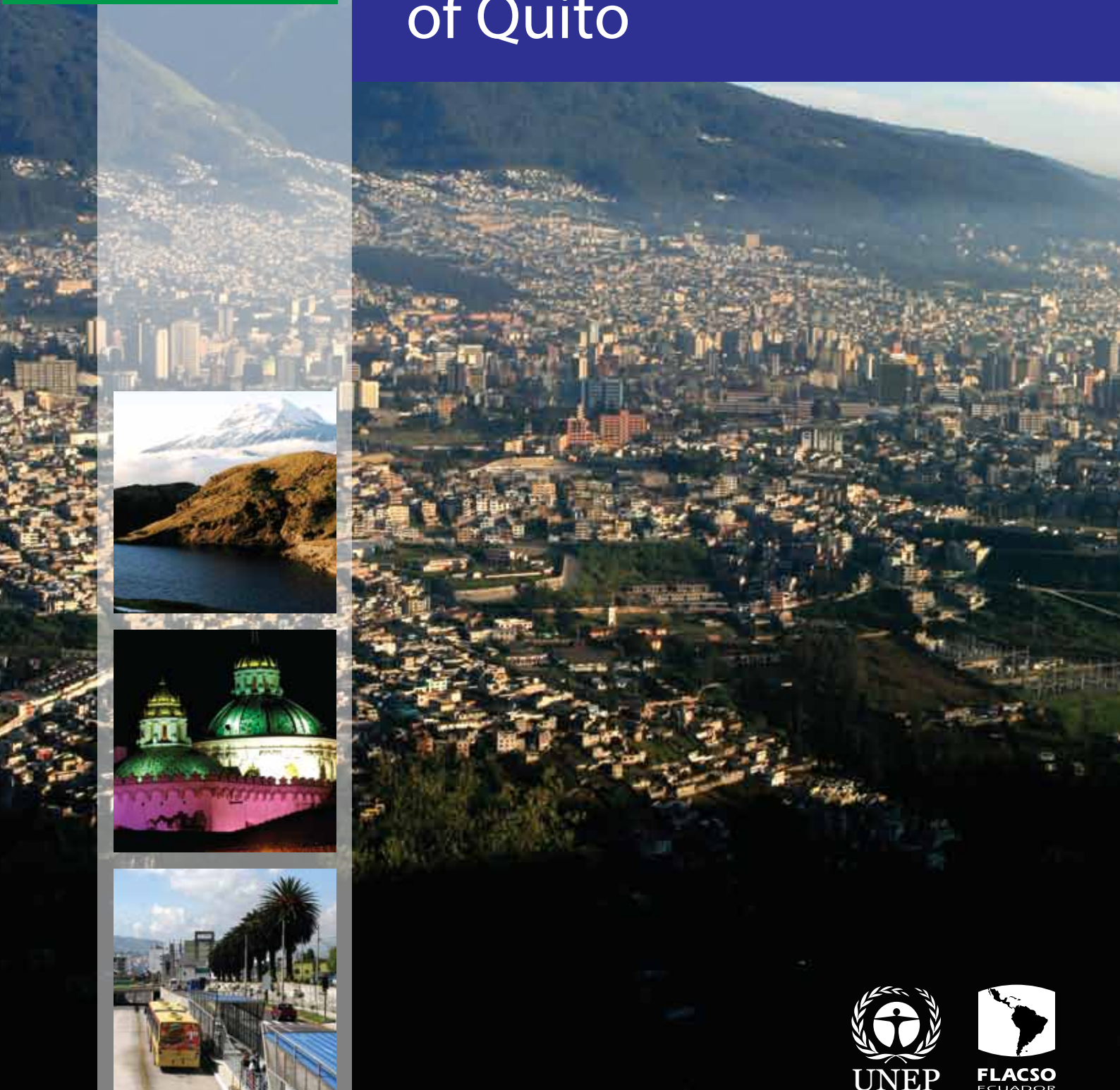


Environment
Climate Change
Outlook:

ECCO

Metropolitan District of Quito



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Quito Environment and Climate Change Outlook Summary

Background

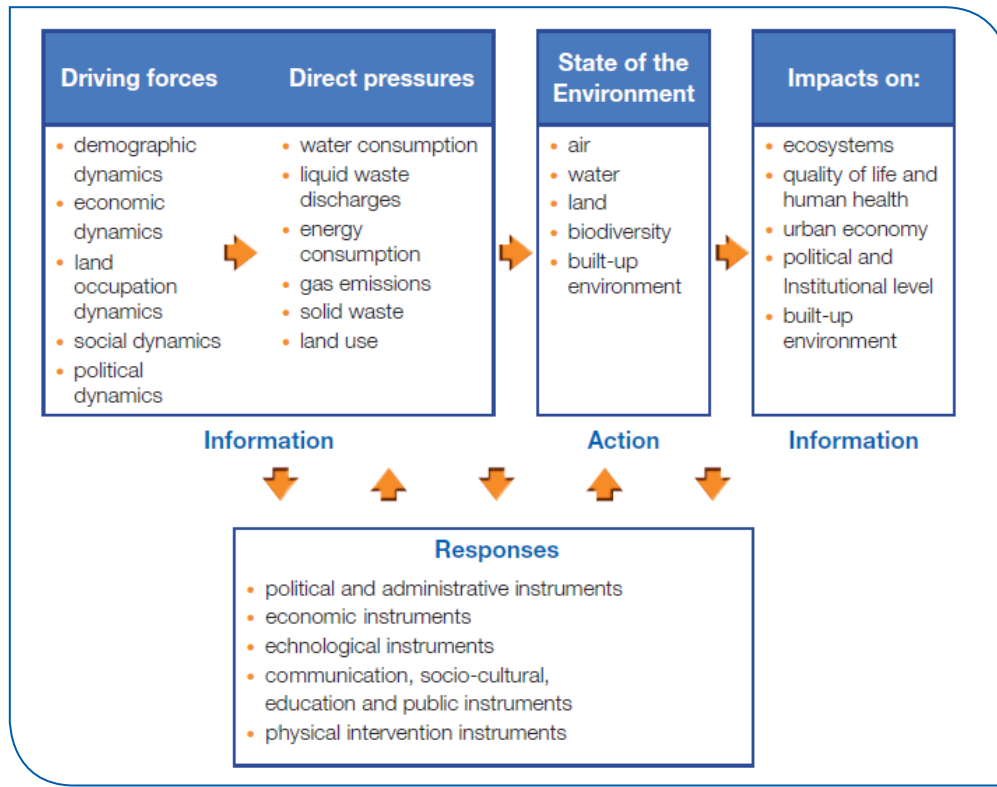
The Quito Environment and Climate Change Outlook (ECCO-Q) is a product of work carried out in collaboration between the United Nations Environmental Programme (UNEP), the Municipality of Quito, the *Fondo Ambiental* (the Environmental Fund) and the *Facultad Latino Americana de Ciencias Sociales* (Faculty of Social Science in Latin America (FLACSO)). The ECCO-Q is based on the methodology of the Global Environmental Outlook (GEO) reports that UNEP developed in 1995, which presents an analysis of the state of the environment. The GEO Cities Report is a training manual that outlines a methodology designed for urban centres to assess their vulnerability to environmental and socio-economic stressors including urban growth, globalization, trade, and consumption of resources, and to identify the implications of these pressures on their social and natural environments. Being an integrated environmental assessment (IEA), the GEO Cities analysis seeks to answer the following questions:

3

- What is happening to the environment?
- Why is it happening?
- What is the impact?
- What action is being taken on environmental policies?
- What will happen if we do not act now?
- What can we do to reverse the present situation?

