydrometeorological events

(Roberts and Parks, 2007: 9).

As was analyzed in Chapter 3, Latin America is a region which is characterized by its fragile natural habitats and abundant natural resources. Moreover, it is the home of thousand of endemic species and of course the Amazon, the World's largest extension of tropical forest, that contains some 20 to 30 percent of the earth's available water and is the storehouse of 50 billion tons of carbon.

On the other hand, Latin America's history has been shaped by its colonial past and, in more recent decades, by dictatorships, military coups and foreign interventions. These have led to the creation of a society that has as main

characteristics high levels of poverty and inequality, while the countries comprising the continent are struggling in the path of development.

As Roberts and Parks argue "developing countries face unique structural constraints. These include unpredictability and long-term decline in the prices of their crucial export commodities, internally unarticulated markets, and feeble postcolonial government institutions, all of which limit their ability to implement good environmental policies and participate in treaty drafting conferences" (2007: 192).

It is widely recognized that while "rich nations have contributed 80 percent of the anthropogenic CO_2 in the atmosphere to become rich and enjoy a tenfold advantage in emissions per capita, when at the same time their emissions also affect poor nations disproportionately" (Schneider and Lane, 2006: 42), the developing countries, due to their increased vulnerability, are the ones mainly affected. Roberts and Parks even argue that "rich nations pay for climate change with dollars and poor nations pay with their lives" (2007:37).

Therefore, it is evident that Ulrich Beck's argument that "poverty is hierarchic, smog is democratic" is far from the truth. In reality, developing countries and especially the poor are the ones that are going to be mainly affected by the climate change impacts. On the other hand, developed countries and the rich, have both the resources and the power to implement and apply measures that will help them adapt to and mitigate of the consequences of climate change.

Furthermore, developing countries, due to their structural characteristics, are not only facing increased vulnerabilities but are also lacking the capacity to negotiate effectively with the countries of the North. They are left "unable to

meaningfully address their emissions of GHGs because of their extremely underdeveloped economies and government agencies" (Roberts and Parks, 2007: 8).

On the other hand, as it was described in Chapter 5, adapting programmes and efforts are taking place in the region. Convention articles, like the UNFCCC (2007: 4.8), are addressing the need of adaptation in developing countries with actions including funding, insurance and the transfer of technology.

Of course, as Paavola *et al.* argue "the capacity of households and communities to adapt depends on their physical assets such as health, education and human-created and natural capital, as well as on institutional arrangements that either facilitate or constrain their attempts" (2006: 274). As it has already been discussed though, in Chapter 3, the region's capacity in the aforementioned matters is low. What is more, as described in Chapter 5, most of the programmes and the efforts that are taking place are local initiatives, without regional planning, focused in small communities.

Thus the countries of the North and the South, the developed and the developing, are faced with a challenge. As Roberts and Parks say "the North needs to offer the South a new global bargain on environment and development issues and signal their commitment to this new 'shared thinking' through a series of confidence-building measures"(2007: 217). The goal should be to "upgrade their developing pathways, diversify their exports to create stronger and more resilient economies, transition to lower-carbon futures, and most important, elicit commitment to a new shared world-view of North-South relations" (Roberts and Parks, 2007: 218).

In terms of adaptation, the challenge is the "achievement of procedural and distributive justice to ensure that the needs of developing countries drive adaptation actions and funding, rather than the other way around" (Mace, 2006: 72).

Therefore, it could be argued that the most important challenge, after a universal acknowledgement of the climate change problem and a realization of the magnitude and of the extent of the impacts, is an agreement on cooperation in equal terms, or in other words an international solidarity, to confront climate change and its impacts.

However, what reality indicates is that the prospects of this happening are quite gloomy. In the last year there have been two groundbreaking proposals from Latin America countries. Ecuador offered to leave the oil in Yasuni National Park undisturbed, in order to protect the park's biodiversity and the indigenous peoples living in voluntary isolation, in return for compensation from the international community, while Guyana offered the preservation of the country's entire 50 million acres of rainforest to the UK in return for sustainable development funds. The response to the first was an almost universal rejection, while an agreement has been reached for the second but to secure the future of only one million acres in Guyana. This could be seen as a clear indication of the fact that the North is still unwilling to move to actions that would prove its dedication to a 'shared thinking' and to international solidarity.

