

ADAPTATION AND MITIGATION STRATEGY FOR CLAMATE CHANGE FOR THE CANTON OF ESMERALDAS

Cities and climate change initiative

UN (HABITAT FOR A BETTER URBAN FUTURE

CITIES AND CLIMATE CHANGE INITIATIVE

Adaptation and mitigation strategy for climate change for the canton of Esmeraldas © United Nations Human Settlements Programme, UN-HABITAT, Ecuador, 2011.

Prepared by:

Tannya Lozada Montero Consultant UN-HABITAT, Ecuador Email: tllozada@gmail.com July, 2011

Coordination:

Mónica Quintana M. Habitat Programme Manager UN-HABITAT, Ecuador

Technical Coordination:

Mónica Rhon Dávila UN-HABITAT, Ecuador

English translation:

Cristina Crosby

Photography:

Francois Laso Roberto Sánchez Mónica Rhon

Graphics, Design, and Diagramming:

Zonacuario, Comunicación con Responsabilidad Social Cía. Ltda.

Printed by:

Global Bussiness

HS Number: HS/041/12E ISBN Number: (Volume) 978-92-1-132456-3

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UN-HABITAT, Ecuador

Av. Amazonas 2889 y La Granja United Nations Bdg. Phone: (593 2) 2460 330 /332 Fax: (593 2) 2249 880 Web page:www.unhabitat.org / www.onuhabitat.org **Quito-Ecuador**

PRESENTATION

Today, climate change is known worldwide as one of the most important challenges of the 21st century, stressing the risk of human settlements based in the most vulnerable areas.

The Cities and Climate Change Initiative (CCCI) of the United Nations Human Settlements Programme (UN-HABITAT), aims to prepare the cities to respond appropriately and to reinforce the mitigation and adaptation capacities of cities to face climate change, particularly in developing countries.

Ecuador was chosen by UN-HABITAT as pilot country in Latin America to develop this initiative, along with Mozambique, Uganda (Africa) and the Philippines (Asia). The cities identified as locations to implement the demonstrative projects are: Esmeraldas, Maputo, Kampala, and Sorsogon.

The activities carried out within this programme are focused on strengthening the adaptation and response skills of local governments, fostering the participation of the civil society, by designing and implementing risk prevention and management policies, concrete strategies and action plans, training and education. One of its objectives is the formulation of an adaptation and mitigation strategy for climate change.

The Decentralized Autonomous Government of Esmeraldas, complying with its responsibility of guaranteeing the safety and quality of life of the population and in response to the world claim of working altogether towards reducing GHG emissions and thus reduce the effects of climate change, have drawn up, jointly with UN-HABITAT-Ecuador, the document herein, as an articulating instrument of a compound of political guidelines that will be implemented locally, contributing to the coordinated and inclusive response that our country will provide to the challenges derived of this global problem.

Summing up, it is an orienting document seeking to provide technical guidelines that will facilitate the design and implementation of policies and actions aiming at fighting the adverse impacts of climate change. It was drawn up in a participative fashion and was based on the empowering documents for the management of development in canton Esmeraldas. It is made up of two strategic objectives and three core themes. A series of Action Lines of each one of the areas identified as priority by the local population are proposed for each one of these components.

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To the Pontifical Catholic University-Esmeraldas, to Luis Vargas Torres Technical University, to the Oceanographic Institute of the Army, to the Deputy Secretariat of Climate Change of the MAE, to the Public Water Company (EAPA), to the National Secretariat of Risk Management, to the Municipality of the Metropolitan District of Quito and the department technical officers of the Decentralized Autonomous Government of Esmeraldas, who provided their knowledge to draw up the implementation strategies of actions from a public institution approach.

A special thanks to the civil society of Esmeraldas, who worked altogether for the elaboration of this strategy.



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ACRONYMS

°C	Degrees Celsius
CCCI	Cities and Climate Change Initiative
CFC	Chlorofluorocarbons
CH ₄	Methane
CO ₂	Carbon Dioxide
COPFP	Organic Code on Public Planning and Finance
DAG	Decentralized Autonomous Government
GHG	Greenhouse gases
HFC	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
LGE	Local Government of Esmeraldas
MAE	Ministry of the Environment
MCCA	Project: "Management for Climate Change Adaptation"
MDMQ	Municipality of the Metropolitan District of Quito
N ₂ O	Nitrous Oxide
РАСС	Project: "Adaptation to Climate Change through effective water management"
PRAA	Project: "Adaptation to Climate Change in Accelerated Glacier Regression in the Tropical Andes"
UNFCC	United Nations Framework Convention on Climate Change

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INTRODUCTION

Climate change understood as the 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, 1992) is, without any doubt, one of the main threats to the sustainable development and wellbeing of our people. Its effects will have influence over all the components felt as essential to the correct functioning of our society (water resources, ecosystems, production processes, infrastructure, and public health, among others) and will have even greater effects on the most vulnerable parts of the population.

It is due to the increase in the concentration of atmosphere gases (known as Greenhouse Gases-GHG), which are fundamental for the life on earth, in moderate quantities, and can provoke artificially elevated temperatures and irremediably modify weather, in high concentrations.

Nowadays, it is possible to state that climate change is unequivocal, as evidenced by data showing an increase in the average temperatures in the air and the ocean, the melting of glaciers and snow in general, and the increase in the average of the level of the sea worldwide. The average temperature of the surface of the earth has increased more than 0.6°C since the 19th century and it is foreseen to increase once more between 1.4°C and 5.8°C for the year 2100.

In response to this threat, countries in the world have come together to coordinate actions and concrete agreements allowing to reduce the expected impacts and, chiefly, reduce the GHG emissions resulting from human activity. In this context, cities play a fundamental role as characterized by their high population, industry, and infrastructure density.

It is estimated that the impacts of climate change worldwide would tend to be more severe in cities, however, it has also been accepted that strategies to reduce greenhouse gas emissions (GHG), implement disaster alert systems, manage and reduce vulnerability of climate change impacts, prove to be much more efficient¹.

¹ UN-HABITAT. 2011. Global Report on Human Settlements 2011: Cities and Climate Change. Earthscan. UK.

CLIMATE CHANGE: TECHNICAL BASES AND EXPECTED EFFECTS

Greenhouse effect is the natural beneficial phenomenon allowing life on earth by maintaining a temperate weather (with a global average temperature of 15° C) and avoiding days from being too hot or nights of being too cold. Thanks to this phenomenon, solar radiation re-emitted by the surface of the earth towards space is, momentarily, retained in the atmosphere by the greenhouse gases (GHG): water vapor, carbon dioxide (CO₂), methane (CH₄), chlorofluorocarbons (CFC), hydrofluorocarbons (HFC), nitrous oxide (N₂O), among others. If this phenomenon did not occur, temperature fluctuations would be intolerable, while a modification in the delicate balance between the absorption and emission of energies would have severe consequences at the global level. (See Graphic 1).



Graphic 1: Greenhouse effect: radiation of the earth is trapped in the atmosphere as a result of the accumulation of greenhouse gases. If the concentration of GHG increases, more heat will be retained in the atmosphere. **Source:** www.kalipedia.com

Since the Industrial Revolution, in the end of the 19th century, human activities have been characterized by the increased use of fossil fuels (i.e. oil, carbon). At the same time, the discovery of new growing techniques and the increasing demand of food and natural products for an ever increasing population, has led to tree felling in great field extensions and the use of highly polluting production techniques. Finally, new life standards and the formation of big cities thirsty of energy and producing great amounts of residues have caused an increase in the GHG concentrations in the atmosphere. An augmentation causing an increase in the capacity of the atmosphere of retaining part of the energy reflected by the earth, which finally produces an increase of temperature, also known as global warming.

Box 1. Main Greenhouse Gases

The concentration of GHG in the atmosphere varies as well as its warming potential, that is, not all gases absorb the infrared radiation in the same fashion nor do they stay for the same amount of time in the atmosphere. The greater the absorption capacity and the greater the average life, the greater its Global Warming Potential (GWP) will be, which is estimated based on CO_2 . For instance, a molecule of N₂O heats up 230 to 310 times more than a molecule of CO_2 , therefore its emissions are highly damaging.



GAS	ISSUING SOURCE	Persistence of the molecules in the atmosphere (years)	Global Warming Potential (PCG: CO ₂ =1). Time frame: 100 years
Carbon dioxide (CO ₂)	Burning of fossil fuels, changes in the use of the land, production of cement	500	1
Methane (CH4)	Burning of fossil fuels, agriculture, livestock, waste management	7 – 10	21-23
Nitrous Oxide (N ₂ O)	Burning of fossil fuels, agriculture, changes in the use of the land	140 - 190	230 – 310
Chlorofluorocarbon (CFC) Refrigerants, aerosols and plastic foams		65 – 110	6200 – 7100
Hydrofluorocarbons (HFC)	Liquid refrigerants	12	

Source: Secretariat of the Environment and Sustainable Development of the State and JICA 2009. Climate Change in Argentina. Buenos Aires, Argentina.

