CLIMATE CHANGE ASSESSMENT FOR ESMERALDAS, ECUADOR: A SUMMARY



CITIES AND CLIMATE CHANGE INITIATIVE

UN HABITAT
FOR A BETTER URBAN FUTURE

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UN HABITAT

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HS Number: HS/157/10E
ISBN Number:(Volume) 978-92-1-132269-9

ACKNOWLEDGEMENTS
This report is based on the Adaptation to Climate Change in Ecuador and the city of Esmeraldas: An Assessment of Challenges and Opportunities, 2009, prepared within the framework of UN-HABITAT's Cities in Climate Change Initiative.

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Design, Layout and Printing: United Nations Office at Nairobi (UNON) Publishing Services Section, ISO 14001:2004-certified

Cover Photos:Photos © UN-HABITAT

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LIST OF ACRONYMS

CAN	Comunidad Andina de Naciones (Andean Community of Nations)
ENSO	El Niño/La Niña-Southern Oscillation
ETA	Regional Climate Model
IMF	International Monetary Fund
INEC	Instituto Nacional de Estadísticas y Censos
IPCC	Intergovernmental Panel on Climate Change
PRECIS	Providing Regional Climates for Impact Studies (Regional Climate Model)
SIISE	Sistema Integrado de Indicadores Sociales del Ecuador
US-EPA	U.S. Environmental Protection Agency
SLR	Sea Level Rise

1.0

INTRODUCTION

Esmeraldas from the air. Photo © UN-HABITAT

1.1 CITIES AND CLIMATE CHANGE

Millions of people around the world are already, or will be, affected by climate change. Urban areas, which typically feature high concentrations of populations and buildings, are particularly vulnerable. Climate change is expected to compound the overall vulnerability of urban areas through rising sea levels, more frequent and stronger weather events, and inland flooding, among other challenges. At the same time, cities are major sources of greenhouse gases, and therefore must stand at the forefront of mitigation efforts. Mitigation and adaptation to the effects of climate change must take into account the vulnerable natural and human systems existing in our urban areas and their surroundings.

In many countries, cities are located in coastal areas, beside rivers, on steep slopes or other risk-prone areas. Infrastructure such as roads, water networks, transmission lines, schools and hospitals providing basic services for urban populations, are vulnerable to extreme climatic events such as floods, storms or landslides. Cities located in tropical coastal areas are particularly vulnerable to cyclones or rising sea levels, the frequency and intensity of which have been on the increase over the past three decades. In addition, salt water intrusion restricts the availability of fresh water in coastal areas, jeopardizing food security as once-fertile land becomes barren due to high salt content. Cities located in the hinterland or along rivers may be vulnerable to flooding. Conversely, areas where climate change is expected to reduce rainfall may be affected by drought, shrinking water tables and food scarcity.

In urban areas, the poor are the most vulnerable to the effects of climate change, and particularly slum dwellers in developing countries.

1.2 UN-HABITAT'S CITIES AND CLIMATE CHANGE INITIATIVE

Cities and local authorities have the potential to influence the causes of climate change and to find how to protect themselves from its effects. The Cities and Climate Change Initiative, a key component of UN-HABITAT's Sustainable Urban Development Network (SUD-Net), promotes enhanced climate change mitigation and adaptation in developing-country cities. More specifically, the Initiative supports the development of pro-poor innovative approaches to climate change policies and strategies. This Initiative builds on UN-HABITAT's rich experience in sustainable urban development (through the Environmental Planning and Management approach of the Sustainable Cities Programme and the Localizing Agenda 21 Programme) as well as on well-recognized capacity-building tools. The Initiative develops, adapts and disseminates the methodologies that put city managers and practitioners in a better position to cope with climate change.

FIGURE 1: Map of Equador

The Cities and Climate Change Initiative also promotes collaboration by local authorities and their associations in global, regional and national networks; the triple rationale being (1) to enhance policy dialogue so that climate change is firmly established on the agenda; (2) to support local authorities' efforts to bring about these changes; and (3) to enhance awareness, education and capacity-building in support of climate change strategies. A major outcome of the initiative will be the development of a set of tools for mitigation and adaptation.

This report comes under the Cities and Climate Change Initiative. Four pilot cities were selected in 2009, and one of their first assignments was for each to assess its vulnerability to climate change. In addition to Esmeraldas, the other three cities are Kampala, Uganda; Maputo, Mozambique and Sorsogon, Philippines. The aim is to provide insights on climate change adaptation and mitigation capacity in cities in developing and least developed countries. The rationale behind this report is to disseminate the early lessons of the Cities and Climate Change Initiative.

1.3 ESMERALDAS

Ecuador is located on the west coast of South America and is crossed by the equator (the country gets its name from the Spanish word for "equator"). Ecuador borders Colombia to the North, Peru to the East and South, and the Pacific Ocean to the West. Ecuador's capital city, Quito, is located in the north central part of the country.

Esmeraldas is a medium sized coastal city located in the northwestern corner of Ecuador and covers a land area of 16,155.97 km². The Teaone and Esmeraldas Rivers flow on one side of the city, and with the Pacific Ocean on the other side they make up the hydrological system of the canton. Esmeraldas is part of the Choco micro-region that has one of the highest rates of biodiversity in the world.

1.4 THE FRAMEWORK FOR CLIMATE RISK ASSESSMENT

The structure of this summary of the Esmeraldas Vulnerability Assessment is based on the proposed Framework for Urban Climate Risk Assessment developed by the Fifth Urban Research Symposium.

Esmeraldas settlements along the river bank are vulnerable to seasonal flooding. Photo © UN-HABITAT

The climate risk assessment framework focuses on how cities are affected by climate change as opposed to how they contribute to climate change, and thus adaptation rather than mitigation is highlighted. The framework analyses climate risk from three interconnected vectors – hazards, vulnerabilities and adaptive capacities. These vectors consist of a combination of physical science, geographical and socio-economic elements that can be used by municipal governments to create and carry out climate change action plans. 1 This summary has been re-structured to highlight these three perspectives.

1.5 ASSESSMENT METHODOLOGY

The Esmeraldas study explores the challenges and opportunities facing Ecuador and the City of Esmeraldas in their adaptation to future climates. It systematizes the climate change projections for Ecuador that are available to decision makers at two levels, explores the potential negative and positive impacts on Ecuador of contrasting future climate scenarios, with emphasis on urban systems, assesses how the current institutional framework and governance conditions promote effective adaptation to the new conditions, and propose a set of tools designed to fill gaps and to promote the adoption of climate-aware economic, social and environmental agendas.

Two workshops, one with national experts and one with city stakeholders, were the main source of information about past and future risks and opportunities associated with climate change. Two contrasting climate change projections for the year 2100 were used in both workshops to illustrate the range of possible futures that adaptation planning must account for and the identification of risks and opportunities. In the workshops, specific operational scenarios were constructed to identify key adaptation vulnerabilities and opportunities for the country and city. Operational scenarios are directly meaningful to policy makers and city managers. The following scenarios were investigated: health, water resources, infrastructure, and energy. The workshops and interviews were also the basis for identifying opportunities and challenges for adaptation.