Nevertheless, however discouraging the above fact can be; the need for further research is eminent. The necessity to delink development from carbon use is now evident, particularly in the developing countries whose economies are expected to grow over the next decades. As it was analyzed in Chapter 5 sustainable

development and biofuels, although proposed as solutions, do not come without problems and impacts of their own. Therefore, research on new development paths should be funded based on a consensus on how North-South countries should reduce GHG emissions. Moreover, further funding should be channeled towards new adaptive programmes that will have the ability to encompass the whole region.

Therefore, as Paavola *et al.* argue, "the principles of avoiding dangerous climate change, forward looking responsibility, putting the most vulnerable first and equal participation" (2006: 277) should be followed for fairer terms in vulnerability and adaptation.

Bibliography

Adger Neil W. *et al.* (2006) 'Fairness in Adaptation to Climate Change'. Massachusetts Institute of Technology.

Adger Neil W. *et al.* (2001) 'Living with environmental change: social vulnerability, adaptation and resilience in Vietnam'. Routledge.

Adger Neil W. and Brown Katrina (1994) 'Land use and the causes of global warming'. John Wiley & Sons LTD.

AIACC (2004) 'It's raining, it's pouring…it's time to be adapting: Report of the second AIACC Regional Workshop for Latin America and the Caribbean'. AIACC.

Barros Vicente (2006) 'Adaptation to Climate Trends: Lessons from the Argentine Experience'. AIACC.

Beck Ulrich (1992) 'Risk Society: Towards a New Modernity'. SAGE Publications.

Bennett, B.C. (1992) 'Plants and people of the Amazonian Rainforests' in Bioscience 42: 599-607.

Bryant Edward (1997) 'Climate Process and Change' Cambridge University Press.

Burroughs William James (2001) 'Climate Change: A Multidisciplinary Approach'. Cambridge University Press.

Burroughs William James (2003) 'Climate: into the 21st century'. Cambridge University Press.

Case Michael (2008) 'Climate Change Impacts in the Amazon: Review of Scientific Literature'. World Wide Fund for Nature (WWF).

CEPAL (2000), '*Un Tema de Desarollo: La reducción de la vulnerabilidad frente a los desastres.* Mexico City CEPAL.

Cline William C. (1992) 'The Economics of Climate Change'. Institute for International Economics. Washington D.C.

Collinson Helen (1996) 'Green Guerillas: Environmental Conflicts and Initiatives in Latin America and the Caribbean' Latin America Bureau.

DFIF (2004) 'Climate Change in Latin America'. Crown Copyright 2004.

Doornbosch R. and Steenblik R., (2007) 'Biofuels: Is the Cure Worse than the Disease?'. Round Table on Sustainable Development, *OECD,* Paris.

Dore Elizabeth (1996) 'Capitalism and Ecological Crisis: legacy of the 1980s' in Collinson Helen (1996) 'Green Guerillas: Environmental Conflicts and Initiatives in Latin America and the Caribbean'. Latin America Bureau.

Evans Ray (2006) 'Nine Lies about Global Warming'. The Lavoisier Group.

Gallagher Ed (2008) '. The Gallagher Review of the indirect effects of biofuels production' Renewable Fuels Agency.

Goodess C.M.,Palutikof J.P and Davies T.D. (1992) 'The nature and causes of climate change. Assessing the long-term future'. Belhaven Press, London.

Halsnaes Kirsten (2002) 'A Review of the Literature on Climate Change and Sustainable Development' in Markandya Anil and Halsnaes Kirsten (2002) 'Climate Change and Sustainable Development: Prospects for Developing Countries'. Riso National Laboratory.

Harper Tom (11/3/2007) 'Scientists threatened for 'climate denial'. The Daily Telegraph www.telegraph.co.uk accessed August 2008.