The analytical framework employed to address these questions is known as the DPSIR Matrix - Driving forces-Pressure-State-Impact-Response, which is presented in Figure 1 (UNEP, 2009). The assessment incorporates the social, economic, political and territorial factors that shape the urban environment.

Figure 1. DPSIR Framework used in GEO-Cities Assessments

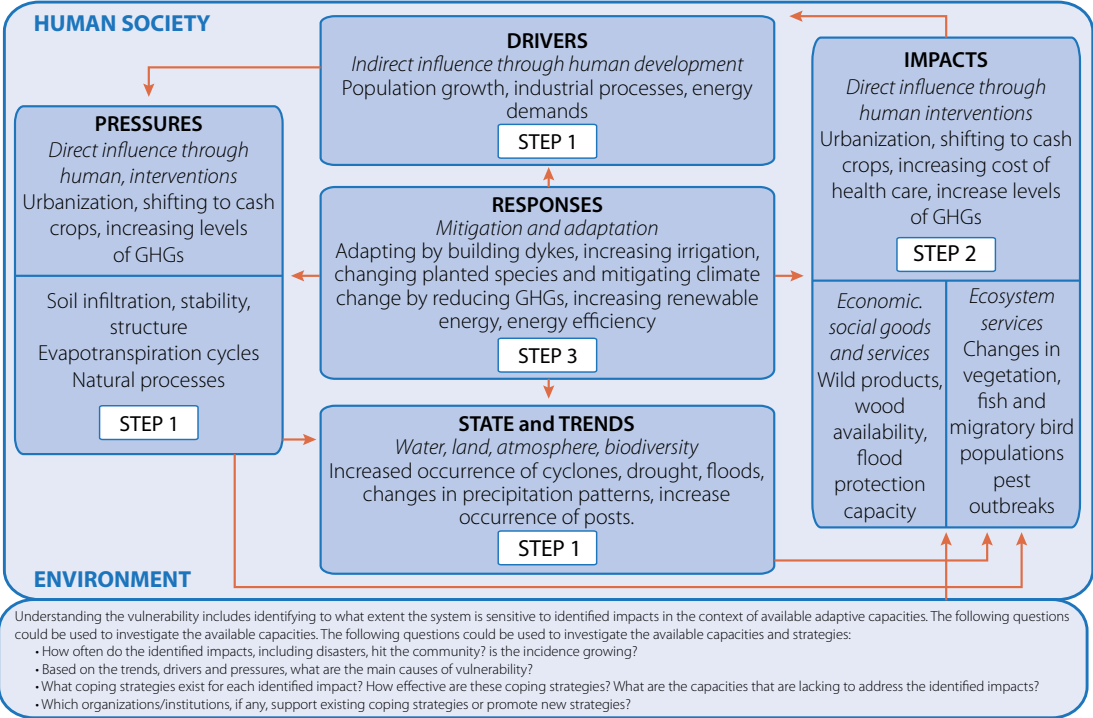


Source: UNEP, 2009.

Recently, UNEP has developed a new component to the methodology, which is designed specifically for cities to evaluate their vulnerability to climate change. Quito is the first city to undertake the assessment with the new module, titled, “Climate Change Vulnerability and Impact Assessment in Cities”. It follows the same procedure and maintains the DPSIR matrix (see Figure 2), beginning first with an assessment of the state of the city’s environment, focusing on issues that are most relevant to climate change – including air, water, biodiversity and land resources and in particular placing importance on the city’s exposure to disasters and natural hazards. Once the factors that explain the present state of the local environment are identified the analysis progresses to examining the local area’s vulnerability to the impacts of climate change. In this part of the evaluation the questions to be answered include: (UNEP, 2010):

- What is the state of the city’s environment, with emphasis on aspects relating to climate change vulnerabilities?
- How will climate change exert pressure on the city’s environment, and what are other drivers and pressures of environmental change with which climate change is likely to interact?
- What are the likely socio-economic impacts of climate change on cities?
- What adaptation responses can address the possible impacts of climate change while helping build the resilience of cities?

Figure 2. Climate Change in the DPSIR Framework



Source: UNEP, 2010.

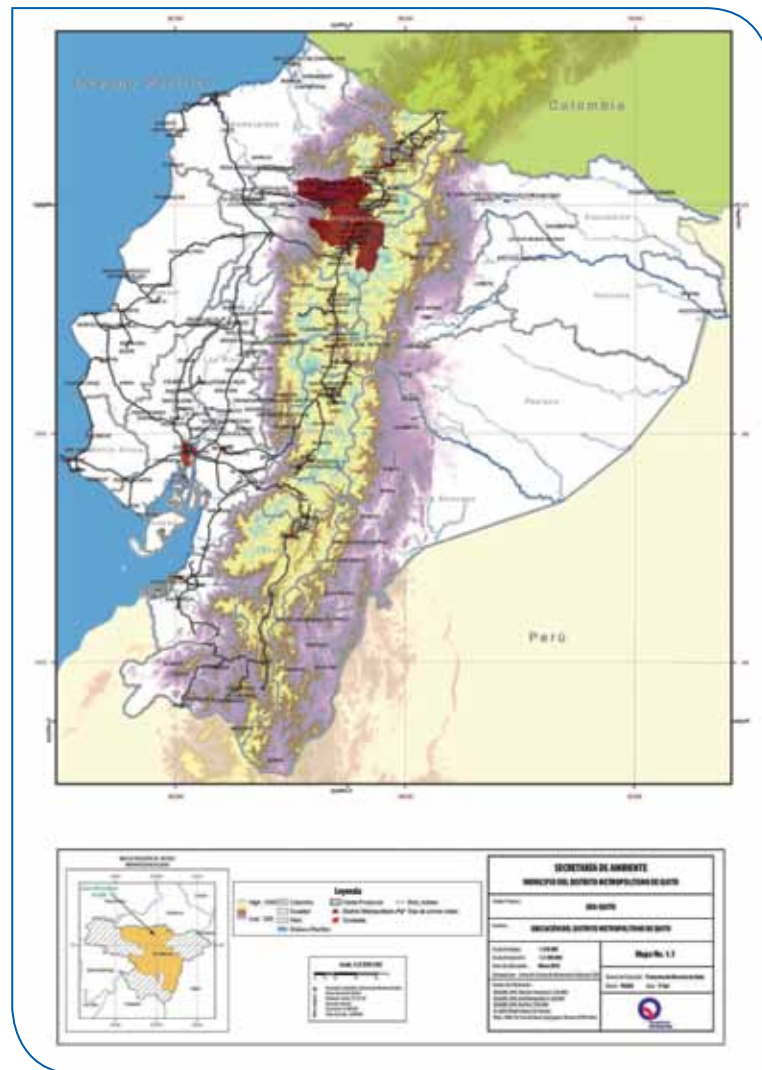
The ECCO-Q analyzes the environmental situation in the city, in the context of multiple pressures and in light of climate change. For Quito, this type of analysis was the first of its kind to compile and integrate all the available environmental and socio-economic information into one cohesive report. The experience in producing the report provided the opportunity to strengthen knowledge and dialog in the city between the academic and scientific community, the public and private sectors and local government.