In the context of the Esmeraldas study, adaptation is defined as a planned modification of current conditions that aims at reducing vulnerabilities that can create human, economic and environmental losses, or at enhancing opportunities that can generate human, economic and environmental benefits arising from climate change. In various studies, Ecuador appears as a country with high vulnerability to climate change due to inadequate governance (Cáceres 2001, CAN et al. 2007, Thow & de Blois 2008) and specific structural conditions, such as its high energy consumption per unit of Gross National Product (Buys et al. 2007).

Although the current analysis provides useful information, the inclusion of additional models for similar emission scenarios would strengthen the results – even though it might render different trends.

[1] *Framework for City Climate Risk Assessment (2009)*

2.0

CLIMATE CHANGE HAZARDS

2.0 CLIMATE CHANGE HAZARDS

Climate change hazards refer to "the climate induced stresses on the city and are identified through observed trends and projections derived from global climate models and regional down-scaling".2 These stresses manifest themselves as heat waves, droughts, inland floods, accelerated sea-level rise and floods for coastal cities, and can be tracked through changes in temperature, precipitation and sea level.

2.1 TEMPERATURE INCREASE

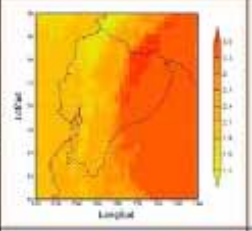
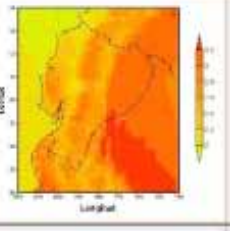
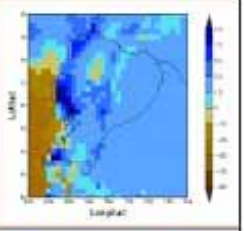
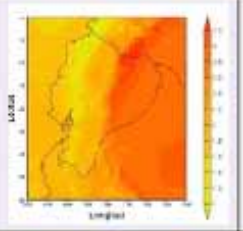
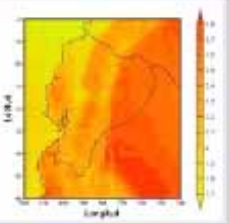
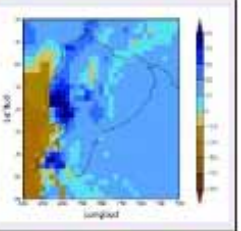
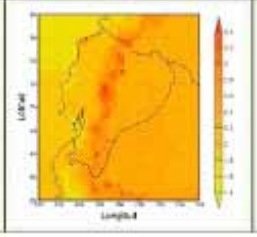
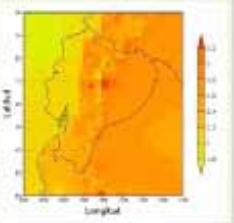
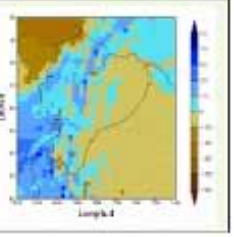
The certainties, variability and uncertainties about climate change for Ecuador are consistent with those found in global climate change assessments. All the climate projections evaluated for this assessment project a general increase in temperatures. This is consistent with a well documented increase in temperature in Ecuador over the last 50 years. Projected increases in maximum and minimum daily temperatures for Ecuador for the period 2000-2100 vary between 2.9 o C and 4.4 o C depending on the scenario applied, and are greater than those obtained across all IPCC models which predict surface air temperature by 2100 to increase between ~2.2 o C and ~3 o C (Donner et al. 2005). The geographic variations of the different projections, however, are significant. For example, the PRECIS-Echam output shows higher increases of maximum and minimum temperatures in the eastern lowlands of the country and lower increases in the northern coast. The TL959 simulation generates greater temperature increases along the Andes (Figure1).

The likely impacts of these climatic changes are the loss of most Andean glaciers and shifts in ecological altitudinal zoning. As a result, highland cities may experience diminishing water supplies from retreating glaciers, temperature inversions and air pollution traps, and worsened urban heat island conditions. Potential indirect impacts are linked to increased immigration of affected rural populations or reduced food production and higher food prices. In lowland cities, increased energy demands, pollution, and heat-related health problems can be anticipated. Overall energy demands are expected to increase drastically not only because of higher temperatures and larger populations, but also due to increased consumption at all levels of society. The climate projections also indicate very high impacts on current cold, high Andean landscapes indicating that three landscapes may disappear: Per-humid cold, Pluvial cold and Hyper-Pluvial Cool-Temperate. Warm and temperate landscapes expand at the expense of cold landscapes in all the models evaluated and landscape shifts suggest a tendency for ecological simplification, with some warm humid landscapes becoming more dominant. Interestingly, using landscapes as indicators of the potential impact of projected climate changes, the significant similarities of the outcomes from B2 and A2 emissions (see Figure 1) scenarios suggests that in addition to high impact vulnerability, Ecuador also has a high source of vulnerability.

Under certain conditions, benefits may be attained from higher temperatures. For example, moderate temperature increases and carbon fertilization could improve agricultural production at higher elevations if irrigation is available, which could benefit Andean urban areas with strong links to their agricultural hinterlands. In general, whether temperature increases have negative or positive impacts depends on the magnitude of the increase, changes in the other dimensions of climate, such as local and watershed-level precipitation patterns, and current social, economic and environmental conditions. However, it is difficult to define the final outcome for any given place in Ecuador because the magnitude of the projected increase varies widely from projection to projection and by emission scenario.

2 *Framework for City Climate Risk Assessment (2009), p 8*

FIGURE 2. Illustration of extreme climate projections for Ecuador

CLIMATE SIMULATION	SCENARIO		Absolute change in Max Temp @ 1.5 meters, 2000 - c.2100	Absolute change in Min Temp @ 1.5 meters, 2000 - c.2100	% change in Precipitation (average mm/day) , 2000 - c.2100
	NAME	SOCIO ECONOMIC ASSUMTIONS			
PRECIS-Echam	A2	Population growth: HIGH GDP growth: MEDIUM Resource availability: LOW Energy use: HIGH Land- use changes: MEDIUM/HIGH Technological change: SLOW			
	B2	Population growth: MEDIUM GDP growth: MEDIUM Resource availability: MEDIUM Energy use: MEDIUM Land- use changes: MEDIUM Technological change: AS USUAL			
TL959	A1b	Population growth: LOW GDP growth: VERY HIGH Resource availability: MEDIUM Energy use: VERY HIGH Land- use changes: LOW Technological change: RAPID			

Source: Modified from www.paacecuador.org. Available on February 28, 2009

The variability and uncertainties associated with the climate change projections available for the Esmeraldas River Basin are consistent with those observed for Ecuador as a whole. Likely impacts of climate and climate-related changes by the end of this century are associated with increases in global and local ocean and land temperatures. For the Esmeraldas River Basin, projected maximum increases in temperature range from +3 oC to +2 oC. These are expected to increase energy demands for domestic and industrial cooling, cause air pollution, water contamination and health problems. Energy demands are expected to increase drastically not only because of higher temperatures and larger populations, but also due to increased consumption levels throughout the city.