Helm Dieter (2005) 'Climate-change policy'. Oxford University Press.

IPCC (1995) 'Second Assessment Synthesis of Scientific-Technical Information relevant to interpreting Article 2 of the UN Framework Convention in Climate Change'. IPCC.

IPCC (1997) 'IPCC Special Report. The Regional Impacts of Climate Change: An Assessment of Vulnerability. Summary for Policymakers'. IPCC.

IPCC (2001) 'Climate Change 2001: Impacts, Adaptation and Vulnerability. A Report of Working Group II of the IPCC. Summary for Policymakers'. IPCC.

IPCC (Magrin G. *et al.*) (2007a) 'Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change'. Cambridge University Press.

IPCC (2007b) 'Climate Change 2007: Synthesis Report. Summary for Policymakers'. IPCC Fourth Assessment Report.

IPCC (2007c) 'Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability. Summary for Policymakers'. Working Group II Contribution to the IPCC Fourth Assessment Report.

IPCC (2008) www.ipcc.ch .Accessed August 2008.

Jonas Susanne and McCaughan Edward J. (1994) 'Latin America Faces the Twenty-First Century: Reconstructing a Social Justice Agenda'. Westview Press.

Kirby Peadar (2003) 'Introduction to Latin America: Twenty-First Century Challenges'. SAGE Publications.

Lawrence Chris (17/7/2008) 'Global Warming Fears Fueled by False Science'. West Virginia Metronews in www.climatechangefraud.com accessed August 2008.

Mace M.J. (2006) 'Adaptation under the UN Framework Convention on Climate Change: The International Legal Framework' in Adger Neil W. *et al.* (2006) 'Fairness in Adaptation to Climate Change'. Massachusetts Institute of Technology.

Merryfield William J. (2006) 'Changes to ENSO under CO2 Doubling in a Multimodel Ensemble'. Canadian Centre for Climate Modelling and Analysis, Meteorological Service of Canada, Victoria, British Columbia, Canada.

Miller Shawn William (2007) 'An Environmental History of Latin America' Cambridge University Press.

Mintzer Irving M. and Leonard Amber J. (1994) 'Negotiating Climate Change: The Inside Story of the Rio Convention'. Cambridge University Press and Stockholm Environment Institute.

Nepstad Daniel C. (2007) 'The Amazon's Vicious Cycles: Drought and Fire in the Greenhouse. Ecological and Climatic Tipping Points of the World's Largest Tropical Rainforest, and Practical Preventive Measures'. WWF International.

Noronha Silvia (2006) 'Agribusiness and biofuels: an explosive mixture – Impacts of monoculture expansion on the production of bioenergy'. Rio de Janeiro: Núcleo Amigos da Terra / Brazil, 2006.

Paavola Jouni *ey al.* (2006) 'Multifaceted Justice in Adaptation to Climate Change' Adger Neil W. *et al.* (2006) 'Fairness in Adaptation to Climate Change'. Massachusetts Institute of Technology

Padua Jose (1997) 'Biosphere, history and conjecture in the analysis of the Amazon problem' in Michael Redclift and Graham Woodgate (1997) 'The International Handbook of Environmental Sociology'. Edward Elgar: Cheltenham

Painter Michael and Durham William H. (1995) 'The Social Causes of Environmental Destruction in Latin America' University of Michigan.

Ratchford J.T. (1996) 'Climate Change: Risky Business of the Policy Front' in Ghan S.J *et al.* 'Regional Impacts of Global Climate Change: Assessing Change and Response at the Scales that Matter'. Battelle Memorial Institute.

Read Peter (1994) 'Responding to Global Warming: the technology, economics, and politics of sustainable energy'. Atlantic Highlands, N.J: Zed Books.

Roberts Timmons J. and Parks Bradley C. (2007) 'A Climate of Injustice: Global Inequality, North-South Politics, and Climate Policy'. Massachusetts Institute of Technology.