Now, it is known that carbon (CO2) has surpassed the preindustrial level of around 280ppm to 379ppm in 2005, with an ever-increasing annual growing rate (for the past 10 years -1995-2005- an average growth of 1.9ppm per year was registered, greater than what was registered in the period 1960-2005: 1.4ppm per year). At the same time, other gases with a greater Global Warming Potential such as methane have gone from having a preindustrial concentration of 700 ppb to 1774 ppb in 2005, with an annual concentration growth rate of 4.14 ppb.² Similarly, the relation between the increase of the carbon dioxide concentration and the augmentation of the temperature is directly proportional. (See Graphic 2)

² Concentration measures used for the measurement of these gases: ppm: parts per million; ppb: parts per billion.



Graphic 2: Relation CO₂ (in blue) and global temperature (in red) in time. The concentration of CO₂ in year 1000 is 280 ppm, and we can observe a rapid increase from the middle to the end of the 1800s. **Source:** www.circuloambiental.net/noticias/mitodelcarbono.htm

Expected effects³

There is great evidence of the first effects of climate change in the region, and in our country. Over the past years, we have been witnesses to the ever greater occurrence of severe and prolonged droughts, the increase in precipitations and floods in big extensions of land. In other regions, there is an accentuated increase of the frequency and intensity of extreme climate events, such as storms, hurricanes or tornadoes.



Box 2: Intergovernmental Panel on Climate Change (IPCC)

Towards the end of the 80s, the United Nations Environment Programme (UNEP), and the World Meteorological Organization created the IPCC, with the purpose of collecting information that could be related to climate change (including scientific, economic and social aspects), as well as proposing response strategies. Nowadays, the IPCC is considered to be the maximum authority in the areas of climate change, providing essential information for the definition of coherent climate policies.

However, it is well-known that data measurement is not enough to predict impacts of climate change in a precise manner, this has led to the IPCC generating models and being able to estimate the quantitative effects of global warming on the weather.



3 See Box 2

According to the IPCC, we can expect two types of changes in the weather in the future: increase of temperature, increase or reduction of precipitations and increase of the sea level (considered to be gradual changes), as well as precise events that are highly destructive: increase in the frequency of the occurrence, duration, and intensity of extreme climate events.

These expected changes will affect natural and human systems (mainly socioeconomic effects) directly and indirectly and in a differentiated way according to the region of the planet and the response capacity of its systems. Worldwide, we have the following most important by sector:⁴

- O Agriculture and forestry: impoverishment of harvests in warmer environments due to thermal stress; soil erosion and degradation; more frequent insect plagues; greater losses of livestock; increase in the risk of uncontrolled fires; salinization of irrigation water.
- O Ecosystems: plant and animal extinction; alter in the patterns of species distribution and functioning of ecosystems; loss, fragmentation, and modification of the habitat; introduction and extension of exotic or introduced species; damages in coral reefs, acidification of oceans (modifying trophic chains and causing the reduction of the fish population).
- O Hydric resources: Increase in the demand of water: problems with the quality of the water (for instance, algae proliferation); glacier melting; increase of the sea level between 9 and 88 cms.; floods in coastline areas; pollution of hydric supplies; increase in the earth surface under hydric stress.



- Human health: Greater mortality risk by thermal causes (especially among the elderly, small kids, and isolated persons); greater risk of respiratory and skin diseases; greater risk of malnutrition and food scarcity; greater risk of diseases transmitted through the water and food.
- O Industry, settlements and society: Increase in the demand of energy for refrigeration, diminishment in the quality of the air in the cities, pressure over the infrastructure (slides, floods); water scarcity for settlements, industry, and societies; less potential of hydroelectric generation, potential migration of the population.

⁴ IPCC. 2007. Summary for Policymakers. In Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Intensity, frequency, and duration of each one of the impacts directly depend on the increase of global temperature resulting from the accumulation of GHG (see graphic 3). It has been foreseen, for instance, that there will be an augmentation of 1°C, compared to 1980-1999 which will cause hydric stress for hundreds of millions, and will dramatically increase with the augmentation in degrees Celsius, as well as a considerable augmentation in the mortality rate and morbidity due to heat waves, floods, and droughts.



CHANGE IN THE WORLD AVERAGE TEMPERATURE COMPARED TO 1980-1999 (°C)

() 1	2	3	4	5 °C		
WATER	Increase in the availability of water in humid tropics and high latitudes Diminution of the availability of water and increase of the drought in the medium and low semiarid latitudes Hundreds of millions of people exposed to the increase of hydric stress						
ECOSYSTEMS	Up to 30% of species Significant extinctions* around the world → Increase in the discoloration of coral Mostly Generalized mortality of coral Terrestrial biosphere tends to a net carbon sources such as: ~15% — ~40% of affected ecosystems Increasing change of habitat of species and risk of uncontrolled fires Changes in ecosystem due to weakness of meridian return circulation — — ►						
FOOD	Negative, complex, a and fishermen Tender to	nd located impacts for smal Tendency of cereal pr to be reduced in lowe ncy of the productivity of so ncrease in medium and hig	l producers, subsistence farn oductivity rr latitudes me cereals h altitudes	ners,Reduction of the producti of cereals in lower latitude Reduction of the producti in some regions	vit <u>y of all types</u> 25 vity of cereals		
COASTS	Increase of the damages occasioned by Loss of approximately 30% of the coastal wetlands in the world** More millions of people suffered coastal floods every year						
HEALTH	HEALTH Increase in the malnutrition load, diarrheic, cardio-respiratory and infectious diseases HEALTH Increase in the morbidity and mortality rate due to heat waves, floods, and drought Change in the distribution of some vectors Considerable increase in health services						
() 1	2	3	4	5 %		

*The signification is defined here as more than 40%

**Based on the increase in the average level of the sea in 4.2 mm/year from 2000 to 2080

Graphic 3: Examples of impacts associated to the average annual global change of temperature. The greater the temperature, the more components of our society will be reached, and more intensively. **Source:** IPCC-AR4



Impacts of climate change in cities⁵

Over the past 60 years, it has been estimated that the amount of persons living in urban areas increased five times. This urbanization process is more accentuated in less developed countries where, in most cases, the expansion of the cities lacks adequate planning allowing to, on the one hand, guarantee the present and future supply of utilities and, on the other hand, carry out an adequate zoning with a view to avoid disasters.

As it was said in the previous section, it is expected that the cities located in coastline areas will be affected by the increase in the sea level resulting from thermal expansion -that is, the increase in the volume due to water heating- and the disappearance of ice plaques. Strong precipitations lasting one or more days have been foreseen, which will cause floods, and in turn can endanger people's lives and destroy property, potentially affecting the energy supply system; they paralyze transportation; pollute clean water sources and treatment systems; move garbage, waste in general and polluting agents (mainly when the collection systems do not provide the supply to the city); and accelerate the dispersion of water-related diseases.

Strong rains can also cause landslides, mainly in the most marginal areas, just like it happened over the past rainy season in Quito, where the saturation of rainwater and the poor drain water treatment provoked the slide of approximately 2,000 m³ of land provoking the death of 5 people, the interruption of the traffic in one of the main highways of the city and the forced relocation of at least 130 families.

⁵ UN-HABITAT. 2011. Global Report on Human Settlements 2011: Cities and Climate Change. Earthscan. UK.







As a result of climate change, it is also foreseen that extreme heat episodes will be ever more frequent, intense and long-lasting; they have a greater impact on the population settled in the cities due to the "heat island" effect that characterizes the cities, temperature will be between 1°C and 3°C higher than in the proximities of the city.

Finally, heat waves will be mostly accompanied by drought episodes, which will affect safe water supply to cities, but will also potentially affect food supply to urban population. 2 22 217 2 34

All these phenomena will affect the infrastructure with greater or less intensity, as well as economic activities sustaining cities. For instance, floods will affect the touristic potential of the city, as well as transportation systems to and from the city.

CLIMATE CHANGE: A GLOBAL AND COORDINATED RESPONSE

Climate change was acknowledged to be a global problem at the First World Climate Conference that took place in 1979. Only 10 years after, with the subscription of *the United Nations Framework Convention on Climate Change* during the First Earth Summit, celebrated in Rio de Janeiro in 1992, the following five main principles for climate change management at the global level were established:⁶

- Countries must protect the climate system for the benefit of present and future generations, on the base of equity and in accordance with their common but differentiated responsibilities and their corresponding capacities.⁷
- Specific needs and special circumstances of developing countries must be taken into account, especially those particularly vulnerable.
- Countries must take precaution measures, that is, privilege the action to face climate change still in the absence of scientific certainty (due to the gravity of the risk it carries and the irreversibility of several of its effects).
- Policies and measures against climate change must be appropriate for the specific conditions of each one of the countries and sustainable development must be promoted.
- Countries must cooperate for the promotion of an international economic system that is open and promotes economic growth and sustainable development. Measures adopted to fight climate change cannot constitute an arbitrary mode of discrimination, nor an undercover restriction to international trade.