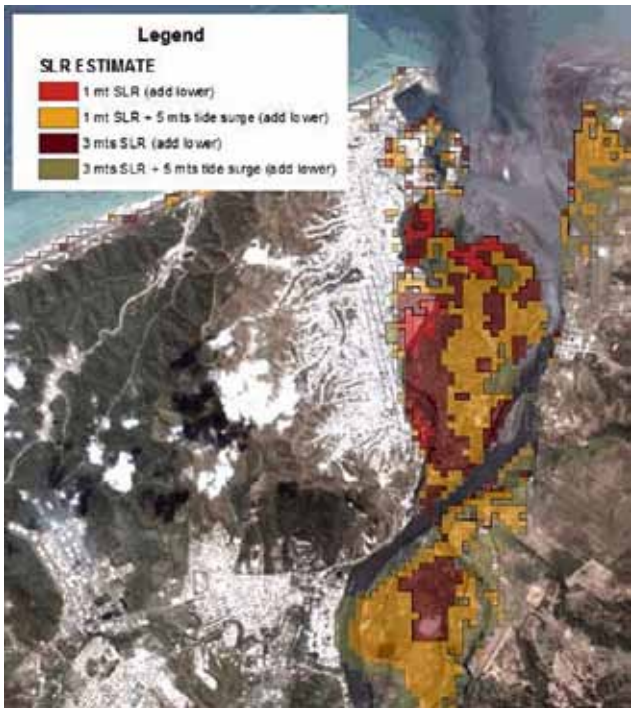
2.2 SEA LEVEL RISE

Other critical outcomes of increased global temperatures are related to sea level rise (SLR). Cornejo (2007) estimated potential sea level rise in the 21st Century to be close to one meter and the First National Communication used three scenarios, the worst being a SLR of 1 meter, and a tide surge variation of 3 to 5 meters. Because recent global SLR estimates vary from one to several meters by the end of this century, a more probable best and worst case scenario are 1 and 3 meters SLR, and a potential tide surge of up to 5 meters

Based on these estimates, two impact scenarios, one low (+ 1 meter) and one high (+ 3 meters), each with a potential 5 meter tide surge, were modeled for this study.In this worst case scenario (+3 m SLR), based on current land use patterns, approximately 11% of the country's urban land area and 20% of the population could be directly affected by rising sea levels. The less pessimistic scenario (+1m SLR) puts these estimates at 3.4% and 12%, respectively. Settlements, infrastructure and water sources would be severely affected or lost in these areas. Some coastal Cantones3 could, in the worst case scenario, lose up to 95% of their land, and in the less pessimistic scenario up to 60% of their land. Cities most affected are around and south of the Gulf of Guayaquil4. Important indirect impacts on urban areas would arise from the economic impacts on rural areas, loss of fisheries breeding areas, and loss of beaches, coastal amenities and recreation areas. Over 50% of rice fields and shrimp farm area could be covered by water permanently or periodically in the worst case scenario, jeopardizing linked urban businesses and employment. Increased risk would also arise from the disappearance of natural coastal buffers, in particular mangroves, which could lose, in a worst case scenario, up to half of its 2002 area.

Under the SLR scenarios examined in this study, between 3% and 6% of the Esmeraldas city built-up area would be permanently or periodically under the sea, displacing between 12,000 to 20,000 people, or 8.4% to 14% of the city's population in 2001 (Figure 2). SLR will also cause extensive land losses in the immediate surrounding area. The two largest islands and the area around the city's airport could be covered

FIGURE 3. Exposure of seal level rise in the City of Esmeraldas.



Source: This study. Aerial Photography from Google Earth

by the ocean in the worst case scenario and nearly half in the plausible scenario. Indirect impacts may arise from the loss of employment associated with extractive activities in nearby mangroves, loss of recreational areas currently planned by the city in these islands, and displacement of an undetermined population already living there. Higher water temperatures may also affect nearby fisheries and related employment.

2.3 EXTREME WEATHER EVENTS

Increased sea temperatures can also be expected to cause more intense, and possibly more frequent, ENSO5-like events and alter marine ecosystems. The effects of the former will be felt mostly in the coastal region that is below 1000 meters of elevation (CAF 2000, Cornejo 2007, Haylock et al. 2006). Losses from the associated floods can have significant economic and human impacts. The costs of the 1997-1998 floods, the most extensive on record, have been estimated to be almost 3 billion dollars, of which 785

3 In the Ecuadorian administrative hierarchy, cantones are the second level below provincias (i.e., province) and above parroquias (i.e., parishes). City governments, or municipalities, manage the territory of a canton, which may include rural areas.

4 Located at the south coast of the country.

5 A climate pattern that occurs across the tropical Pacific Ocean on average every five years, resulting in floods, droughts and other weather disturbances in many regions of the world, which vary with each event.

million corresponded to infrastructure and 1,186.8 million to agricultural loses, equivalent to eight to 11% of country's Gross National Product for those years. For the rest of the country, precipitation projections are much less certain, with model outputs showing completely opposite future precipitation patterns, with maximum reductions and gains of up to 80% from current conditions.

Esmeraldas city is located at the extreme north of the area of influence of ENSO events and has experienced important related loses in the past two decades. The 1997-1998 ENSO event, for example, destroyed or damaged over 1,000 homes and affected 1,300 families. The main reasons were overflowing of rivers in local isolated watershed areas and landslides due to intense precipitation and extreme tides (CAF 2000). Destruction of roads isolated affected areas by interrupting commodity flows and increasing shortages. In the city itself, in addition to life and property losses, rain water networks were blocked by sediments and debris and city roads were severely damaged. Similar risks can be expected in the future from rising sea surface temperatures (SST).

Other dimensions of climate change for the city are more difficult to define. Projections of changes in total annual precipitation vary from -50% to + 50%. Based on current conditions, a given transition path may cause hardships, such as floods or blackouts, or improvements, such as lower risks of floods or better access to drinking water. There are several small, isolated watersheds in this area that would be affected severely by either extreme. Unlike large basins, and especially those with direct connection with the highlands, there is little room for compensating local increases or decreases in precipitation.

2.4 IMPACTS OF CLIMATE CHANGE HAZARDS

The specific impacts of climate change on the city of Esmeraldas identified by stakeholders vary depending on the climate transition path guiding the analysis of potential adaptations and vulnerabilities.

Under climate change scenarios predicting a path towards hotter and more humid climates, Esmeraldas would face even greater and more frequent floods and would thus require more complex planning and management. Given the current level of exposure to floods and landslides, increased precipitation would cause additional life and property loses. Additional concerns for stakeholders were increased stress on the city's water delivery system and biological contamination from an open sewage system. Increased precipitation and higher temperatures would also create a more suitable environment for tropical parasites and diseases causing personal hardships and productivity losses as well as psychological stress. In addition, there would be higher exposure to pollution from waste-water dumping from the city's oil refinery, the cooling waters of thermoelectric plants, the timber industry south of the city, and the agrochemicals used by the palm and banana plantations upstream of the Esmeraldas and other rivers of the city. A potential source of risk is the city's trash dump in the upper watershed of a local stream that drains into important, low income settlements in the south of the city. Because local precipitation in the city has been generally low (~700 mm/year), water contamination from the dump has not been considered an important issue. Climate change could reverse that. In contrast, improved agricultural opportunities in the surrounding areas could benefit the city's economy.

Under climate change scenarios predicting a path towards hotter and dryer climates, Esmeraldas could potentially experience lower risks of flooding, and lower stress on its water delivery systems. In contrast, stakeholders considered water shortages and water price increases a major concern if the environment becomes dryer. Currently, almost 100% of the water used by the city comes from the Esmeraldas River. Additional concerns of a drying environment are economic stress due to reduced agricultural productivity in surrounding areas and increased incidence of diseases associated with poor sanitation.