FLACSO was the institution responsible for the ECCO-Q project, which had the technical support from the secretary of environment and the economic support from the municipality’s environmental fund. It is important to stress the collaborative and participatory nature of the work undertaken, through the participation of various institutions and specialists in the city. The report is a product of a participative process that was initiated with a workshop that was attended by public and private institutions, which resulted in the establishment of a technical team that collected data and information for the different components in the DPSIR framework. Other more specialized workshops were held with experts in each subsector, and a final presentation of the results was presented to all the stakeholders who had participated in the project. The aim of the final workshop was to validate the conclusions and form recommendations. It is anticipated that the evaluation and recommendations may facilitate Quito’s development objectives, which are to confront the city’s environmental and social problems in order to become “la ciudad del buen vivir” (the city of good living).

Chapter 1: Physical and Geographical Characteristics

The metropolitan district of Quito is located in the Pichincha province, and is the capital of Ecuador (Figure 3). The city occupies an area of 423,000 ha and is situated between 500 and 4,790 metres above sea-level, making it the second highest administrative capital in the world. The city is geographically located in the mountain range of the Andes surrounded by several active volcanoes such as the Pichincha, and the Guayllabamba and Esmeraldas rivers.

Figure 3. Location of Quito in Ecuador



Source: Dirección Metropolitana de Planificación Territorial, 2006.

Because of the city's altitudinal range up to 15 climate classes can be found ranging from tropical wet in the lowlands to cold and dry conditions in the highlands, which has also bestowed the city with a wide range of vegetative ecosystems: tropical forest, dry forests, shrubs, and the Paramos¹. The central part of the city can be classified as having a temperate-humid climate with an average temperature of 14.78 °C. The average precipitation in 2007 was 1,053 mm however this varies depending on the area of the city, with the north being much dryer, registering 700 mm that same year (CORPAIRE, 2009). The climatic pattern known as El Niño also impacts the city periodically, which can result in intense rains and floods.

The city's geographical location makes its population and infrastructure vulnerable to natural disasters such as earthquakes, landslides, floods, and volcanic eruptions, which has been exacerbated through rapid urban development especially on steep slopes.



¹ A neotropical ecosystem found in the upper Andean region formed by glacier valleys and consisting of lakes, peat bogs and grasslands.

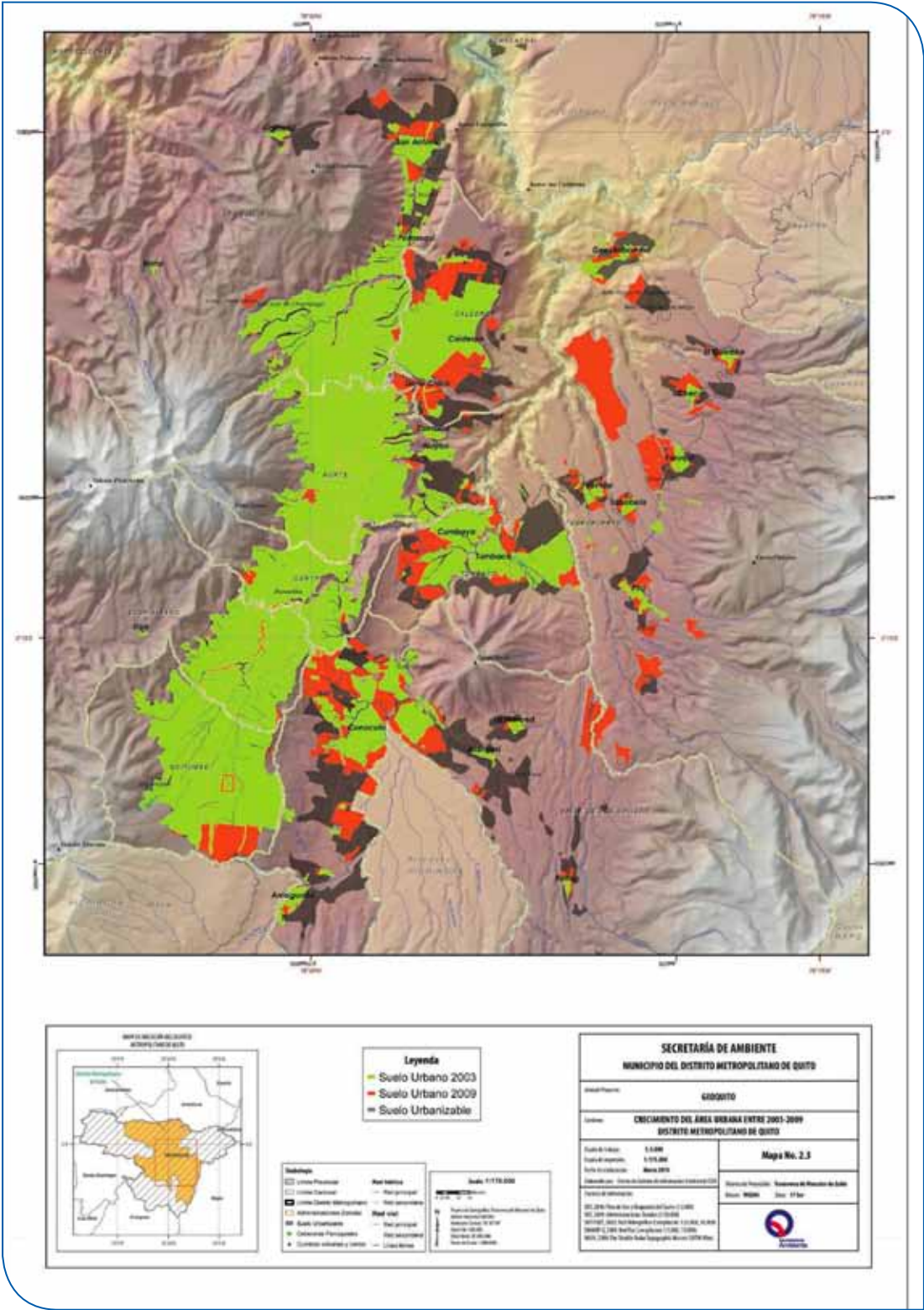
Chapter 2: Socio-Economic Characteristics

The city is politically divided into nine administrative zones and two metropolitan delegations that are further divided into 65 subdivisions, 31 encompass the urban metropolitan area and the remainder are located in suburban zones.