Roberts Timmons J. and Thanos Nikki Demetria (2003) 'Trouble in Paradise: Globalization and Environmental Crisis in Latin America'. Routledge, Taylor & Francis Books, Inc.

Royal Society, The (2008) 'Sustainable biofuels: prospects and challenges'. The Royal Society 2008.

Royal Society, The (2007) 'Climate Change Controversies: A Simple Guide'. The Royal Society 2007.

Sachs Wolfgang (1997) 'Sustainable Development' in Redclift Michael and Woodgate Michael 'The International Handbook of Environmental Sociology'. Edward Elgar: Cheltenham.

Sachs Wolfgang (1993) 'Global Ecology: A New Arena of Political Conflict'. Wolfgang Sachs and contributors.

Satterthwaite David *et al.* (2007) 'Adapting to Climate Change in Urban Areas: The Possibilities and Constraints in Low- and Middle-Income Nations'. International Institute for Environment and Development.

Schneider Stephen H. and Lane Janica (2006) 'Dangers and Thresholds in Climate Change and the Implications of Justice' in Adger Neil W. *et al.* (2006) 'Fairness in Adaptation to Climate Change'. Massachusetts Institute of Technology.

Simms Andrew and Reid Hannah (2006) 'Up In Smoke? Latin America and the Caribbean: The threat from climate change to the environment and human development. The third report from the Working Group on Climate Change and Development'. New Economics Foundation.

Smeets Edwatd *et al.* 'Sustainability of Brazilian bio-ethanol'. Universiteit Utrecht Copernicus Institute Department of Science, Technology and Society.

Stern Nicholas (2007) 'The Economics of Climate Change: The Stern Review'. Cambridge University Press.

UNDP-GEF, (2003) 'Capacity Building for stage II adaptation to Climate Change in Central America, Mexico and Cuba'. UNPD PIMS ID # 2220, United Nations Development Program: Global Environmental Facility.

UNFCCC (2007) 'Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries' .United Nations Framework Convention on Climate Change 2007.

US Committee for the Global Atmospheric Research Program (1975) 'Understanding Climate Change. A Program for Action'. National Academy of Sciences. Washington D.C. 1975.

US Country Studies Program Support for Climate Change. Studies, Plans, and Technology Assessments (1999) 'Climate Change: Mitigation, Vulnerability, and Adaptation in Developing and Transition Countries'. The US Country Studies Program.

Vergara Walter (2005) 'Adapting to Climate Change: Lessons Learned, Work in Progress, and Proposed Next Steps for the World Bank in Latin America'. The World Bank, Latin America and Caribbean Region.

Vergara Walter (2007) 'Visualizing Future Climate in Latin America: Results from the application of the Earth Simulator'. The World Bank, Latin America and the Caribbean Region.

Wheldon Julie (5/3/2007). 'Greenhouse effect is a myth, say scientists'. Daily Mail www.dailymail.co.uk accessed August 2008.

World Bank (2008) www.worldbank.org . Accessed August 2008.

World Commission for Environment and Development (1987) 'Our Common Future', Oxford, Oxford University Press.

WHO (2008) www.who.int . Accessed August 2008. World Health Organization.

Online Sources

AIACC	www.aiaccproject.org
BBC	http://news.bbc.co.uk
CEPAL	www.eclac.org
Climate Change Fraud	www.climatechangefraud.com
Daily Mail, The	www.dailymail.co.uk
Daily Telegraph, The	www.telegraph.co.uk
Department for International Development	www.dfid.gov.uk
Global Environmental Facility	www.gefweb.org
Guardian, The	www.guardian.co.uk
IIED	www.iied.org
IPCC	www.ipcc.ch
Knowledge Network on Vulnerability and Adaptation to Climate Change	http://ncsp.va-network.org
Lavoisier Group, The	www.lavoisier.com.au
Nature Conservancy, The	www.nature.org
Royal Society, The	www.royalsociety.org
UNFCCC	http://unfccc.int
White House, The	www.whitehouse.gov
World Health Organization	www.who.int
World Bank, The	www.worldbank.org
WWF	www.wwf.org