Likewise, a series of commitments were made, which demanded the countries be classified according to their historical responsibility, that is, the volume of greenhouse gas emissions during their development process. The groups are the following:



⁶ United Nations. 1992. United Nations Framework Convention on Climate Change. Available at: http://unfccc.int/resource/ docs/convkp/convsp.pdf

⁷ Historically, it is well-known that most of greenhouse gas emissions are originated by developed countries; therefore it is they who have the obligation of taking the initiative to fight the causes and consequences of climate change.

- O "Parties⁸ in Annex I": mainly developed or industrialized countries, for instance: Australia, United States, Canada, Japan, members of the European Union.
- "Parties in Annex II": are those countries that should provide financial resources to help developing countries to meet their obligations.
- O "Parties not in Annex I": developing countries

We can highlight the following commitments:

- 1) Prepare periodical national inventories of anthropogenic emissions.
- 2) Formulate, apply, and regularly update national and regional programmes containing measures oriented towards the mitigation of climate change.
- 3) Promote and support the transfer of technologies, practices and processes that control, reduce or prevent greenhouse gas emissions.
- 4) Cooperate in the preparation for the adaptation to the impacts of climate change, through the development of appropriate plans.
- 5) Foster education, training, and awareness of the public on climate change and stimulate participation.
- 6) Parties, in Annex I, must adopt national policies and apply measures that limit and reduce their greenhouse gas emissions.



In 1997, the subscription of the Kyoto Protocol helped to clearly define the reduction goals of the Parties in Annex I, as well as the tools these countries have in order to comply with the commitments (the so-called Flexibility Mechanisms). In general terms, the Parties in Annex I committed to an aggregated reduction⁹ of greenhouse gas emissions of 5% less than the emission levels verified in 1990. This goal must be met during the first period of the commitment, set between 2008 and 2012, thus, for example, emissions registered for the United States between 2008 and 2012 must be 7% less than those verified in year 1990. Japan will have to make a 6% reduction. The European Union signed a joint and sole commitment on behalf of all its member countries and distributed a different load to each country in accordance with the social, economic and environmental variables, following the principle of "load distribution". In this context, Germany and Denmark must each reduce 21%, Italy and the Netherlands 6%, while France and Finland must maintain their emissions at the same level.

At the same time, it was established, among others, to create an Adaptation Fund and an assurance system for the observance of commitments assumed by the Parties.

^{8 &}quot;Parties" are all the countries signatory of the United Nations Framework Convention on Climate Change (UNFCCC).
9 Aggregated reduction is the term used to refer to those countries included in Annex I, which have particular reduction rates depending on their greenhouse gas emission levels.

Since the establishment of these international agreements, and mainly since the subscription of the Kyoto Protocol, several initiatives at the local, national, and international level have been implemented, including emission mitigation projects. But, in general terms, little has been the progress in the institution of efficient adaptation policies and tools.

MITIGATION AND ADAPTATION

In the context of the UNFCCC and its empowering instruments, **mitigation** is understood as the actions and policies aimed at reducing GHG emissions and improving drains. These activities are aimed at the following areas:

- **Energy supply:** the promotion of renewable energies (hydroelectric, solar, eolian, geothermal and bio-energy) reducing the dependency on energy generated with fossil fuels (for instance, thermoelectric sources-bunker, diesel and natural gas); improvement in the supply and efficiency of the distribution.
- **Transportation:** vehicles with a better use of fuel; substitution of private transportation with public systems; promotion of non-motorized transportation; planning of the use of land and transportation.
- **Buildings:** Efficient lighting and use of the light of day; more efficient refrigeration devices; improvement of the burners in the kitchens.
- **Waste:** recovery of CH4 in dumps; burning of waste with recovery of energy; controlled treatment of waste water; recycling and minimization of waste.

Adaptation actions are those allowing to reduce the vulnerability of human and natural populations to the impacts of climate change.

- **Water:** Water storage and conservation techniques; efficiency of the use of water and irrigation; encourage to save water.
- **Infrastructure/settlements:** Relocation of endangered neighborhoods; marine contention walls and tempest barriers; city growth planning; improvement in the sewer system; promotion of green spaces and shadow trees.
- **Human health:** Plans to reduce the impact of heat in health; medical emergency services; salubrious water; public education in actions to prevent diseases related to weather vectors.

Taken and modified from:

UN-HABITAT. 2011. Global Report on Human Settlements 2011: Cities and Climate Change. Earthscan. UK. IPCC, 2007: *Climate change 2007: Synthesis report. Contribution of Working Groups I, II and III to the Fourth Assessment Reports of the Intergovernmental Panel on Climate Change* [Core writing team: Pachauri, R.K. and Reisinger, A. (Eds.)]. IPCC, Geneva, Switzerland, pp. 104.



CLIMATE CHANGE IN ECUADOR

Ecuador committed to work along other countries to face climate change, by subscribing the Framework Convention on Climate Change (FCCC) and its consequent ratification, through Resolution of August 1994. In 1999, the National Weather Committee (NWC) was established in order to design and establish policies and strategies for the execution of international commitments acquired by the country. However, actions fostered by this institution were isolated and had little impact. In 2008, the Constitution of the Republic, in article 414, established that: The State will adopt appropriate and cross-cutting measures for the mitigation of climate change, through the limitation of emissions of greenhouse gases, deforestation and atmosphere contamination; at the same time, it will apply measures for the conservation of forests and vegetation, and will protect the population in risk, establishing the obligation of the State regarding this subject for the first time in a national instrument. This commitment is reflected in the National Plan for Good Living (PNBV) in objective 4, adopting the following content as a policy: "foster the adaptation and mitigation to climate variability stressing the process of climate change" (PNBV, 2009). In this context, in October 2010, the Inter-institutional Committee of Climate Change was created, made up of government agencies, having as one the main objectives to coordinate, set and facilitate the comprehensive execution of the national policies related to climate change, as well as the National Strategy of Climate Change.

Despite the fact that, nowadays, there is no clear distribution of responsibilities between the central government and the decentralized autonomous governments in the dealing with climate change, the protagonist role of the latter in territorial planning and development is clearly established in the Organic Code of Territorial Organization, Autonomies and Decentralization (COOTAD). The COOTAD establishes, among others, the competence regime, functions, and budgets of the Decentralized Autonomous Governments, as a response to a process of compulsory and progressive decentralization. That is, in the new scheme of political and administrative organization where political, administrative and financial autonomy is prioritized, autonomous decentralized governments have a predominant role in the implementation of climate change policies at the territorial level; for instance, provincial governments are in charge

of managing the environmental policy at the provincial level, as well as executing works in basins and micro-basins, while municipal governments are in charge of regulating, preventing, and controlling environmental pollution.

Evidence in Ecuador

Its geographical location, natural characteristics, poverty levels and limited capacity of adaptation turn Ecuador into a country that is highly vulnerable to the impacts of this phenomenon. Additionally, the country is affected very recurrently by El Niño/South Oscillation (ENOS), which is estimated to happen more frequently as a result of climate change. The phenomenon of El Niño in Ecuador causes losses in the fishing industry, coastline erosion and floods. Likewise, it has an impact in the harvest, livestock, housing, and infrastructure causing the loss of human lives and high material losses.



The INAMHI reports show an increase of 0.8°C, 1.4°C and 1.0°C in the annual average temperature, absolute maximum temperature and absolute minimum temperature, respectively, between 1960 and 2006. Likewise, extreme meteorological events were registered in Ecuador, such as intense precipitations, floods, and droughts. For this same period of analysis, an increase of 33% in the annual average precipitation level was observed in the provinces of El Oro, Guayas, Santa Elena and Manabí. Between 66% of natural disasters in the country have been associated with precipitations and it is estimated that nearly 12% of the population nationwide is exposed to floods.¹⁰

Between 1997 and 2006, the loss of glaciers has been evident, with an estimated reduction of 28%. For instance, Cotopaxi volcano lost 39% of its glaciers between 1976 and 2006, of this loss, 12% occurred in the past 10 years.¹¹ In the case of Antisana, a loss of 39% between 1956 and 2005, with a reduction rate of seven to eight times faster between 1995 and 2000.¹²

Climate projections

The climate scenarios in Ecuador analyzed within the frame of the CCCI Programme with the Municipal Government of Esmeraldas, indicate an overall increase of the temperature in the country, which is consistent with the observations having taken place for the past 50 years. The

Cadier, E., Maisincho, L., Ulloa, D., Mella, R., Mothes, P., Schaeffer, M. 2007. Second campaign of glacier measurements at Cotopaxi volcano. Manuscript. IRD-INAMHI-European Union-Military Geographic Institute-National Polytechnic School. Quito-Ecuador.
 Cáceres, B., Francou, B., Favier, V., Bontron, G., Maisincho, L., Tachker, P., Bucher, R., Taupin, J.D., Delahchaus, F., Chazarin, J.P. 2007. Glacier 15 at Antisana. Ten years of glaciological investigations. In Proceedings of the first International Conference on the Impact of Climate Change on High Mountain Systems. Bogotá – Colombia: pp. 63-74.