Overall, adaptation to climate change in and around the City of Esmeraldas requires a complex set of actions designed to compensate current vulnerabilities and to avoid expanding the range of risks associated with natural events. According to stakeholder assessments, adaptation to climate change in Esmeraldas would consist of structural adjustments, such as the constructions of upstream water storage and flood control systems (e.g. dams and reservoirs), levies to protect flood-prone neighborhoods, the consolidation of the existing drinking water and sewage systems and their expansion into new settlements, and institutional tools, such as zoning plans and cadastral capacity that improve governance. Economic diversification would also reduce vulnerability by increasing the resilience of residents and facilitating the consolidation of marginal urban areas.

3.0

VULNERABILITY TO CLIMATE CHANGE

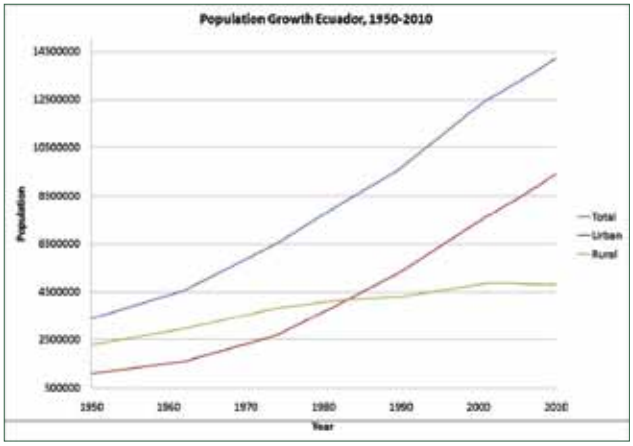
3.0 VULNERABILITY TO CLIMATE CHANGE

According to the Framework for City Climate Risk Assessment, vulnerability refers to the 'physical attributes of the city and its socio-economic composition that determine the degree of its susceptibility. The variables affecting vulnerability include flood-proneness (proximity to coast or river), land area, elevation, population density, percentage of the poor, and quality of infrastructure.'6

3.1 URBANIZATION DYNAMICS

The current trends of urbanization in Ecuador began in the 1960s. During this period the Ecuadorian economy changed drastically, both in terms of its underlying resource base and its spatial organization. At that time, the most important urban poles were Guayaquil and other coastal cities, such as Machala and Quevedo, where the export economy of the period was anchored; two crops, bananas and coffee, accounted for up to 92% of yearly exports (IMF 1991). In the early 70's, urban polarities changed due to increased government investment and the development of oil dependant urban-based industries and services in the highlands, mainly in Quito, and the booming towns of the northern Amazon lowlands; a trend that continued well into the 1990s. In the past two decades, more decentralized urban growth has taken place, linked to a service and transport-hub economy, such as in Santo Domingo de los Colorados, and to the expansion of agro-industries and fisheries, such as in Cayambe and Machala. Since the early 1980s, more people live in cities than in rural areas (Figure 3). By 2001, over 60% of the people lived in urban areas and it is estimated that by 2010, more than 66% of the population will be urban (INEC 2003). With poverty levels in rural areas twice that of urban levels (SIISE 2008), there is a continued flow of rural population to urban areas. As in most of the developing world, urban expansion has concentrated populations in marginal areas (e.g., mangrove wetlands and hillsides) of low economic and political value, often reflecting their vulnerability to climate events and other natural risks.

FIGURE 4. Population trends in Ecuador, 1950-2010



Source CEDIG 1985, INEC 2009

The official population estimate for the canton of Esmeraldas for the year 2010 is 188,694, of which 66% is urban, up from 162,225 in 2001, an increase of 16% in nine years. Esmeraldas is currently the 12th largest municipality and its urban component the 15th largest city in Ecuador7. In most respects, the city is a typical Ecuadorian medium sized city; its social and economic indicators comparable to those of other cities in the same size group. Previously, the growth rate of Esmeraldas was lower than that of similar cities because of poor economic opportunities. However, in the 1980's, the city's economy began a transformation with the construction of the country's second oil refinery and port, and the expansion of timber production in the forests north of the city.

6 *Framework for City Climate Risk Assessment (2009), p 9*

7 *Projection from INEC (2004)*

The Ecuadorian urban system, while keeping the underlying primacy that has characterized Latin America, is slowly evolving into a diverse urban network with an increasingly important component of medium size cities. In the last three decades medium sized cities, between 150,000 and one million people grew at an average of 3.6% a year, with some soaring over 5%. As a result, the share of medium sized cities increased from 3.8% of the urban population of Ecuador in 1982 to 18.4% in 2001 (INEC 2003).

Medium-sized cities have a distinctive character that differentiates them from small urban centers and approximates them to large cities but with some important disadvantages, such as lower governance capacities, as suggested by significantly higher financial dependence on the central government. Most are unable to impose or foster adaptation, their priorities and their demands being the provision of basic services for existing and new neighborhoods.

Table 1. Social and governance indicators for Ecuadorian cities based on their size. (Sources: a) CDC 2003, b) SIISE 2008, c) INFOPLAN 2003.)

		City Size 2001						
		>= 500,000		100,000 – 500,000		10,000-99,999		SOURCE
		N = 2		N = 13		N = 19		
VARIABLE	PERIOD OR VARIABLE	AVERA(EST	DEV	AVERA(E	ST DEV	AVERA(EST	DEV	a
ANNUAL GROWTH RATE	1974 - 1982	4.4	0.1	4.8	1.2	3.2	7.4	a
	1982 - 1990	3.0	0.2	3.0	1.3	2.3	4.1	a
	1990 - 2001	2.2	0.1	2.7	1.6	1.7	2.1	a
	1974 - 2001	3.1	0.1	3.4	1.3	2.3	3.0	a
AVERAGE DENSITY (p/km2)	1974	1098	856.8	238	647.5	46	107.3	a
	1982	1586	1220.3	348	880.4	60	149.0	a
	1990	2005	1515.4	438	1030.8	72	180.6	a
	2001	2533	1931.9	592	1256.0	91	252.6	a
SOCIAL INDICES *	EDUCATION INDEX (0-100)	76.4	5.3	67.9	6.5	48.6	8.7	b
	HEALTH INDEX (0-100)	67.6	0.2	63.0	3.5	50.6	6.0	c
	HOUSING INDEX (0-100)	63.5	3.4	61.8	3.4	51.2	5.6	c
	TELEPHONE (% OF HOMES)	49.4	12.7	34.0	8.3	15.3	9.8	b
	CROWDINESS (% OF HOMES)	63.5	8.1	61.8	3.5	51.4	8.4	b
	BASIC UNMET NEEDS (% OF POPULATION)	43.1	13.4	54.4	7.9	78.2	12.3	b
GOVERNANCE	MUNICIPAL FINANCIAL AUTONOMY	52.9	7.8	32.0	10.4	14.4	11.1	c
	MUNICIPAL CAPITAL INVESTMENT	45.8	11.49	48.2	12.76	56.7	11.57	c