Like many Latin American cities, Quito has experienced rapid and unplanned development. In 60 years the population has grown from 319,000 inhabitants to 2,231,705. Within the last 15 years the population density has increased from 61 to 91 inhabitants/ha (Figure 4). This rapid population growth has resulted in the construction and establishment of many informal settlements, often located in hazardous areas such as steep slopes and in flood zones.



Figure 4. Urban Growth in Quito 2003-2009



Notes: Green area indicates urban land in 2003 and in red color growing area in 2009
 Source: Dirección Metropolitana de Planificación Territorial, 2006.

The growth of the city has created three distinct zones: the “compact” urban centre, the “dispersed” suburbs and the “isolated” rural areas. These areas are distinguished not only by their physical appearances but also by the unequal distribution of health, education, cultural, administrative and recreational services as these tend to be centrally located. Because of the lack of services in the periphery residents must commute daily into the centre resulting in heavy traffic flows, congestion and air pollution. The problems associated with the unplanned and rapid urban growth are presented in Table 1.

Table 1. Problems Associate with unplanned Urban and Suburban Growth

Urban Centre	<ol style="list-style-type: none"> 1) High rate of land occupation as only 7.57% of the land is considered vacant 2) Population density has increased from 61 to 91 inhabitants/ha 3) Limited public spaces 4) A reduction in the population residing in the central part of the city has created negative impacts such as increased traffic and insecurity in the centre. 5) Excessive concentration of services and activities in the centre 6) High demand and increase in vehicular traffic generating air and water pollution 7) Limited accessibility of services between neighborhoods 8) Housing settlements in ecologically important areas on the periphery 9) Conflicts between industry and residents over space and services 10) Deterioration of the public perception of the city
Suburbs	<ol style="list-style-type: none"> 1) Discontinuity of the land due to the physical geographical characteristics resulting in a limited connection of roads and transportation services 2) High level of soil fragmentation 3) Lack of planning and design resulting in limited development of services and increased traffic to the city 4) Insufficient infrastructure for health, water, sewage, and collection of waste 5) Illegal occupation of lands

This high rate of urbanization has resulted in high levels of informal settlements, occupation in vulnerable areas and protected lands. Almost 70% of the population resides on land that is considered to be moderately risky, 15% in high-risk areas and 15% in higher risk areas.

It is precisely this rapid and unplanned urbanization that exposes and enhances the city’s vulnerabilities to natural disasters.

Demographics

The population in 2011 was 2.3 million and is projected to continue growing into the future. It is young with almost 50% under the age of 25 and 30% between the ages of 25 and 44. The ethnic background of the population is primarily mestizos (almost 84%), 7.5% white, 5.3% indigenous, 1.7% mixed, and 1.6% black.

Statistics show that almost 43.50% of households are below the poverty line. The poorest segment of the population is located in the periphery of the city. Inequality in the city is high with 20% of the poorest accounting for 5.62% of the income and the 20% of the richest accumulating more than 50% of the wealth.

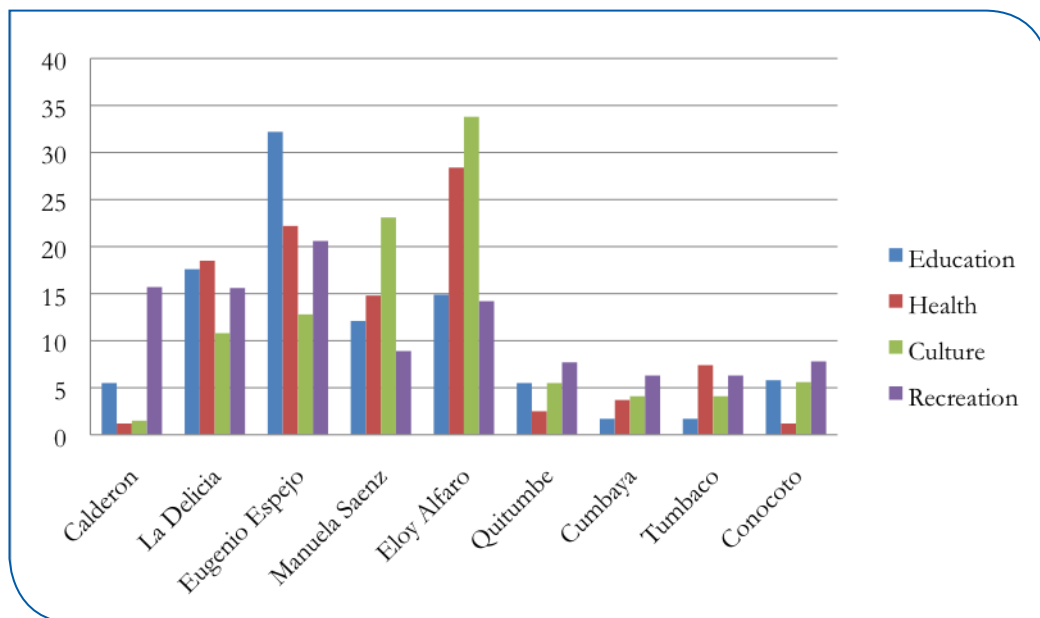
The primary health problems in the city are related to illnesses in the respiratory, digestive and nervous systems and circulatory diseases affecting particularly the poor segment of the population. Of those who report being ill, only 58% visit a health professional and those who do not explain that this is due to economic reasons (inability to miss work). A further barrier to accessing health services is that fact that 77% of the facilities are located in the urban centre.

Housing and Services

Poor planning and regulation over housing at the municipal level has created a situation where 53% of settlements are considered informal and 443 neighborhoods are illegal. These neighborhoods and settlements are often located on the outskirts of the city and tend to be vulnerable to flooding and landslide events. High housing prices in the city centre also act as a push factor as many residents cannot afford the rental costs.

The unequal distribution of services has serious social, economic and environmental impacts. Figure 5 presents each administrative zone and their services as a percentage of the total available in the city and as demonstrated, infrastructure investment and development has been concentrated the central part (north centre and south) with almost 77% of the health services located in this zone. As such, the population situated in the periphery (north and valley) must commute into the centre increasing traffic flows to 1.85 trips per inhabitant daily. These same areas are also the least connected to the public transit system and as a result private vehicle use is expected to double from 20% of trips made in 1998 to 40% in 2020.

Figure 5. Distribution of Services by Administrative Zones (%)



Notes: North: Calderon, La Delicia; North Centre: Eugenio Espejo, Manuela Saenz; South: Eloy Alfaro, Quitumbe; Valley: Cumbaya, Tumbaco, Conocoto. Source: Adapted from FLACSO ECCO-Q, 2011.

Some key social indicators are presented in Table 2.