¹⁰ MAE. 2010. Second National Communication. Draft for revision.

expected impacts are the loss of glaciers, the extinction of the species, and the disappearance of ecosystems as a result of the change in local conditions, hydric stress in the cities located in the Andes, increase in the air pollution rates, and an intensification of the "urban island heat" phenomenon.¹³ Potential indirect impacts are the migration of affected populations, reduction of food production with a consequent increase in food prices. In the cities in lower areas, it is expected to have an increase in the demand of electricity for cooling and health problems related to heat.¹⁴

Climate change in Esmeraldas



Esmeraldas

The Canton of Esmeraldas is located in the North-west of Ecuador, by the Pacific Ocean, in the bio-geographical region called Chocó.¹⁵ Precipitations, estimated at the provincial level, vary between 777mm in the canton of Esmeraldas to more than 200mm in cantons with greater vegetation. The temperature for the canton of Esmeraldas varies between 25°C and 26.2°C, while the hydrological system is composed of the rivers Esmeraldas and Teaone, which flow directly into the Pacific Ocean in the surrounding areas of the city.¹⁶

¹³ It is denominated as such for it provokes an augmentation in the temperature in urban areas as a result of the accumulation of heat due to the presence of concrete and other heat-absorbing materials. This phenomenon is directly proportionate to the size of the city and can be interpreted as the difficulty to dissipate the heat at night, unlike non-urban areas.

¹⁴ Sierra, R., Flores, S., Zamora, G. 2009. Adaptation to Climate Change in Ecuador and the City of Esmeraldas: an Assessment of Challenges and Opportunities.

¹⁵ The Chocó region is characterized by being one of the areas with greatest biodiversity in the world.

¹⁶ UNEP, Municipality of Esmeraldas, FÚNDAMYF. 2006. Geo Esmeraldas: Urban Environment Perspectives. Panama.

The city of Esmeraldas, head of the canton and capital of the province, is considered to be mediumsized compared to other cities in Ecuador, with an estimated population of 124,538. Just like the other cities in Ecuador and the region, the growth of the city is mainly associated with shantytowns in its surroundings, thus by year 2009, the Department of Planning of the Municipal Government estimated that 60% of the peripheral neighborhoods did not have construction permits.

Potential impacts

For Esmeraldas, potential impacts of climate change are related to the increase in superficial temperatures at sea and land. For the area of the Esmeraldas river basin, increase projections in the superficial temperature varies from $+2^{\circ}$ C to a maximum of $+3^{\circ}$ C.¹⁷ This means an increase in the demand for energy for refrigeration, air and water pollution, and health problems. When the increase of the sea is evaluated, it is possible to observe that between 3% and 6% of the city would be permanently or periodically flooded by the sea towards the end of the century, which would cause 8.4% to 14% of the current population to be evacuated. Likewise, it is foreseen that the two greater islands and the area closest to the airport may be covered by the sea (in the more pessimistic projections or scenarios). It is also expected that these impacts affect the economic potential of the city, given the loss of areas with touristic and recreation potential, the lack of fishes in the sea, as well as mangrove swamps and the evacuation of the population to higher areas.¹⁸

The projection of change over the precipitation patterns for the region is much more difficult to define. They vary from -50% to +50% in the current conditions. In practical terms, this means that the city can be severely affected by intense and frequent precipitations, occasioning the flood of certain areas and landslides in other areas of the city, or can be affected by one great drought that would mainly hinder the access to water and evidently to agricultural activities in the area (it would affect the quality of life of the population by increasing the prices of the agricultural products that are more scarce). Uncertainty on the direction that precipitation patterns may take complicates the adaptation efforts that the city may be able to implement, and it also shows the importance of working in the preparation of the citizens for these future scenarios.¹⁹

These potential changes in the weather conditions in the canton and the impacts they can have over the quality of life stress the importance of the active and permanent participation of the inhabitants of urban and rural areas, who must be aware of the expected changes and work in defining the best way to adapt to these new weather patterns. With this objective, the Adaptation and Mitigation Strategy for Climate Change in the city of Esmeraldas has been drawn up. This document aims at facilitating planning at the local level in topics related to climate change and preparing the city to face a potential climate disaster.

¹⁷ Projections on climate change are based on mathematic models that, according to the information available, determine the potential variations of the weather. According to the variables taken into account for their modeling, scenarios can drop more optimist or pessimist, projections.

¹⁸ Sierra, R., Flores, S., Zamora, G. 2009. Adaptation to climate change in Ecuador and the city of Esmeraldas: an assessment of challenges and opportunities.

¹⁹ The Municipal Government, with the support of UN-HABITAT, prepared vulnerability maps for the urban and rural areas of the canton, which will serve as a base for decision-making in the very close future.



ADAPTATION AND MITIGATION STRATEGY FOR CLIMATE CHANGE

Strategy for climate change in the canton of Esmeraldas is a guiding document seeking to provide technical guidelines to facilitate the design and implementation of policies and actions directed towards fighting the adverse impacts of climate change. It was built in a participative way and was based on the empowering documents of the development management of the canton of Esmeraldas (Local Participative Development Plan for Change in Esmeraldas and Local Agenda 21). It is formed of two (2) strategic objectives and three (3) strategic core themes.

For each Objective and Core Theme, a series of Action lines are proposed for each one of the areas identified as priority by the population of the canton.

VISION AND GENERAL OBJECTIVE

Vision

The citizenship and the public agencies in the canton of Esmeraldas are aware, prepared and currently implementing actions that are timely reducing the causes and impacts of climate change.

General objective

Design and implement comprehensive mitigation and adaptation policies, plans, and actions towards climate change with the active participation of local actors, information generation and management, and inter and intra-institutional coordination.

STRATEGIC OBJECTIVES

Strategic objectives include action lines that authorities and citizens of the canton of Esmeraldas commit themselves to implement with the view to reducing their contribution to climate change and preparing the city for the potential effects of this phenomenon.

Strategic Objective 1:

LIMIT GREENHOUSE GAS EMISSIONS AND STRENGTHEN CARBON DRAINS IN THE CONSTRUCTION OF A GREEN CITY.

The contribution of Ecuador in terms of greenhouse gas emissions is less than 1% of the total of the world. According to the Second National Communication, the agricultural sector is the biggest contributor followed by the sector of the change in the use of the land and the energy sector (sub-sector transport). However, it is a priority to take measures in order to limit the emissions and therefore contribute to the global commitment of facing this problem. Additionally, greenhouse gas emissions in spite of not being significant nationwide, have repercussions in the health of the inhabitants of the city, reducing their quality of life. Chronic respiratory problems have been detected more than once among the inhabitants of the canton.

In this context, Strategic Objective 1 proposes to reduce greenhouse gas emissions as a mechanism to guarantee the constitutional right of the population to live in a healthy environment.

1. ACTION LINE TRANSPORTATION AREA:

- Oe1.1: Gas emission regulation in public and private transportation.²⁰
- Oe1.2: Promotion of the use of public transportation.²¹
- Oe1.3: Promotion of the junking process of old vehicles.
- **Oe1.4:** Encouragement of the use of non-motorized vehicles.²²



²⁰ Based on the emission levels allowed by the Ecuadorian Law, or following international standards, it is possible to implement a system for the control of emissions at the moment of registering the vehicle, as well as for random controls.

²¹ This promotion can be carried out by: 1. Demanding that the owners of public transportation vehicles improved their conditions following hygiene and security standards. 2. Defining clear circulation and construction stop routes; 3. Restraining parking areas through the implementation of a fare (e.g. the experience of Quito and Loja).

²² Through the construction of specialized roads (for instance, cycling routes) and the issuing of by-laws for the respect among drivers.

2. ACTION LINE ENERGY AREA:

Oe2.1: Improvements in the electricity supply service and the efficiency in its distribution.

Oe2.2: Promotion of energy efficiency through the replacement of incandescent bulbs with saving bulbs.²³

Oe2.3: Regulation of the use of energy in public spaces²⁴ and awareness to the population on the importance of saving electricity.

Oe2.4: Promotion of construction with weatheradapted typologies.²⁵

Oe2.5: Fostering the use of renewable energy sources (e.g. solar panels to heat water).



3. ACTION LINE WASTE AREA:

Oe3.1: Design and implementation of a solid waste management system allowing capturing methane.

Oe3.2: Promotion of waste recycling at all levels (e.g. public buildings, schools, universities, homes).



Strategic Objective 2:

REDUCE THE SOCIAL, ECONOMIC AND ENVIRONMENTAL VULNERABILITY OF HUMAN AND NATURAL SYSTEMS IN ORDER TO FACE CLIMATE CHANGE.