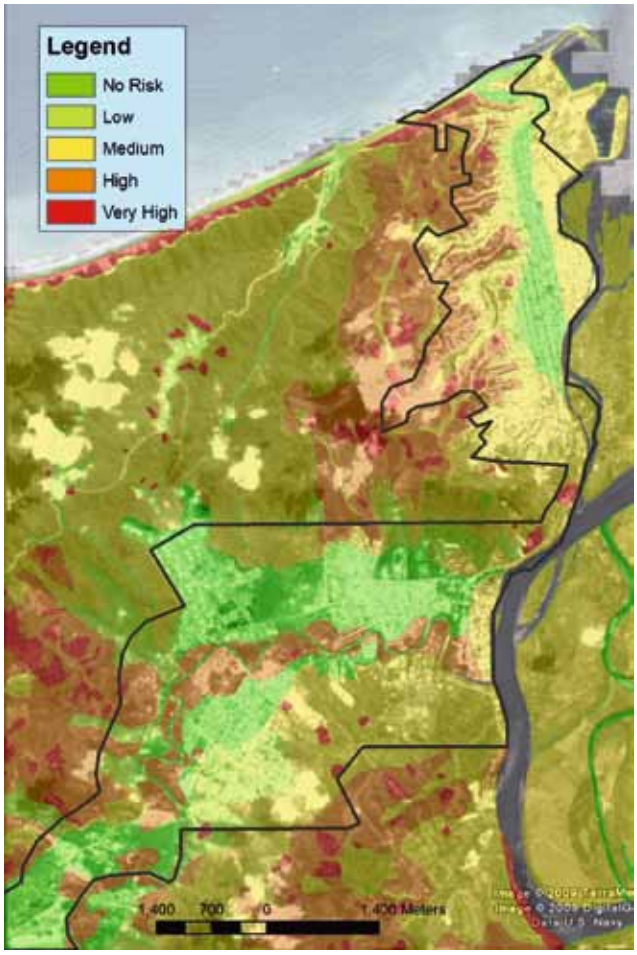
3.1.1 GROWTH OF SPONTANEOUS SETTLEMENTS

Much of the expansion of the Ecuadorian urban footprint in the past 40 years has been in the form of spontaneous settlements, often on forcibly occupied lands, that have been extended by individual and state actions. Households slowly build and improve on their individual sites and the state provides public goods and space in stages. In time, most marginal settlements have been incorporated into the formal components of cities through this process of consolidation. However, urban consolidation makes it less likely that populations in risk areas can be moved to safer sites, limiting short-term opportunities to advance adaptation objectives that are not on-site physical and structural.

3.1.2 SETTLEMENT IN HIGH-RISK AREAS

As in most cities in Ecuador and Latin America, urban growth in Esmeraldas has mostly been associated with occupation of land in areas surrounding the consolidated city, most of which is high-risk due to natural disasters (in 2009, the City's Planning Department estimated that close to 60% of the dwellings did not have a building permit). The first settlement of what is today Esmeraldas stood above the flood zone of the Esmeraldas River. Since then, a significant fraction of the new settlement areas have been on flood zones, mainly in the south along the Teaone and Esmeraldas Rivers, and on the Piedad and Prado Islands in front of the city. Until the 1990s, new settlements faced risks primarily related to floods but since then an important fraction of the new settlements are developed on landslide prone sites, probably attracted by the significant infrastructure improvements in older hillside settlements. Overall, sixty six percent of the city shows medium to high exposure to climate related risks (see Figure 4).

FIGURE 5. Flood and landslide risk for the City of Esmeraldas.



Source: City Planning Department. Aerial photograph from Google Earth.

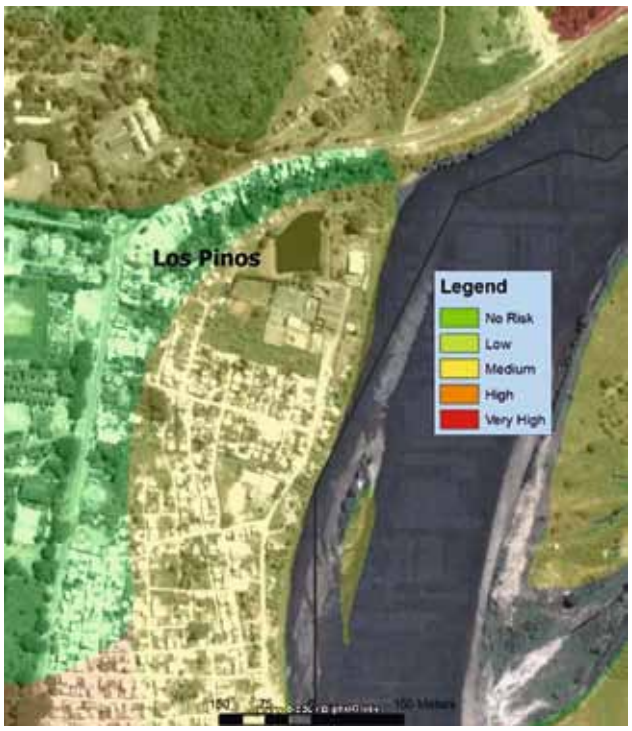
Table 2. Historical risk levels from floods (blue) and landslides (red) for the City of Esmeraldas. Each risk tabulated independently based on risk and historical maps from the City's Planning Department.

Period	Upland		Flood Zone		Stable Areas		Unstable Areas		Total (Has)
	H a s		H a s		H a s		Has		
1880	30	100.0	0	0.0	30.0	100.0	0.0	0.0	30
1960	158	98.8	2	1.3	145.0	90.6	15.0	9.4	160
1975	489	87.3	71	12.7	398.0	71.1	95.0	17.0	560
1980	381	78.6	104	21.4	474.0	97.7	8.0	1.6	485
1990	331	84.7	60	15.3	370.0	94.6	21.0	5.4	391
2004	1133	88.0	154	12.0	996.0	77.4	220.0	17.1	1287
TOTAL	2522	86.6	391	13.4	2413.0	82.8	359.0	12.3	2913

The City of Esmeraldas in particular, faces significant challenges due to physical exposure. This corresponds to situations where human populations or property are located in high risk areas and it is not possible, politically, socially or economically, to change their location. One of the key challenges Esmeraldas will face is the ongoing expansion of informal settlements along flood zones of the Taeone and Esmeraldas Rivers and the low-lying Piedad and Prado islands, which are likely to be affected by climate change through SLR and ENSO-like events. Such is the case of Los Pinos, an informal settlement that inundates often with a mixture of river and nearby sewage pond waters (Figure 5).

Spatially the growth of the urban component of the canton in the last decade has concentrated in the south of the city, in new neighborhoods such as La Tolita, Tiwintza, San Rafael and Los Pinos. In general, while the most recent settlements lack infrastructure, in particular paved access roads, piped water, sewage systems, and social services, in older spontaneous settlements, such as Esmeraldas Libre and La Propicia, basic services have been acquired - mostly electricity, piped water and paved access roads - through negotiation with the city's municipality. In these areas significant urban consolidation is evident, to the point that settlements in high risk areas look similar to those in safe areas. Currently, a new front of settlement expansion has opened in the mangrove islands in front of the city at Isla Piedad and Isla Prado. Because new roads are being opened into these formerly hard-to-access islands, including a bridge to link the city to the airport on the other shore of the Esmeraldas River, it is possible to foresee additional growth of informal settlements in these islands, and further on the other shore of the river.

FIGURE 6. Esmeraldas - hazard risk at Los Pinos neighborhood, sewage pond and flood zone



Source: Adaptation to Climate Change in Ecuador and the city of Esmeraldas: An Assessment of Challenges and Opportunities. Rodrigo Sierra, Saskia Flores, Giannina Zamora. November, 2009. P30.