Table 2. Quito Social Indicators

Literacy rate (2006)	Men 97.5% Women 95%
Population with a university education (2006)	27%
Mortality rate (2001)	4.1%
Birth rate (2001)	20.8%
Infant mortality (2001)	21.9%
Increase in housing prices (2010)	Pomasqui 161% Historical centre 136%

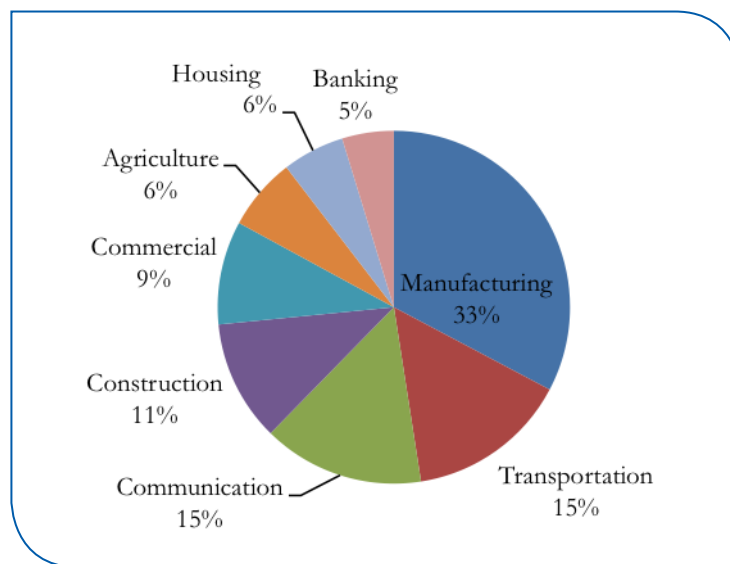
Source: Adapted from FLACSO ECCO-Q, 2011

Almost 99% of the population has access to potable water and 94% with sewage systems. Although the majority of the population has access to a sewage system most domestic water is disposed of in the local rivers, particularly the Machangara, Monjas, and San Pedro, without treatment.

Economy

Quito is the economic zone of Ecuador with 65% of the manufacturing facilities and 31% of registered firms of which employ 45% of the local population and generate 41.5 % of the income in the country. Figure 6 shows the breakdown of Quito`s economic sectors by importance of income generation.

Figure 6. Quito's Economic Sectors



Source: Adapted from FLACSO ECCO-Q, 2011.

In summary, the key socio-economic characteristics in the city are:

- Poverty affects a large proportion of the population
- Lack of services for the most vulnerable segments of the population
- High concentration of economic activity in informal sectors
- Lack of technical training
- Loss of local indigenous products and activities
- High debt among the poorest segments of the population

Consumption of Resources

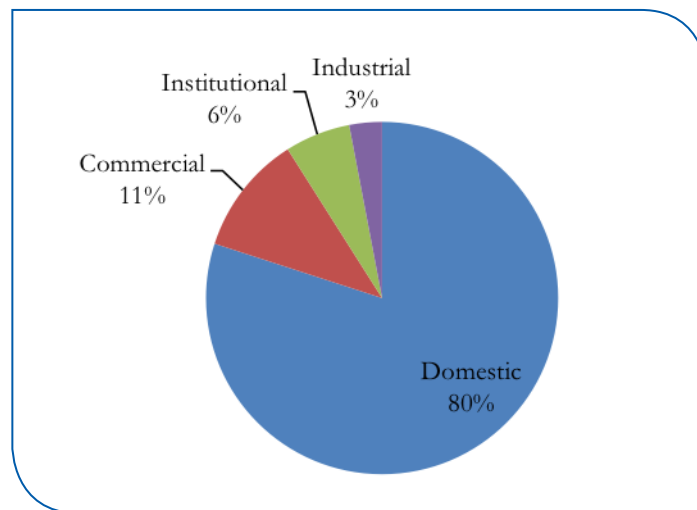
The city`s water is distributed through a system of 2,100 km of pipelines and 252 storage tanks that can hold 280,000 m³ of water. Residential access to water increased between 1990-2001 from 60% to 70%. However some neighborhoods in the city are much less connected, experiencing rates of 40% or lower, with one neighborhood, Gulea, reporting a value as low as 10%. In eight years the population with access to potable water increased by 30% to 98.6% of the inhabitants.

The number of people connected to the sewage system also increased by 43.7% between 2000 and 2008 due to the construction and extension of pipelines, which now covers 94.1% of the city.

Water consumption per inhabitant is estimated to be 160 litres per person per day. When water consumption is analyzed based on area a difference is observed between the city and the surrounding suburbs. In the city consumption is 155.8 m³ and for the surrounding suburbs it is 172.4 m³ mainly because of the high number of pools and gardens.

The demand for water is projected to grow from 9,000 l/s in 2010 to 14,999 l/s in 2040. Consequently, in order to meet the expected water requirements in the future an increase of 2,33 l/s annually will need to be achieved. The vast majority of water consumption is by the domestic sector as Figure 7 clearly indicates.

Figure 7. Water Consumption by Sector (2005-2009)



Source: EMAAP-Q 2009.

Consumption of Fuels

The most common fuels consumed in the city are gasoline extra, diesel, gasoline super, and liquefied petroleum gas (LPG). Although Ecuador produces a significant amount of petroleum, it is of very poor quality, and characterized by the low level of API density and its high sulfur content. In combination with the lack of modernization and technology used at the refineries the air contamination associated with its use is exacerbated.

The diesel premium that is produced is sold solely in Quito where the municipal government has permitted the local petroleum company EP Petroecuador to sell the

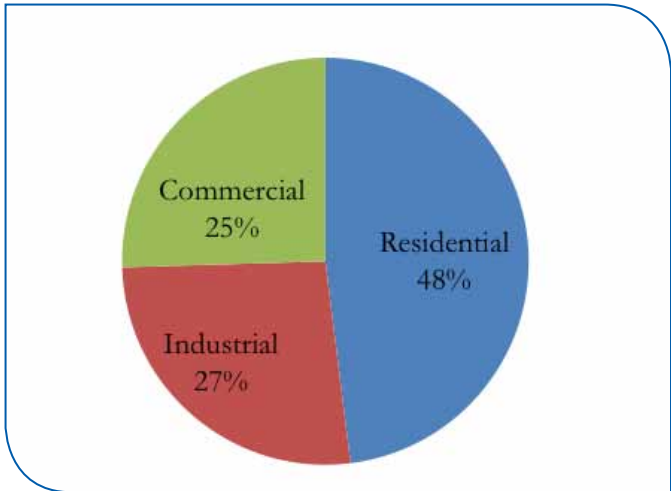
fuel with a sulfur content of 500 ppm. In comparison cities such as Bogota and Santiago have a sulfur content of 50 ppm (ARPEL, 2007 in Arango, 2009).

As for gasoline production, Ecuador`s sulfur content is 2000 ppm making it the highest in Latin America compared to Brazil's 1200 ppm, Mexico with 1000 and Chile's low 30 ppm (ARPEL, 2007 in Arango, 2009).

Consumption of Electricity

The *Empresa Electrica Quito* (EEQ) is responsible for the distribution of electricity in the city connecting 98% of the population. The total electricity consumption in 2009 was 3,066.4 GWh, of which the residential sector is the largest consumer, as demonstrated in Figure 8.

Figure 8. Electricity Consumption by Sector (2009)



Source: EEQ, 2010.