In spite of the measures encouraged after the signature of several international commitments in the end of the past century, an increase of the global temperature in at least 2°C over the following years is inevitable. In this perspective, it is urgent to take measures allowing reducing

²³ One can start by replacing incandescent bulbs in public lights.

Regulations limiting the abuse of electricity (e.g. the exaggerated use of speakers) support the reduction of GHG and noise pollution. For instance, houses which reduce its dependency on cooling systems, based on an initiative carried out by UN-HABITAT and the School of Architects of Ecuador, through the CCCI Programme.

the impacts of climate change, anticipating to potential damages and minimizing the threats of economic development, infrastructure, health and ecosystems. Therefore, prevention, preparation, response and recovery facing the impacts of this phenomenon are a priority to local and national authorities. Response capacities must be aligned to a disaster risk reduction and early response strategy.

Thus, Strategic Objective 2 seeks to define actions to be implemented in the short term in order to increase resilience in the city and all the population with a view to face the impacts of climate change.

1. ACTION LINE PLANNING AND USE OF THE LAND:

Oe1.1: Relocation of neighborhoods in risk areas.²⁶

Oe1.2: Addition of climate change criteria in the definition of expansion areas (areas becoming urban).²⁷

Oe1.3: Slope reforestation and natural barrier formation for border protection.²⁸

Oe1.4: Construction of green areas within the urban perimeter.²⁹

Oe1.5: Promotion of permaculture.³⁰



2. ACTION LINE HEALTH:

Oe2.1: Campaigns for the implementation of measures on prevention, control and monitoring of sickness and conditions affecting human health in relation to climate change.³¹

Oe2.2: Strengthening of reorganization systems (garbage recollection, city cleaning).

3. ACTION LINE WATER:

Oe3.1: Improve the water supply system³² and diversify water sources.

Oe3.2: Regulate industrial and service effluents, in general, to avoid pollution of water sources.³³

Oe3.3: Foster "water harvesting" programmes at home.³⁴

²⁶ All the information on vulnerable areas can be found in Annex III (both for slope areas and flood areas).

²⁷ In this case, besides areas in risk, water supply is also taken into account.

²⁸ Reforestation in evicted areas can forbid its reoccupation, and it additionally helps contain slopes and may contribute to carbon kidnapping if species used have a high content of biomass. Natural barrier formation (such as mangrove swamp reforestation) is the less costly and most sustainable flood prevention measures.

²⁹ The construction of green areas helps reduce the temperature in the city by offsetting the phenomenon "Heat island".

³⁰ Permaculture is considered to be a practice promoting the design of sustainable human settlements, including: reuse of waste (bottles, tires), agricultural spaces, water saving and recycling, rainwater harvesting, breeding of small animals, etc., and also fosters food sovereignty. Through the CCCI Programme, and thanks to the Municipal Government of Esmeraldas, a demonstrating space called *"Buen Porvenir"* (Good Future) is being implemented at the neighborhood "Las Acacias".

³¹ It may be implemented through the mobile health units.

³² This action line has two objectives. 1. Guarantee the access to safe water and 2. Avoid leaks.

³³ For instance, effluents of mechanic shops.

³⁴ Water harvesting is a low-cost initiative and is mainly related to giving the best use to water.



Oe3.4: Actively participate in conservation processes of basins and micro-basins at the provincial level.

Oe3.5: Improvements in sewer systems and implementation of high technology in the comprehensive management of residual waters.

STRATEGIC CORE THEMES

The Strategic Core Themes include actions aiming at guaranteeing the appropriate management of climate change in canton Esmeraldas, at the level of local authorities and civil society. They also include actions allowing to reduce the effects of climate change.

Strategic Core Theme 1

GUARANTEE THAT CITIZENSHIP AND INSTITUTIONS HAVE SYSTEMATIZED, UPDATED AND COMPREHENSIVE INFORMATION FOR DECISION-MAKING.

Information collection on the effects of climate change and its main causes have been carried out nationwide and cover some pilot areas. In this context, the Strategic Core Theme 1 seeks to collect information allowing to plan concrete actions.

ACTION LINE 1.1: COLLECTION OF RELEVANT INFORMATION

- Monitor Greenhouse Gases at the canton level.
- O Initiate and modernize the meteorological stations in the canton.
- Analyze potential impacts of climate change at the canton level, in accordance with the models defined at the national level by the Ministry of the Environment.

ACTION LINE 1.2: INFORMATION MANAGEMENT

- Design and implement a local and comprehensive information system for climate change.
- Define a mechanism allowing to strengthen meteorological networks.



Strategic Core Theme 2

PROMOTE AND GUARANTEE THE IMPLEMENTATION OF COMMUNICATION, EDUCATION, AND CIVIL PARTICIPATION AND SOCIAL CONTROL SPACES.

The efficiency of the measures to be taken in order to diminish the causes of climate change and mitigate its impacts is directly related to the response capacity of the local population. A population that has been trained is in the capacity of discussing and defining the best strategies to face this challenge. With this background, Strategic Core Theme 2 proposes to define spaces of discussion and education on climate change as the first step to social strengthening. At the same time, and considering the fundamental role of young people in addressing this threat, a space of reunion and training of new leaders will be promoted.

ACTION LINE 2.1: TRAINING AND NETWORKS

- Promote the "Young people network against climate change".
- Promote actions in which citizens have access to comprehensible information on climate change.
- Promote open calls and public events allowing to let the population know about the actions that can be taken at home to contribute to mitigate climate change.



ACTION LINE 2.2: EDUCATION

- Promote the creation of spaces for the training of specialists in climate change.
- O Promote non-formal education spaces for leaders of the civil society.
- Sponsor program reform in environmental management with the purpose of including courses on climate change and risk management in basic education.
- Facilitate institutional strengthening in order to guarantee the appropriate management of adaptation and mitigation activities at the level of municipal and local governments.

Strategic Core Theme 3

GUARANTEE RESEARCH, DEVELOPMENT AND TRANSFER OF TECHNOLOGY

One of the causes of climate change is the use of highly polluting technology. Since the beginning of the industrial era, the activities of human societies have been characterized by the imperious need to consume energy (in all its variables) in ever-increasing amounts. Completely changing our way of living to one less dependent on energy will require the effort of more than one generation, therefore, our survival in this very moment depends on our capacity to use and develop cleaner technologies. With this background, Strategic Core Theme 3 proposes to strengthen the exchange of experiences at the national and local level with the aim of setting up cleaner industries and technologies, in general, in canton Esmeraldas.

ACTION LINE:

- Promote the implementation of clean technologies through tax incentives.
- Promote specialized cooperation agreements allowing to transfer specific technology for climate change.
- Encourage research on climate change at universities and higher education institutes in the canton.
- Facilitate the implementation of high technology in municipal dependencies.





PARTICIPATIVE CONSTRUCTION

The Adaptation and Mitigation Strategy for the Canton of Esmeraldas was conceived as a guide for the implementation of actions that will lead the city of Esmeraldas to significantly contribute to the reduction of greenhouse gases and, at the same time, prepare the citizenship for the events resulting of this phenomenon. Its drawing-up followed the principles enshrined in the Constitution of the Republic, especially the one establishing that "citizens, individually or collectively, will have a protagonist role in the decision-making, planning, and management of public affairs".³⁵

Several meetings with local and national authorities and with civil society were held. The potential impacts of climate change at the local and national level and their implication in the development and well-being processes were discussed. Then, the main actions or measures to be adopted in the short-term were identified, as well as the commitments of the citizens. The latter was expressed in the "Declaration of Esmeraldas" including the main worries and commitments of the inhabitants of canton Esmeraldas with a view to facing the challenge of climate change.



Finally, the need to include climate change criteria in the new Plans of Development and Territorial Planning that are being prepared as part of the application of COPFP.³⁶

³⁵ Constitution of the Republic - Art. 95: "The citizens, individually and collectively, will protagonist role in the decision-making, planning, and management of public affairs, and the popular control of the dependencies of the State and the society, and its representatives, in a permanent process of construction of citizen power. The participation will be oriented by the principles of equality, autonomy, public deliberation, and respect for the differences, popular control, solidarity and interculturality. Citizen participation in all affairs of public matter is a right, that will be exercised through the mechanisms of representative, direct and community democracy".

³⁶ COPFP - Art. 41: "Development plans are the main guidelines for the Decentralized Autonomous Government regarding strategic decisions of development within the territory. They will have a long-term vision and will be implemented through the exercise of the competences assigned by the Constitution of the Republic and the Law, as well as those transferred as the result of the decentralization process".

Art. 43: "Territorial planning includes development planning instruments having as their purpose to plan, match and harmonize strategic development decisions regarding human settlements, economic-productive activities and natural resource management in function of the territorial qualities, through the definition of guidelines for the materialization of the long-term territorial model, as established by the corresponding government authority".