4.0

ADAPTIVE CAPACITY

4.0 ADAPTIVE CAPACITY

The adaptive capacity of a city refers to the "institutional attributes of the city and its actors that determine the degree of its capability to respond to potential climate change impacts"
8 It measures the willingness and ability to cope and respond positively to the stresses of climate change.

4.1 NATIONAL POLICIES AND ACTION PLANS

Ecuador has an ample institutional platform at the level of the central government to support adaptation. The underlying institutional frameworks for climate change adaptation (and mitigation) are the Constitution of 2008 and the United Nations Framework Convention on Climate Change (UNFCC), signed in 1992. Additional thrust is provided by the commitments made by Ecuador in 1996 at the Habitat II Conference in Istanbul, where the country agreed to work to improve the quality and access to appropriate housing and infrastructure of the country.

Since the signing of the Climate Change Convention in 1996, the Ministry of Environment has been the focal organization and the counterpart for the Climate Change Convention. The Ministry has created a Climate Change Under-Secretary to lead action and planning and to coordinate with other agencies working or affected by related issues. The Ministry has also has spearheaded several studies to assess the impacts of climate change effects in strategic sectors such as agriculture, water resources, tropical forests, coastal areas, deforested areas and areas vulnerable to floods. The Ministry of Environment's Adaptation to Climate Change Project is the main tool to disseminate the information available about climate change. Additional support is provided by the Ministry of Foreign Affairs, National Institute of Meteorology and Hydrology, Naval Oceanographic Institute and various cooperating national (e.g., SIISE) and international organizations (e.g., UNDP, UN-HABITAT, US-EPA).

The Ministry of Environment is leading the development of a National Climate Change Strategy, which will propose national policies to manage and mainstream climate change, including the design of "Sectoral and Multi-Sectoral Adaptation to Climate Change Plans". The National Climate Change Strategy seeks to develop an integrated social response to reduce the vulnerability and enhance the opportunities of the country and to mainstream climate change into national policies for sustainable development. To do this, it proposes: 1) Strengthening the country's capacity to monitor climate and assess vulnerabilities, 2) Developing green house gas emission inventories, 3) Planning and implementing mitigation measures, and 4) Planning and implementing climate change adaptations. The National Institute of Meteorology and Hydrology and the Naval Oceanographic Institute are responsible for generating and monitoring climate information, with the former managing continental information and the latter oceanic data. However, these institutions are limited in processing existing archived and generate new information that could enhance climate change assessments for the country as they lack staff dedicated exclusively to climate change issues. Also, and in addition to the inadequacies of high-resolution or statistically downscaled global climate models highlighted earlier, local models developed with regional modeling platforms, such as ETA or PRECIS, use baseline climate models, or climatologies, which according to local climate experts do not reflect Ecuadorian climate systems well. These shortcomings limit the applicability of these models to guide climate change adaptation work, including this study. Further, available climate series are incomplete, with fewer than 10 weather stations with complete series for 30

8 *Framework for City Climate Risk Assessment (2009), p 9*

A neighbourhod in Esmeraldas. Photo © UN-HABITAT

continuous years or more. Also, a significant amount of climate data remains on paper. The National Institute of Meteorology and Hydrology has begun a process of systematization of existing climate data with the objective of defining an official climatology for the country to be used in the next generation of national climate projections.

In 2005 the country began to implement a series of plans and projects to initiate adaptation and mitigation processes. So far, operational adaptation efforts have emphasized water management issues. The National Adaptation to Climate Change Project aims at reducing the vulnerability to climate change by strengthening water governance at the national and local level and integrating climate change risk concepts in water management and programs. Overall, however, the institutionalization of mitigation objectives has advanced more than those of adaptation, maybe because of the opportunities they represent through, among other options, clean development mechanisms and potential green-house credit markets (for now mainly carbon credits). The Climate Change Under-Secretary is in charge of promoting CDM projects and provides guidance at all stages of project development. There is no equivalent, either governmental or non-governmental, to promote adaptation programs and projects.

Additional thrust and tools for climate change adaptation arise from risk management policies and national objectives. The 2008 Ecuadorian Constitution, amongst other provisions, obligates the State to protect the population from human-induced and natural disasters, and to mitigate associated negative impacts and restore the appropriate social, economic and environmental conditions. Closely linked and under the Constitution are: a) the National Development Plan and b) the National Security, Sovereignty, and Democracy Strategy. These provide the direct framework for the country's efforts to manage risks related to natural disasters. The National Secretariat for Risk Management with the participation of other State organizations coordinates the work of risk management and will develop the National Strategy to Reduce Risk and Disasters. Operationally, the responsible agency is the newly created National Secretariat for Risk Management of the Ministry of Internal and External Security. Although this institutional structure does not address climate change directly, it supports the management of risks relevant to climate change adaptation in urban and rural areas. The Strategy, in particular, constitutes the underlying guide to enhance risk management capacities in the country and bring risk management to the level of national policy.

The three largest cities in Ecuador, Guayaquil, Quito and Cuenca, have began institutional efforts to incorporate climate change criteria in city planning. Of the smaller cities, Esmeraldas has also taken some steps to assess its exposure to climate change and future options. Medium-sized and small cities face significant barriers for developing independent, and city specific climate change strategies. Although these barriers are the same as those found at the national level, they also include sectoral management requirements that are inconsistent with management capacities as the following analysis in the City of Esmeraldas shows.

4.2 CITY-LEVEL POLICIES AND PLANS

The City of Esmeraldas does not have a formal strategy, ordinance or regulation to promote adaptation to climate change. Recent municipal administrations have taken steps that have reduced the vulnerability of the city to certain types of climate exposure but the inherent structure of the city and its historical expansion conditions continue to present significant challenges for city managers.

In terms of governance, city managers recognize as a key climate change-related challenge the city's technical inability, and sometimes political resistance, to implementing and enforcing zoning regulations. Technically, while city managers recognize that various forms of risk need to be taken into account when assigning property rights to city dwellers, the scale of the information available to reach decisions about the appropriate use of land is insufficient. Politically, climate change decisions can rarely be justified in terms of future urban needs (that are measured in decades, and almost never in generations), which complicates the communication and negotiation of climate change related objectives.

In recent years, the Municipality of Esmeraldas, with the support of civil, governmental and non-governmental organizations, has been working to improve the city's adaptability to climate change. The main source of institutional support to climate change adaptation and mitigation objectives in Esmeraldas has been UN-HABITAT's Localising Agenda 21 (LA 21) Program. This program has worked with city managers to enhance local capacity and urban planning to respond to climate change. Specifically relevant for climate change adaptation, the city's Planning Department has acquired technical and human capabilities to perform basic planning activities and is currently developing a zoning program for the city and surrounding area (i.e., the county). As a result, Esmeraldas has adopted zoning tools to manage certain risks (although climate change is not yet considered in the decision making process). Zoning is an effective tool for reducing exposure to specific climate risks, such as floods. LA 21 also supported the implementation of environmental programs, including the initial coordination of an information tool to systematize risk data and to incorporate risk into the city's planning and management processes; however, additional technical support is needed to manage this information. UN-HABITAT has also facilitated inter-city cooperation with other cities in Ecuador, such as Cuenca and Loja, in issues related to sustainable urban planning. As in most cities of Ecuador, climate change related studies and activities planned for or implemented in Esmeraldas have been conducted without taking into account concrete climate scenarios.