Most of the electricity production is derived from hydro sources as the installed capacity of hydropower is 91,530 kWh while thermal production is 43,400 kWh (EEQ, 2010).

Atmospheric Emissions

Three sources of atmospheric emissions have been identified in Quito: mobile sources (mostly vehicles), stationary (landfills) and area (includes emissions from small producers or activities that are too numerous to be considered stationary such as the use of industrial solvents).

Mobile Sources Emissions

Of the three sources of atmospheric emissions mobile sources are the most polluting accounting for 97.8% of CO, 75.8% of N₂O, 67.4% of CO₂, 53% NO_x and 46% of PM_{2.5}. The increase in private vehicle ownership has grown by 28.5% passing 145 vehicles per 1000 people in 2002 to 187 in 2008 directly contributing to the high levels of atmospheric emissions. An estimated 30,000 new vehicles are incorporated into the city yearly bringing the total amount of vehicles circulating Quito to 415,000 in 2009. The majority of these vehicles (92%) operate on gasoline and only 8% consume diesel fuel. The public buses operate on technology that is equivalent to Euro II, which have strict emission standards resulting in very low levels of air pollution.

Stationary Source Emissions

Emissions from stationary sources consists of 94.1% methane, most of which are derived from the Zambiza landfill, followed by 85.4% sulfur dioxide, of which 42.8% are an outcome of the thermal generation plants.

Area Source Emissions²

The majority of ammonia emissions (79.5%) are derived from numerous and small activity sources such as the use of solvents, domestic fertilizer application and petroleum stations. Also considerable is that 52.8% of PM₁₀ are derived from sources such as unpaved roads, quarry sites, and soil erosion. In this category, volatile organic compounds (VOCs) account for 43%, which are derived from commercial and domestic use of solvents, the processing and generation of energy and petroleum stations and the use of pesticides and chemical fertilizers in the flower cultivation industry.

Wastewater Discharge

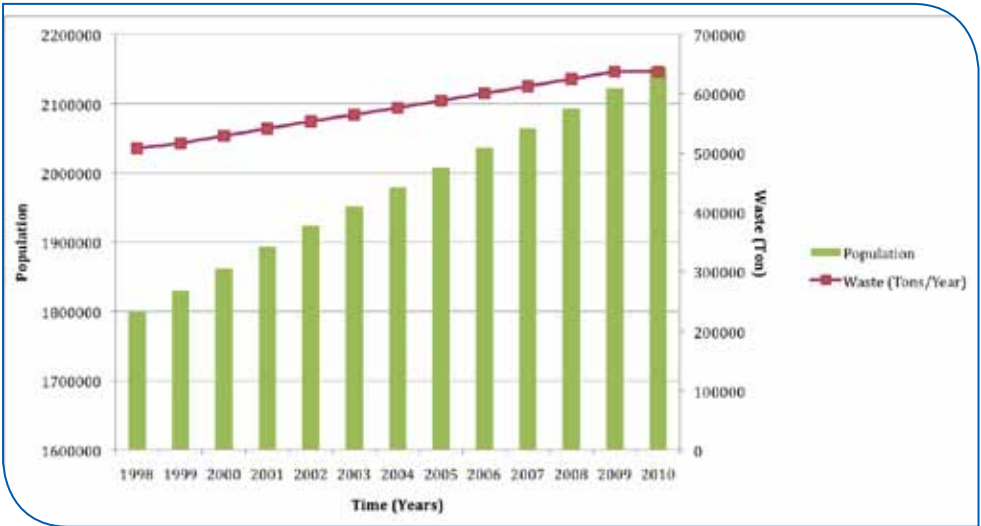
Most of Quito's wastewater is discharged directly into the sewage system and rivers without any treatment. In fact, only the industries that are required by the Municipal Law and city by-law 213 (*Ley de Regimen Municipal y la Ordenanza 213*) treat their wastewater and the few companies that do so voluntarily. As a result, the rivers located in proximity of the city are suffering from high levels of pollution, especially the Machángara river that receives almost 75% of the city's wastewater, garbage and debris.

² Area source emissions are those air pollutants emitted from many individually small activities such as gasoline service stations, small paint shops, and consumer use of solvents. Area sources also include open burning associated with agriculture, forest management, and land clearing activities.

Solid Waste Generation

Solid waste generation in the city is directly correlated with the population growth that has occurred in the short period of time as shown in Figure 9.

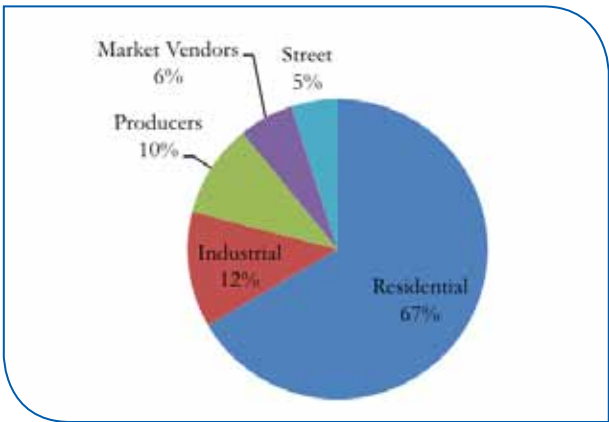
Figure 9. Population Growth and Waste Generation (1998-2010)



Source: EMASEO, 2009.

The majority of the waste produced in the city is from the residential sector, as presented in Figure 10.

Figure 10. Waste Generation by Source (2009)

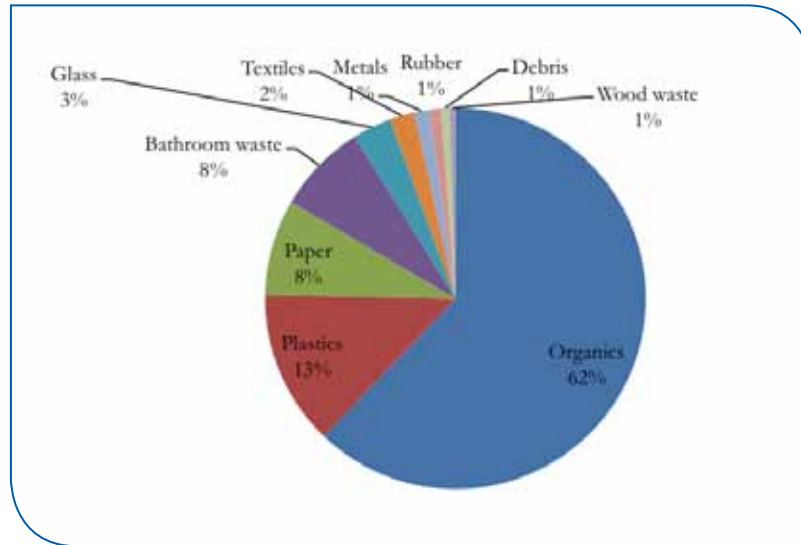


Source: EMASEO, 2009.

The composition of Quito’s waste is presented in Figure 11. The fact that 70% of the waste is composed of biogenetic materials (organics and paper) is the primary reason

for the high level of methane emissions from the local landfill, which contributes significantly to the city’s greenhouse gas emissions inventory.