ADAPTATION AND MITIGATION STRATEGY FOR





GLOSSARY (taken and modified from: IPCC, 2007: Climate change 2007: Synthesis report. Contribution of Working Groups I, II and III to the Fourth Assessment Reports of the Intergovernmental Panel on Climate Change [Core writing team: Pachauri, R.K. and Reisinger, A. (Eds.)]. IPCC, Geneva, Switzerland, pp. 104).

Absorption, dispersion, and radiation emission

Electromagnetic radiation can interact with the matter in many different ways, as atoms or molecules of a gas (for instance, an *atmospheric gas*) or as solid or liquid particles (for instance, an *aerosol*). Matter, itself, *emits* radiation in function of its composition and temperature. Radiation can be absorbed by matter, and the energy that is *absorbed* can be, by itself, transferred or re-emitted. And last, radiation can also be deviated from its original trajectory (dispersed) as an effect of its interaction with matter.

Adaptation

Initiatives and measures elaborated to reduce the vulnerability of natural and human systems before the real or expected results of a climate change. There are different types of adaptation; for instance, preventive and reactive, private and public, and autonomous and planned. Some adaptation examples are the construction of river or coastline dams, the substitution of plants that are sensitive to thermal shock with other, more resisting ones, etc.

Aerosol

micrometers (one millionth of a meter) remaining in the atmosphere for several hours. Aerosols can be natural or *anthropogenic*. They can influence the *weather* in several ways: directly, dispersing and *absorbing* radiation, or indirectly, acting as cloud condensation nucleus or modifying the optical properties and the life of clouds.

Anthropogenic

Resulting of a human activity or produced by humans.

Atmosphere

Gas coating surrounding the Earth. The dry atmosphere is composed almost in its entirety of nitrogen (volumetric mixed coefficient: 78.1%) and oxygen (volumetric mixed coefficient: 20.9%), plus a certain number of remaining gases, such as argon (volumetric mixed coefficient: 0.93%), helium, certain highly active radiation greenhouse gases, such as carbon dioxide (volumetric mixed coefficient: 0.035%) or ozone. Besides, the atmosphere contains water vapor, which is also a greenhouse gas, in very variable amounts though, in general, in a volumetric mixed coefficient of approximately 1%. The atmosphere also contains clouds and *aerosols*.

B.

Biodiversity

All the diversity of existing organisms and ecosystems in different spatial scales (from the size of a gen to the scale of a *biome*).

Biomass

Total mass of present living organisms in a given area or volume; the recently dead vegetable material is usually defined as dead biomass. The amount of biomass is expressed through its dry weight or through its content of energy, carbon or nitrogen.

C.

Carbon kidnapping

See Incorporation.

Climate change

Variation of the weather that can be identified (for instance, through statistic tests) in the variations of the average value and/or the variability of its properties, persisting during long periods of time, generally decades or even longer. Climate change can occur due to internal natural processes, to *external forces or anthropogenic changes persisting in the composition of the atmosphere or the use of the land.* The *United Nations Framework Convention on Climate Change (FCCC) of the United Nations,* in its Article 1, defines climate change as *the 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.*" The FCCC therefore differentiates between climate change attributed to human activities altering the atmospheric composition and climate variability attributed to natural causes.

Climate projection

Projection of the response of **climate system** to diverse **scenarios** of **emissions** or concentrations of **gases** and **aerosols of greenhouse effect**, or scenarios of **radiation forces**, frequently based on simulations through climate models. The difference between climate projections and climate predictions responds to the circumstance in which climate projections depend on the scenario of emissions/concentrations/radiation forces used, based on relative suppositions, for instance, a socioeconomic and technological future that may or may not materialize and that is subject to, consequently, a considerable degree of **uncertainty**.

Climate variability

The concept of climate variability explains the variations of the average status and other statistical characteristics (typical deviation, extreme phenomena, etc.) of the *weather* in all spatial and time scales broader to those applied to meteorological phenomena. Variability can be caused by natural internal processes of the *climate system (internal variability)* or to internal or anthropogenic *variations of external forces (external variability)*.

Countries included in Annex I

Group of countries included in Annex I (according to the amended version of 1998) of the *United Nations Framework Convention on Climate Change (UNFCCC)*, including all the countries members to the OECD in 1990, and countries of economies in transition. In virtue of Articles 4.2 a) and 4.2 b) of the Convention, countries in Annex I commit themselves to specifically go back, separately or jointly, from now to 2000 to its emission levels of *greenhouse gases* of 1990. Otherwise indicated, all the other countries are denominated "countries not included in Annex I". In http://unfccc.int you can find a list of the countries included in Annex I.

Countries included in Annex II

Group of countries included in Annex II of the *United Nations Framework Convention on Climate Change (UNFCCC)*, including all the countries members to the OECD in 1990. In virtue of Article 4.2 g) of the Convention, these countries must provide all the financial resources to help developing countries to meet their obligations, for instance, by preparing national reports. Countries in Annex II should also promote the transfer of rational environmental technologies to developing countries. In http://unfccc.int you can find a list of the countries included in Annex II.

Countries of Annex B

Group of countries of Annex B of the Kyoto Protocol that have agreed on an objective regarding its greenhouse gas emissions, including all the countries of Annex I (according to the amended version of 1998), except Turkey and Belarus. At http://unfccc.int you can find a list of the countries included in Annex I. See Kyoto Protocol.

D.

Deforestation

Conversion of a wooded extension into non-wooded. The term forest and other similar terms, such as *forestation, reforestation* and *deforestation,* are explained in the Special report of the IPCC on the use of land, change in the use of land and forestry (IPCC, 2000).

Drain

All process, activity or mechanism detracting a *greenhouse gas*, aerosol or any of its precursors in the *atmosphere*.

Drought

In general terms, drought is defined as the "long absence of accentuated insufficiency of precipitation", or "an insufficiency originating lack of water for any activity or group of people", or also "a period of abnormally dry meteorological conditions prolonged enough for the absence of precipitations to cause a relevant hydrological imbalance" (Heim, 2002). Drought has been defined in many different ways. *Agricultural drought* is a lack of humidity in the most exterior of thickness in the land (root area), affecting harvest; *meteorological drought* can be mainly identified by a prolonged deficit of precipitation; and *hydrological drought* is characterized by a river flood or by lacustrine or freatic levels inferior to regular values. *Mega-droughts* are prolonged and extensive droughts lasting more than the regular time, a minimum of a decade.

Ecosystem

Ε.

System constituted by living organisms that interact between them and with its physical environment. The limits attributed to an ecosystem are somehow arbitrary, and depend on the aspect considered or studied. Thus, an ecosystem can include very small spatial scales to the entirety of the planet.

Energetic efficiency

Quotient between the useful *energy* produced by a system, conversion process of activity and its *energy input*.

Energy

Amount of work or heat produced. Energy can be classified in several types, and is useful for human purposes when it flows from one place to the other, or when it transforms into some other type of energy. *Primary energy* (also known as "*energy sources*") is the one contained by natural resources (e.g. carbon, oil, natural gas, or uranium) before experimenting anthropogenic conversions. In order for it to be usable (e.g. in the form of light), primary energy has to be converted and transported. *Renewable energy* is obtained from continuous or recurrent energy currents in the natural environment, and includes non-carbon technologies, such as solar, hydroelectric, eolian, energy from waves and tides, or geothermal heat, as well as neutral carbon technologies, such as biomass. *Contained energy* is the one used to produce a material substance (such as processed metals, or construction materials), considering the energy used in the production installation (order zero), the one used to produce materials for the producing installation (first order), and so on.

Extinction

Permanent disappearance of a biological species in the entire planet.

Extreme meteorological phenomenon

Meteorological phenomenon. Although there are several definitions of "weird", the weirdness of an extreme meteorological phenomenon would be normally equal or superior to the *percentiles* 10 or 90 of the observed probability density function. By definition, the characteristics of a status of *extreme time* can vary in function of the place in an absolute sense. A meteorological phenomenon cannot be directly attributed to an *anthropogenic climate change*, since there is little chance that it occurred naturally. When a guideline of an extreme atmospheric activity persists for a certain amount of time (for instance, during a season), it can be classified as an *extreme climate episode*, especially if it produces an average or a total that is in itself an extreme value (for instance, intense *droughts* or precipitations all throughout a season).

F.

Food insecurity

Situation when a population has access to safe and nutritious food in sufficient amounts, in order for it to grow and develop according to the normal parameters and to carry out an active and healthy life. *Food insecurity* can be caused by a lack of food, insufficient purchasing power, or the inappropriate distribution or use of food by the family.

Forest

Type of vegetation where trees predominate. The definitions of "forest" in several places in the world are different, in accordance with the diversity of bio-geophysical conditions and social and economic structures. Within the framework of the *Kyoto Protocol* there are certain particular criteria. This term and others very similar to it, such as *forestation, reforestation or deforestation,* are examined in the Special report of the IPCC on the use of land, change in the use of land and forestry (IPCC, 2000).