Settlements on the hills are prone to landslide.
Photo © UN-HABITAT

Additional initiatives with climate change adaptation value arise indirectly from other municipal programs, such as the Health and Environment Program (Programa Salud y Medio Ambiente Esmeraldas - SYMAE). The program has promoted the creation of Canton's Health Council, which includes a forum for risk management

and disaster prevention, and supports the development of Participatory Rural Appraisals as a planning tool for rural parishes and as baseline development of the climate change strategy in these areas. It also provides assistance for rural infrastructure (sewage, water, dry toilets) development, and the development of waste management feasibility studies and ordinances. Indeed, it is important to note that most of what has been accomplished in sanitation, infrastructure, and urban planning capacity has not been motivated by concerns over climate change, but through strategies seeking better planning processes and poverty reduction. Still, risk reduction and adaptation to past natural threats has contributed significantly to reducing climate change vulnerabilities in Esmeraldas. Such interest, however, is not necessarily a good indicator of the level of understanding of the risks, needs, and opportunities associated with future climate transitions and, therefore, cannot be counted to generate further adaptation without additional support directed specifically at highlighting the differences and variability of potential climate transitions.

4.3 CHALLENGES TO ESMERALDAS'S ADAPTIVE CAPACITY

Challenges to the adaptive capacity of Esmeraldas include limitations associated with lack of information and risk management tools, including cadastral tools and early warning systems, and insufficient financial capacity to implement adaptation measures. For example, in Los Pinos9 neighborhood, the city is unable to relocate the resident families because it lacks the resources to buy land. In 2008, 50% of Esmeraldas' annual budget of US$ 21 million was spent on general operations expenditures (salaries, fuel). With an estimated target population of over 180,000, the city was only able to invest about US$ 60 per person on improvements. Indeed, few cities in Ecuador have the capacity to invest in flood and water storage systems, relocation programs for high-risk populations, or promote structural adaptations to improve efficiencies in resource use and transmission. Medium-sized and small cities in particular show important constraints to develop and implement local adaptation plans because of limited financial resources. Because the relocation of families living in the city's flood zones is economically and politically unlikely, adaptation will require physical modification, such as the construction of levies and discharge channels. However, application of structural modifications needs to be carefully evaluated and accompanied by measures to reduce any resulting physical exposure of settlements and infrastructure.

In addition, there are conditions that jeopardize or slow down the pace of adaptation. Three such conditions stand out: 1) minimal local governance related urban planning and city management issues relevant to climate change adaptation, 2) incongruent levels of coordination and planning between the central government and its regional dependencies, the city's government, and Esmeraldas' civil society, and 3) lack of understanding of the value-added to standard municipal actions and plans by adaptation to climate change. A low level of governance is expressed by a generalized inability, and sometimes political resistance, to enforce zoning laws. Incongruent management domains occur when adaptation depends on managing a risk factor, a resource or a sector that is not under the city's control. In general, water, energy and health planning and policy fall outside of the city's jurisdiction as defined by the 2008 Ecuadorian Constitution. The obligations of municipal governments include the provision of drinking water, risk management, and land use planning but operational capacities and programmatic efforts are concentrated at the level of the central government. Water policy and management roles, for example, are assigned to the central government and, through a new upcoming water law, to a national authority and by delegation possibly to provincial governments. In the current draft of the law, cities could participate and comment on water policy issues but could not vote on them. Similar gaps exist in the energy and health sectors. Although the issue of reliable risk information is probably the most urgent from a zoning perspective, there are other management sectors of the city that also require improved governance, such as eradication of corruption and the control of emissions from factories, the refinery and cars. Additional limitations include the lack of a consensus climate projection to guide and motivate adaptation strategies and planning, incompatible time and geographic scales between policy and climate change agendas (i.e., contrasting priorities), and the lack of capacity on the part of the central and local governments to manage the territory.

9 *Los Pinos is an informal settlement located in a flood prone area to the south of the city.*

5.0

CONCLUSIONS AND RECOMMENDATIONS

A detailed study of urban dynamics (Angel et al. 2005), concluded that "Developing country cities should be making realistic - yet minimal - plans for urban expansion, designating adequate areas for accommodating the projected expansion, investing wisely in basic trunk infrastructure to serve this expansion, and protecting sensitive land from incursion by new urban development". While reasonable, such strategy is inconsistent with the informality and spontaneous nature of urban growth in developing world's cities, governments priorities normally defined in years and often in elected periods, and household and firm priorities defined in days, weeks or, at best, months. At the same time, when assessing the viability of climate change adaptations, it is important to understand that within the assumed chaos of urban expansion there is a clear social logic: People in the developing world take advantage of the resources at their disposal (labor, capital, entitlements) and are willing to accept a necessary level of risk. In Esmeraldas, this means settling in areas that regularly flood and that are expected to flood regularly in the future. Many of these areas, which began as informal, makeshift settlements, cannot be differentiated today from other, safer areas of the city. These high-risk urban areas, with paved roads, brick houses and social facilities such as schools, are abandoned when the water rises, only to be occupied as soon as the water ebbs. Adaptation strategies need to recognize and accept this reality rather than propose ideal courses of action that cannot be realized. Accepting such realities, however, does not mean that the information predicting the seriousness, if not the details, of the impacts of climate change is not a priority.

Broadly, the challenge for enabling agents (such as UN-HABITAT) is to enhance urban capacities to engage climate change with flexible tools that could allow cities to identify specific adaptations that are dependent on both current conditions and priorities taking into account future risk balances and the nature of expected climate changes. Specifically, from the challenges and vulnerabilities identified for Ecuador and the City of Esmeraldas, the following proposals of actions and tools arise:

Esmeraldas town.
Photo © UN-HABITAT/ Municipio de Esmeraldas

5.1 RECOMMENDATIONS FOR NATIONAL LEVEL INTERVENTIONS

It is hoped that the Esmeraldas experience can be the basis for the formulation of a National Urban Climate Change Adaptation Blueprint to complement the National Climate Change Strategy. The priority at the level of national urban systems should be to bring adaptation to the same level of implementation as mitigation, moving from generic strategies and mandates to specific adaptation interventions. The following tools would contribute to this process:

1. A National Climate Change Information System to make systematized consensus information available to stakeholders in appropriate scales and formats to guide adaptation efforts. This requires supporting and enhancing climate change research and monitoring, in particular by the National Institute of Meteorology and Hydrology and Naval Oceanographic Institute, and the formation

of a National Consultative Group of Experts on climate change. The role of the Consultative group would be to interpret abstract climate change dimensions to terms that city managers can use to communicate with their constituencies and to clarify local consequences and concerns at the level of households and firms. Sector based approaches, consistent with the management strategies of cities in general, and of the City of Esmeraldas in particular, are necessary to bridge the significant gap in the institutionalization of the concepts and objectives of adaptation to climate change at levels that are directly relevant for urban planning and to improve their ability to take effective action and manage risk and opportunities.