Figure 11. Quito’s Waste Composition (2010)



Source: EMASEO, 2010.

Although the industrial sector generates less waste than the residential sector, the waste they do produce has serious environmental implications. For instance in 2006, 7,265 tonne of hazardous waste was produced, mostly from ornamental producers and metal plating and textile industries.

Waste collection serves 91% of the population. For more than 21 years the final disposition of waste was at the Zambiza landfill, which lacks modern technology and management practices resulting in significant environmental impacts such as soil contamination and air and water pollution. In 2002 the landfill was closed and a new one was established 40 km outside of the city: *El Inga*. The landfill was constructed so that the waste is deposited into cells that are lined with a waterproof membrane and covered with dirt to avoid adverse environmental impacts.

Biodiversity

The most significant factors effecting Quito’s biodiversity is population growth and urban expansion. The expansion of the city has resulted in a high rate of land conversion mostly due to agricultural activities as 78.7% of the land is used for this purpose. Related to the high level of agricultural production is the number of fires and burnt areas. Farmers use fire to clear the land and to facilitate the planting of crops and in exceptionally dry seasons fires can burn out of control effecting surrounding forested areas.

Deforestation

Ecuador's forest area is 9,865,000 ha or almost 36% of the country's land surface. A recent FAO (2011) study estimates that the national annual rate of deforestation between 2000-2010 was 1.8% a slight increase from the previous decade, which was 1.5%. Currently the deforestation rate is only available on a national level and not a local scale.

Road Construction

Road construction has kept pace with the economic and urban growth of the city. A network of approximately 10,000 km of roads have been developed connecting the city to the pacific coast with some passing through the Amazon forest. Road construction has serious implications for biodiversity and ecosystems in the region as it facilitates the penetration of human activities into areas that were once inaccessible.

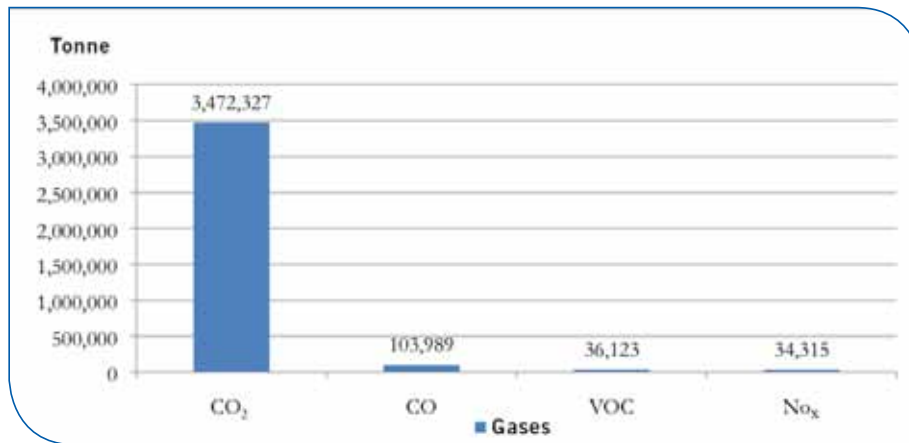


Chapter 3: State of the Environment

Air

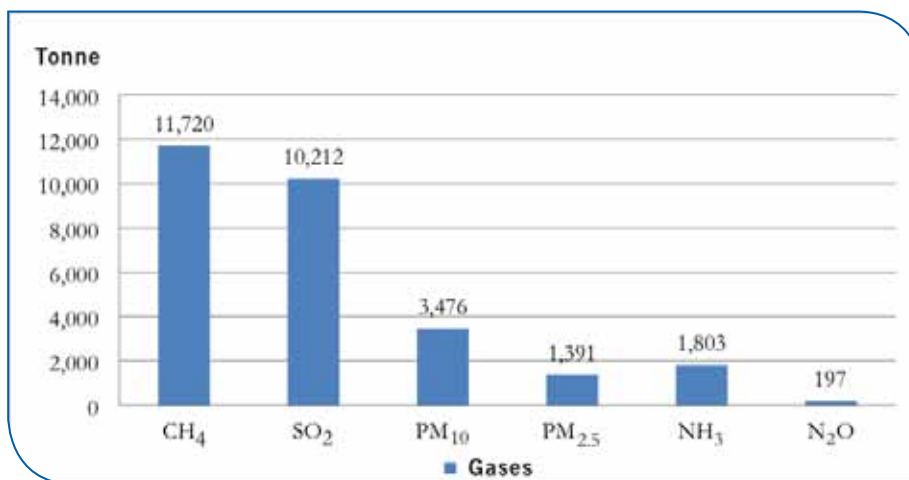
In 2007 CORPAIRE was the local organization responsible for monitoring air quality. Data from that year demonstrates that the gases with the highest concentration in the air are CO₂, CO, VOCs and NO_x as shown in Figure 12 and the least polluting, but still significant gases are presented in Figure 13.

Figure 12. Most Polluting Gases (2007)



Source: CORPAIRE, 2008.

Figure 13. Least Polluting Gases (2007)



Source: CORPAIRE, 2008.

Based on air monitoring data from 2004-2009 with the exception of PM_{2.5} all gases remained within the set national standards. However when the WHO standards are applied all gases with the exception of CO concentrations exceed the established limits indicating that the city may need to revise their standards. Table 3 compares the air standard quality indexes between the WHO and the national standards.

Table 3. Comparison between National Air Standards and WHO

Pollutant	National Standards (µg/m ³)	WHO 2005 (µg/m ³)
SO ₂ (annual)	80	50
PM _{2.5} (daily)	65	25
CO (8 h)-mg/m ³	10	10
O ₃ (8h)	120	100
NO ₂ (annual)	100	40

Source: Adapted from FLACSO ECCO-Q, 2011.

Water Sources

The growth in population and urban expansion has increased the demand on the local water resources. This has resulted in the need to build infrastructure in order to access sources located further away from the city, which has often been accompanied by additional environmental and social problems.

Subsurface sources of water are derived from precipitation, the paramos and the glaciers. The glacier melt is an important source of fresh water for the city and because of the city’s location 88% arrives thanks to gravity and only 12% needs to be pumped. The rivers surrounding Quito are also a key resource including the Papallacta, Guayllamba, Antisana and Pita rivers.

Subterranean sources include eight aquifers, which have an estimated reserve of 4,892 l/s (EMAAP-Q, 2010).

Quality

Between 2001 and 2005 the water quality of the three main rivers; Machángara, San Pedro, and Monjas was monitored and in each case it was determined to be very polluted. Although the water quality of the three rivers are classified as “very polluted” they differ slightly from one another. The Machángara was found to be in poor quality in all the points that were monitored; the Monjas showed very poor quality in 5 of the 8 points, and the San Pedro showed the best quality of the three registering medium in all points monitored.

The drinking water is treated by the EPMAPS and data from 2007 to 2009 show that the water leaving the plant for human consumption is of optimal quality.