Fuel replacement

In general terms, it consists of the introduction of a Fuel A in substitution of other fuel B. In the context of climate change, it is understood that the carbon content in A is lower than in B (for instance, natural gas as replacement of carbon).

G.

Global warming potential (GWP)

Index based on the radiation properties of an homogeneous mixture of *greenhouse gases*, measuring the *radiation forces* produced by a mass unit of a *greenhouse gas* homogeneously mixed in the current *atmosphere*, integrated all along a determined time frame, regarding the forcing by *carbon dioxide*. GWP represents the combined effect of the different permanence periods of these gases in the atmosphere and the relative efficacy of their absorption of *salient infrared radiation*. The *Kyoto Protocol* is based on the GWP of the emission impulses all throughout 100 years.

Greenhouse effects

Greenhouse gases efficiently absorb *infrared radiation* emitted by the surface of the Earth, by the *atmosphere* due to such gases and the clouds. Atmosphere radiation is emitted in all directions, particularly towards the surface of the Earth. Therefore, greenhouse gases retain heat in the system surface *-troposphere*. This phenomenon is called *greenhouse effect*. Thermal infrared radiation of the troposphere is strongly related to the temperature of the atmosphere in the altitude where it is emitted. In the troposphere, the temperature is usually lower with altitude. In fact, infrared radiation towards the space comes from an altitude where the average temperature is -19°C, in balance with the net entry *solar radiation*, while the surface of the Earth continues to be at a much higher temperature of +14°C in average. An augmentation on the concentration of greenhouse gases gives place to a greater infrared opacity of the atmosphere, and therefore, to an effective radiation towards the space from a higher altitude at a lower temperature. This originates *radiation forces* which intensify the greenhouse effect thus provoking the denominated *intensified greenhouse effect*.

Greenhouse Gas (GHG)

Gas component of the atmosphere, it can be natural or anthropogenic, absorbing and emitting radiation in given wave lengths of the thermal infrared spectrum radiation emitted by the surface of the Earth, by the atmosphere and clouds. This property gives place to the greenhouse effect. Water vapor (H₂O), carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄), and ozone (O₃) are the primary greenhouse gases of the atmosphere of the Earth. The atmosphere contains, as well, a certain amount of greenhouse gases which are completely anthropogenic, such as halocarbons or other substances containing chlorum and bromine, included in the Montreal Protocol. Apart from CO₂, N₂O and CH₄, the Kyoto Protocol contemplates greenhouse gases sulfur hexafluoride (SF₆), hydrofluorocarbons (HFC) and perfluorocarbons (PFC).

H.

Halocarbons

Term that designates collectively a compound of organic species that are partially halogenated including chlorofluorocarbons (CFC), hydrochlorofluorocarbons (HCFC), hydrofluorocarbons (HFC), halons, methyl chloride, methyl bromide, etc. Many of the halocarbons have an elevated *Global Warming Potential*. Halocarbons containing chlorum and bromine also intervene in the exhaustion of the ozone layer.

Hydric stress

It is said that a country suffers hydric stress when the amount of freshwater available in proportion to the detracted water constrains development considerably. In the evaluations at the world scale, it is frequently said that the basin suffers from hydric stress when the availability of water per inhabitant is inferior to 1,000 m³/year (based on the average of run-offs over long periods). An indicator of hydric stress also used at times is a water detraction volume above 20% of available renewable water. A crop experiments hydric stress when the amount of water available in the soil, and therefore real *evapotranspiration*, is lower than the demand of potential evapotranspiration.

Hydrofluorocarbons (HFCs)

One of the six gases or compounds of *greenhouse gases* which is proposed to be reduced in the *Kyoto Protocol*. They are commercially produced in substitution of chlorofluorocarbons. HFCs are broadly used in refrigeration and fabrication of semiconductors.

Ι.

Impacts (of climate change)

Effects of *climate change* on natural and *human* systems. Whether or not the *adaptation* process is considered, it is worth distinguishing between potential and residual impacts:

- **Potential impacts:** All impacts that could strike in relation to a projected climate change, without taking adaptation into account.

- Residual impacts: Impacts of climate change that could strike after the adaptation.

Incorporation

Addition of a substance to a reservoir. The incorporation of substances containing carbon, and in particular *carbon dioxide*, is usually called *(carbon) kidnapping*.

Industrial revolution

Period of rapid industrial growth, with social and economic consequences of great scope; it started in Great Britain in the second half of the 18th century, expanding to all of Europe afterwards, and then, to other countries, including United States. It was a process mainly unchained by the creation of the vapor machine. The industrial revolution marks the beginning of a strong augmentation in the use of fossil fuels and emissions, particularly carbon dioxide

from fossil origins. In this report, the terms pre-industrial and industrial designate, sort of arbitrarily, the previous and posterior periods after 1750, respectively.

Infrastructure

Equipment, supply systems, production companies, installations and indispensable basic services for the development, functioning, and growth of an organization, city or nation.



Kyoto Mechanisms (also called Flexibility Mechanisms)

Economic mechanisms based on market principles that the Parties of the *Kyoto Protocol* can use to try to mitigate the economic effects that could cause the requirements for the reduction of *greenhouse gas emissions*. They include the joint application (Article 6), the *Mechanism for a clean development* (Article 12) and *Emission rights trading* (Article 17).

Kyoto Protocol

The Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC) was adopted during the third session period of the Conference of the Parties (COP) within the FCCC, celebrated in 1997 in Kyoto. It contains legally binding commitments, apart from those indicated in the FCCC. Countries in Annex B of the Protocol (mostly countries of the OECD and countries with economies in transition) agreed to reduce their emissions of anthropogenic greenhouse gases (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride) in minimum 5% below the levels of 1990 during the commitment period of 2008 to 2012. The Kyoto Protocol entered into effect on February 16, 2005.



Measures

Technologies, processes and practices reducing *greenhouse gases* emissions or its effects under previewed effects. Measures are defined as *renewable energy technologies, waste minimization processes, displacements to the workplace using public transportation, etc.* See also *Policies.*

Methane (CH₄)

Methane is one of the *greenhouse gases* that the *Kyoto Protocol* is proposed to reduce. Is the main component of natural gas, and is associated to all the hydrocarbons used as fuels, livestock and agriculture. *Methane of carbon stratus* is the one found in carbon streaks.

Methane recovery

Gas emission collection, *methane* (for instance, in oil or gas wells, carbon stratus, turbo engines, gas pipeline, dumps, or anaerobic digesters) in order to use it as a fuel or for some other economic purpose (for instance, as input for a chemical process).

Mitigation

Technological changes and replacements reducing the supply of resources and emissions by production unit. Although there are several social, economic, and technological policies that would reduce emissions, mitigation, referred to *climate change*, it is the application of policies oriented to reducing *greenhouse gases* emissions and potentiating *drains*.

P.

Policies

In the language of the United Nations Framework Convention on Climate Change (UNFCCC), policies are adopted and/or commended by governments, frequently jointly with companies and industrial sectors in the country or with other countries with the purpose of accelerating *mitigation* and *adaptation measures*. For instance, taxes on carbon and other energy sources, the implantation of efficiency norms for the use of fuel in cars, etc. Common and coordinated or harmonized policies are those adopted jointly by the parties.

Projection

Potential evolution of a magnitude of group of magnitudes, frequently calculated with the help of a model. Projections are different to predictions in the sense that the former are based in given suppositions -for instance, on the socioeconomic and technological future, which may or may not be met- and, therefore, have a considerable degree of *uncertainty*.

R.

Reforestation

Planting of *trees* in areas previously occupied by trees but were later destined to other uses. The term forest and other similar terms, such as *forestation, reforestation and deforestation,* are explained in the Special report of the IPCC on the use of land, change in the use of land and forestry (IPCC, 2000).

Resilience

Capacity of a social or ecological system to absorb an alteration without losing its basic structure or functioning modes, nor its self-organization capacity, or its capacity to adapt to stress and change.

S.

Salinization

Salt accumulation in the soil.

Solar radiation

Electromagnetic radiation emitted by the sun. Also denominated **short wave radiation**. Solar radiation includes a characteristic interval of wave lengths (spectrum), determined by the temperature of the Sun, and with a maximum reached in the visible spectrum.

Source

It usually designates a process, activity or mechanism that releases a *greenhouse gas* or *aerosol*, or a precursor of a greenhouse gas or aerosol, to the *atmosphere*. It can also designate, for instance, a source of *energy*.

Sustainable development (SD)

The concept of sustainable development was introduced for the first time in the World Strategy for Conservation (UICN, 1980), and is based on the concept of sustainable society and natural resource management. It was adopted by the FCCC in 1987 and by the Conference of Rio in 1992, as a process of change harmonizing the exploitation of resources, the direction of investments, the orientation of technological development and institutional change, and increasing the current and future possibilities of meeting the needs and aspirations of human beings. Sustainable development includes political, social, economic and environmental policies.