2. A National Climate Change Adaptation Fund to support the implementation of concrete adaptation measures that address specific vulnerabilities of urban areas and their regions of influence. Most of the adaptation options identified in this study will not take place without concrete incentives and support equivalent to that available for mitigation actions, requiring in most cases subsidies or transfers to be executed. Also, adapting effectively to climate change requires not only reducing current and future vulnerabilities but also taking advantage of potential opportunities and new comparative advantages. Development policies are as important as climate policies to ensure sustainability and climate stabilization (IPCC 2007).
3. A National Urban Climate Change Adaptation Blueprint to guide the assessment of city specific vulnerabilities to climate change and the development of local climate change adaptation (and mitigation) strategies, including the efficient articulation of national development, sectoral and climate change adaptation objectives and tools to local/specific urban planning and management objectives. The blueprint would be a systematic protocol for cities to articulate correctly general/ broad national adaptation objectives and relevant resource management tools to local/specific urban planning and management objectives. In particular, the blueprint should serve as a facilitating how-to-do, step by step guide to link the objectives defined by the central government's development agenda and the mandates, temporal action scales, and capacities of local city governments. This tool should provide a systematic guide to the construction of city level strategies, and could also provide rules to support actions for adaptation.

It is important to note that the first two tools are already contemplated in the Ministry of Environment's National Climate Change Strategy draft. Its completion, adoption, and implementation would constitute an important and concrete tool to guide and promote adaptation to climate change in Ecuador.

5.2 RECOMMENDATIONS FOR CITY LEVEL INTERVENTIONS

At the level of the City of Esmeraldas, tools are needed to increase the perceived value of adopting a Climate Change aware agenda and to guide the development of the city's Climate Change Strategy. Specifically, the following tools are proposed:

1. A City of Esmeraldas' Climate Change Adaptation Strategy to facilitate the systematization and participatory integration of technical and political agendas in areas that concern climate change. The strategy should: 1) be the basis of concrete regulatory (e.g., ordinances) or economic tools (e.g., taxes), 2) design and implement the necessary information systems (e.g., early warning, sectoral interpretations of climate channge risks and opportunities), and 3) put to work supporting tools for implementing programs that advance the climate change agenda, with emphasis on zoning, territorial organization, risk prevention, water source and treatment. The strategy should address the specific vulnerabilities of the city, with emphasis on processes that increase physical exposure, generating adequate capacities and resources, and correcting institutional inefficiencies. Corrective measures to reduce risk for existing populations or property located in high risk areas and preventive measures to minimize the expansion of the high-risk footprint should be evaluated. In some sectors, strategies for generating economies of scale may be needed (e.g. water). Application of structural modifications needs to be carefully evaluated.
2. Capacity Building in Urban Planning and Design Strategy to improve governance capacities that advance the climate change agenda, including zoning tools, a cadastral system, and an early warning and risk monitoring system. It should include plans for information development and human resource support, with emphasis on the environmental and planning units of the Municipality. These conditions are necessary for the efficient implementation of the City's Climate Change Strategy.

REFERENCES

Angel, S., S. Sheppard, and D. Civco. 2005. The Dynamics of Global Urban Expansion. Transport and Urban Development, The World Bank. USA: Washington D.C.

Buys, P., U. Deichmann, C. Meisner, T. Ton That, and D. Wheeler. 2007. Country Stakes in Climate Change Negotiations: Two Dimensions of Vulnerability. Policy Research Working Paper 4300. World Bank, Washington, D.C., USA.

Cáceres, L. 2001. Comunicación Nacional de la República del Ecuador para la Convención Marco de las Naciones Unidas. Comité Nacional sobre el Clima-Ministerio de Ambiente. Quito.

CAF (Corporación Andina de Fomento). 2000. Las Lecciones del Niño. Memorias del Fenomeno del Niño 1997-1998. Retos y Respuestas para la Region Andina. Ex Libris. Venezuela: Caracas. 311 pp.

CAN (Secretaría General de la Comunidad Andina), Programa de las Naciones Unidas para el Medio Ambiente y Agencia Española de Cooperación Internacional. 2007. Cosa Seria este Clima. Panorama del Cambio Climático en la Comunidad Andina. Typographics. Lima.

Cornejo, P. 2007. Ecuador Case Study: Climate Change Impact on Fisheries. Human Development Report Office. Occasional Paper 47.

Donner, S., W Skirving, C. Little, M. Oppenheimer and O. Hoegh-Guldberg. 2005. Global assessment of coral bleaching and required rates of adaptation under climate change. Global Change Biology 11: 2251–2265

Haylock, Tm., C. Peterson, L. Alves, T. Ambrizzi, Y. Anunciação, J. Baez, V. Barros, M. Berlato, M.

Bidegain, G. Coronel, V. Corradi, V. Garcia, A. Grimm, D. Karoly, J. Marengo, M. Marino, D. Moncunill, D. Nechet, J. Quintana, E. Rebello, M. Rusticucci, J. L. Santos, I. Trebejo, and L. A. Vincent. 2006. Trends in Total and Extreme South American Rainfall in 1960–2000 and Links with Sea Surface Temperature. Journal of Climate 19:1490-1512.

IMF (International Monetary Fund) 1991. International Financial Statistics Yearbook. Washington, International Monetary Fund.

INEC (Instituto Nacional de Estadística y Censos) 2003. Ecuador: Estimaciones y Proyecciones de Poblacion, 1950-2025. Serie OI, 205. Available at www.inec.gov.ev on March 3rd , 2009.

INEC (Instituto Nacional de Estadística y Censos) 2004. Proyección Cantonal 2000-2010. Available at www.inec.gov.ev on March 3rd, 2009.

IPCC (Intergovernmental Panel on Climate Change). 2007. Technical Summary. Climate Change 2007:

Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 23-78.

Mehrotram Shagun et al. 2009. Framework for City Climate Risk Assessment. www.uccrn.org/.../Framework_for_City_Risk_Assessment-June17.pdf accessed on 15 Feb 2010

Oppenheimer, M. and A. Todorov. 2006. Global Warming: the Psychology of Long Term Risk. Climatic Change 77: 1–6.

Sistema Integrado de Indicadores Sociales del Ecuador (SIISE). 2008. http://www.siise.gov.ec/Principal.aspx. Available on March 3rd, 2009.

Thow, A. & M. de Blois. 2008. Climate change and human vulnerability: Mapping emerging trends and risk hotspots for humanitarian actors. UN Office for Coordination of Humanitarian Affairs, Maplecroft and CARE International. Geneva.

UN-HABITAT's Cities and Climate Change Initiative promotes enhanced climate change mitigation and adaptation in developing country cities. Esmeraldas is a pilot city of the Initiative, and this document is an initial output of the city's Cities and Climate Change Initiative activities. This summary on climate change assessment for Esmeraldas is based on the report titled "Adaptation to Climate Change in Ecuador and the City o f Esmeraldas: An Assessment of Challenges and Opportunities"

The Esmeraldas Climate Change Assessment explores the challenges and opportunities facing Ecuador and the City of Esmeraldas in their adaptation to future climates. Starting with an overview of the climate change hazards that the city is exposed to, the study examines various climate change projections, exploring the potential negative and positive impacts of contrasting climate scenarios. This is followed by an examination of the vulnerability of Esmeraldas to climate change, focusing on current urban dynamics. The assessment then looks at Esmeraldas' adaptive capacity to climate change, focusing on policy and institutions at both national and local level. It concludes with recommendations for both national and local level interventions to improve climate change adaptation in Esmeraldas.

HS Number: HS/157/10E
ISBN Number:(Volume) 978-92-1-132269-9

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