T.

Transfer of technology

Exchange of knowledge, corresponding *hardware* and *software*, money and goods between the interested parties, allowing to socialize a kind of *technology* that is used with *adaptation* or *mitigation* purposes. It includes the socialization of technologies such as technological cooperation between countries or within the same country.

U.

Uncertainty

Manifestation of the degree of ignorance of certain values (for instance, the future situation of the *climate system*). It can also be due to a lack of information or a disaccord regarding what is known or even cognizable. It can reflect several types of situations, from the existence of quantifiable mistakes in data to an ambiguous definition of a concept of term, or an uncertain *projection* of human behavior. Therefore, the uncertainty can be represented through quantitative values (for instance, an interval of calculated values through diverse models), or through qualitative assertions (reflecting, for instance, the opinion of a team of experts).

United Nations Framework Convention on Climate Change (UNFCCC)

It was adopted in New York on May 9, 1992, and subscribed that same year during the Earth Summit, celebrated in Rio de Janeiro, by more than 150 countries plus the European Communities. Its main aim is to "stabilize greenhouse gas concentration in the atmosphere at a level that would hinder anthropogenic interferences that could be dangerous for the climate

system." It contains clauses that compromise all the parties. In virtue of the Convention, the parties included in *Annex I* (all the members of the OECD by 1990 and countries characterized by their *transition economies*) committed to go back, from here to year 2000, to the emission levels of *greenhouse gases* not controlled by the Montreal Protocol in effect in vigor in 1990. The Convention entered into effect in March 1994.

Urbanization

Conversion of lands that were once in its natural state or in a managed natural state (for instance, agricultural lands) into cities; process originated by a net migration of the rural space to an urban area, leading to a growing percentage of the population of one country or region to live in settlements defined as *urban centers*.

Use of the land and change in the use of the land

The *use of the land* is the compound of dispositions, activities, and contributions in relation to a certain type of terrestrial cover (i.e., a compound of human actions). It also designates the social and economic objective guiding the management of the land (for instance, land pasture, wood extraction, or conservation). The *change in the use of the land* is a modification in the use or management of the land by humans, which can induce a change in the terrestrial cover. Changes in the cover of the earth and the use of land may influence the superficial *albedo*, through the *evapotranspiration*, in *fountains* and *drains of greenhouse gases*, or in other properties of the *climate system*, therefore in the capacity to exert a *radiation force* and/or other impacts over the *weather*, locally and globally.

V.

Vector

Hematophagous organism (e.g. an insect) transmitting a pathogenic organism from one carrier to another.

Vulnerability

Degree of susceptibility or incapacity of a system to face the adverse effects of *climate change* and, in particular, the *variability of the weather* and extreme phenomena. Vulnerability will depend on the nature, extension, and speed of the climate change to which a system is exposed, and its *sensitivity* and *adaptability*.

W.

World surface temperature

Estimation of the average global temperature of the air in the surface. For long-term variations, however, only the anomalies are used (for instance, deviations regarding climatology), generally in the form of pondered world average in the area where the anomaly of the temperature in the surface of the sea was detected and the anomaly of the temperature of the air in the earth's surface.

ANNEX II

Everybody's problem: Ideas to contribute to the fight against climate change

Climate change is everybody's problem, therefore, reducing the sources of the problem and building better conditions for future generations is everybody's responsibility. Below, we have described some actions that can be applied at home allowing us to reduce our contribution to worsen climate change, saving money and contributing to the development of our country.



ENERGY

- Replace conventional light bulbs with saving bulbs.
- Buy only electrical appliances with the energy efficiency label.
- Unplug all electrical appliances when not in use (unplug the cell phone charger when not in use).

WATER

- Start applying rainwater collection and harvesting techniques.
- Close the water tap, the shower, and after brushing your teeth.
- Do not wash your car using a hose.
- Keep all water taps and pipes in a good state, in order to avoid leaks.

TRANSPORTATION



- Maintain your vehicle in a good state.
- Make a periodic revision of the air in the tires; with an optimum air level you can reduce the use of fuel by 3%.
- Walk or use public transportation.
 - Prefer to use cars with low fuel consumption.



GARBAGE AND WASTE

- Recycle paper, newspapers, and containers. Separate organic garbage.
- Reuse containers.
- Buy products with the recycling logo or made of recycled materials.

Based on information of the Environmental Protection Agency of the United States (EPA). Available at: www.epa.gov/climatechange/wycd/index.html

ANNEX III

Map of vulnerabilities by landslides and floods in Esmeraldas and expansion areas



ANNEX IV

Declaration of Esmeraldas

The following declaration is the result of the work of the civil society and local authorities present in the work tables of the **"Sectoral Formulation of the Adaptation and Mitigation Strategy for Climate Change in canton Esmeraldas"**, celebrated in the city of Esmeraldas on Tuesday 14 and Wednesday 15 in December 2010 and February 15, 2011.

CONSIDERING:

- That Articles 14 and 71 of the Constitution of Ecuador recognize the right of the population to live in a healthy and ecologically balanced environment, as well as the right of nature of being respected and the maintenance and regeneration of vital cycles, structure, functions, and evolution processes.
- That Article 13 of the Constitution of Ecuador recognizes that individuals and collectivities have a right to safe and permanent access to healthy and nutritious foods in sufficient amounts.
- That Article 95 of the Constitution of Ecuador acknowledges that "The citizens, individually and collectively, will play a leading role in the decision-making, planning, and management of public affairs, and the popular control of the dependencies of the State and the society, and its representatives, in a permanent process of construction of citizen power. The participation will be oriented by the principles of equality, autonomy, public deliberation, and respect for the differences, popular control, solidarity and interculturality.
- That Article 414 of the Constitution of Ecuador establishes that the State will adopt appropriate and cross-cutting measures for the mitigation of climate change.
- That climate change, nowadays, is the greatest threat to all living forms on Earth, as well as different cultures and ways of survival.
- That unsustainable economic growth of the more industrialized countries of the planet in the main cause for the emission of greenhouse gases (GHGs) provoking global warming.
- That local governments have little resources to adequately manage the environment.
- That the fight against climate change involves betting for new public policies, at the national, provincial and local level, for them to bring us closer to a model of life that is more sustainable and friendlier with the environment.
- That climate change is everybody's problem and, therefore, this is an issue that must be tackled by the whole of the society at all levels.
- That ecosystem diversity is the sap that nurtures culture diversity; therefore, taking care of the environment is also a way of respecting different ways of life and cultural manifestations.

WE DEMAND FROM THE LOCAL AND NATIONAL GOVERNMENT, INSTITUTIONS, COMPANIES AND SOCIAL ACTORS THEY:

- Design and implement immediate actions aimed at changing our production and consumption habits towards sustainable and environment-friendly modes, turning Esmeraldas into an example for Ecuador.
- Immediately reduce the sources of pollution for the city of Esmeraldas, requiring institutions and public and private agencies assume their environmental and social responsibility; in a view of having a clean and living city for everybody.
- The Municipal government establishes, in coordination with the national competent authorities, an information, control and follow-up system of the industrial activities and its pollution levels, always keeping the priority for Good Living in a healthy environment.
- Include climate change criteria in planning processes in development and territorial planning at the local and national level.
- Preserve our natural and cultural heritage, forbidding those productive activities that menace public health.
- Guarantee that the citizens of Esmeraldas have equal access to utilities, public spaces and living in a healthy environment.
- Give due initiation to reforestation activities, soil recovery, and comprehensive management of hydrographic basins.
- Immediately implement a comprehensive management system of solid and liquid waste.
- Promote work and production alternatives that are respectful towards nature and replace the current development model.
- Include climate change as a cross-cutting and comprehensive topic that will allow building a society that is aware of the actions that need to be taken for the city and the country to reach a sustainable development.
- Promote spaces for citizens to meet, discuss, receive training and increase participation, where the national and local government and the citizens can strengthen social dialogue participative management and will to change.
- Prioritize accountability for it to be carried out in a periodic and timely fashion, from the part of the Municipal Government, as well as the representatives of the Central Government, on the measures that are being applied to guarantee the right of the population to live in a healthy environment.

WE, AS CITIZENS OF ESMERALDAS, COMMIT TO:

- Create a network of institutions and young specialists who work and consolidate actions for the Environmental Management and Climate Change
- Create groups of environment managers in the communities
- Manage waste in communities in an appropriate way, through organizations
- Contribute to the reduction of sound and vehicle pollution
- Reduce the use of plastics and persistent organic pollutants (POPs)
- Give a correct destination to electronic waste, and batteries
- Contribute to save energy
- Reduce pollution in rivers
- Support research on climate change at all levels of education
- Promote knowledge on climate change and risk management
- Socialize this declaration and monitor its implementation



ADAPTATION DMITIGATION AN **STRATEGY FOR R THE CANTON OF ESMERALDAS**