Land Use

Quito's territory covers 423,071 ha and may be divided into three types of zones, the majority is characterized by "non-urbanized" space which covers 90% of the total area. This land includes areas for agriculture, protected sites, sustainable use of resources and residential space. The urbanized zone consists of 7.6% of the territory and "potential urbanization areas" covers 2.4%.

The majority of Quito's soil is fertile and apt for agriculture production. A notable exception is the eastern valley and the southern part of the city, which despite their fertile soils are being progressively encroached upon by urban expansion.

Although 90% of Quito's land is classified as non-urbanized the processes of soil degradation can be noted in almost all of the territory. In fact, approximately 66% of the soil is classified as having light to high levels of susceptibility to erosion and an estimated 30% of the land surface area is affected by anthropogenic activities.

Protected Areas

There are 23 protected areas covering 180,000 ha of land, of which 21 correspond to zones of "Forest and Vegetation Protection". These areas act as a barrier to limit urbanization and agricultural expansion. The remaining two protected sites (ie. the geo-botanical reserve of Pululahua and the ecological reserve of Cayambe-Coca) are reserves belonging to the National Patrimony of the State (*Patrimonio Nacional del Estado*). Despite these protected areas, deforestation and changes in land-use continue, especially in the northwestern part of the city.

Land Pollution

The two primary sources of land pollution are from waste generation and agricultural production. Pollution from waste affects approximately 20 ha of the land surface, which includes the old landfill sites in the city. When accounting for the pollution from the current landfill and that found in the canals, the total surface area affected by waste pollution is between 36-38 ha. The lack of citizen participation to dispose of waste appropriately is a key factor explaining the high levels of waste found in the streets, rivers, and open spaces.

Pollution related to agriculture production is derived from the application of fertilizers and pesticides; however presently there are no studies that quantify the actual amount of land that is impacted.

Biodiversity

Quito's extensive altitudinal range has bestowed it with a wide range of ecosystems from tropical forests to dry grasslands. The high level of biological diversity is

demonstrated by the: 2,230 plant species, 368 mammals, 540 bird species, 90 species of amphibians and 49 reptiles and 21 aquatic species. There also exists a high level of species endemism; approximately 254 vascular plants, 63 birds, 16 mammals and species endemic to the region of Quito.

Built Environment

The historical centre of Quito is fraught with problems related to its heritage space, housing, use of public spaces and the quality of the environment as described in Table 4. Although many of these problems may be associated with the lack of urban planning and increase in population, it is also important to note the city’s vulnerabilities to natural disasters that may cause significant damage to the buildings and infrastructure such as the large 1987 earthquake.

Table 4. Environmental and Social Problems in the Built Environment

Area	Problems
Heritage	<ul style="list-style-type: none"> -Deterioration of spaces and symbols that have diminished the character of Quito -Changes in the road design in the old part of the city that have caused ruptures in the overall urban fabric
Housing	<ul style="list-style-type: none"> -Physical deterioration of housing units -Deterioration of living conditions -Overcrowding of living areas -43% of housing is unoccupied due to its poor condition
Use of Public Space	<ul style="list-style-type: none"> -Concentration of activities in buildings that change uses regularly -High concentration of activities and services that threaten to collapse the physical structures -Lack of zoning for economic activities -Street market business that causes problems of accessibility and congestion
Environmental Quality	<ul style="list-style-type: none"> -High vehicle pollution -High visual pollution from the illegal use of signs and cables -Degradation of the landscape and surrounding parks -Degradation of urban space from vehicle parking -Deterioration of the urban image -Deterioration of basic sanitary conditions

Chapter 4: Impact on the State of the Environment

The state of the environment, pressures and impacts are summarized in Table 5.

Impact on Biodiversity

The reduction and fragmentation of ecosystems has had serious impacts on the biological communities living within them. It is estimated that 75% of Quito's land area has been encroached upon. Compared to other regions of the country, such as the Amazon, which has greater biological diversity, the number of species that are threatened to some degree (under the categorization of vulnerable to extinct) are much higher in Quito.

Impacts on Water Resources

The water from the main rivers: Machángara, Monejas, San Pedro and Guayllabamba is not suitable for human consumption, agriculture or recreational activities nor does it provide a healthy environment for aquatic species.

Impacts on Land Cover

Quito has an estimated 317,256 ha of vegetative cover, of which 106,693 ha have been exposed to human activities, mostly due to urban expansion.

Land cover is also impacted from agricultural practices. Recent growth in the , export trade in flowers and ornamental plants has caused land that was once for local food production to be converted to cultivate these cash crops, which also require intensive application of fertilizers and pesticides.

Table 5. Summary of the State of Environment

State of Environment	Pressure	Impact
Biodiversity	-Reduction in habitat -Habitat fragmentation	-10% bird species threatened (condor) -Extinction of the jambota frog and 40 more threatened -12 mammals threatened (spectacled bear, short-tailed Andean rat)
Water	-Domestic organic materials -Detergents -High concentration of oils and grease	-Unsuitable for consumption -Loss of recreational benefits -Visual pollution (visible film, color, odor)
Land	-Human activities mining, agriculture, fires	-Urban growth transforming the land -Occupation of area's with steep slopes making it difficult to access services -2,100 ha of land show signs of soil degradation

Impact on the Quality of Life and Human Health

Health Illnesses Related to Atmospheric Pollution

There are very few studies that have been carried out in the city evaluating the effects of air pollution on the local population. One study demonstrates that children attending schools in all areas of the city (central, periphery and rural) exhibit high levels of carboxyhemoglobin in their blood stream. However children in the central zone are more likely to suffer from respiratory illnesses than children living outside of the centre (Fundación Natura, 2000; 2001).

A second study in 2007 examined the health effects of particulate matter on the population living in three different neighborhoods. The study also included a neighborhood that has had little to no exposure to the pollutant to serve as a reference point. The results demonstrated that the population exposed to particulate matter had a higher prevalence of tuberculosis, fibrosis, silicosis and silicotuberculosis. The study postulates that poverty, difficult living conditions and the presence of particulate dust increase the likelihood of being susceptible to these infections and that living

in proximity to areas that have a high presence of particulate matter such as mining concessions greatly increases this vulnerability (DMMA-FA-IFA, 2007).

Water Related Illnesses

Consuming agricultural products that were irrigated with water contaminated with pesticides raises the risk of developing digestive illnesses.

Impacts on the Urban Economy

Pollution and environmental degradation can pose an economic burden on the city. In Quito, costs related to atmospheric pollution are mainly due to hospital and ambulance services and the loss of healthy working years among the population. Between 1991 and 2000 an estimated \$US 34,385,815 was spent due to air pollution.

Similarly, water pollution and its decontamination have resulted in significant economic costs. For instance, between January and June 2009, \$US10,650,659 was spent to treat 99,768,868 m³ of water. Additional economic losses are due to waste generation and its disposal and the need to revitalize the heritage spaces in the historical centre. The costs related to environmental clean up are presented in Table 6. Annually it is estimated that \$US 68,928,928 is spent to due to pollution.

Table 6. Cost Spent on Environmental Cleanup

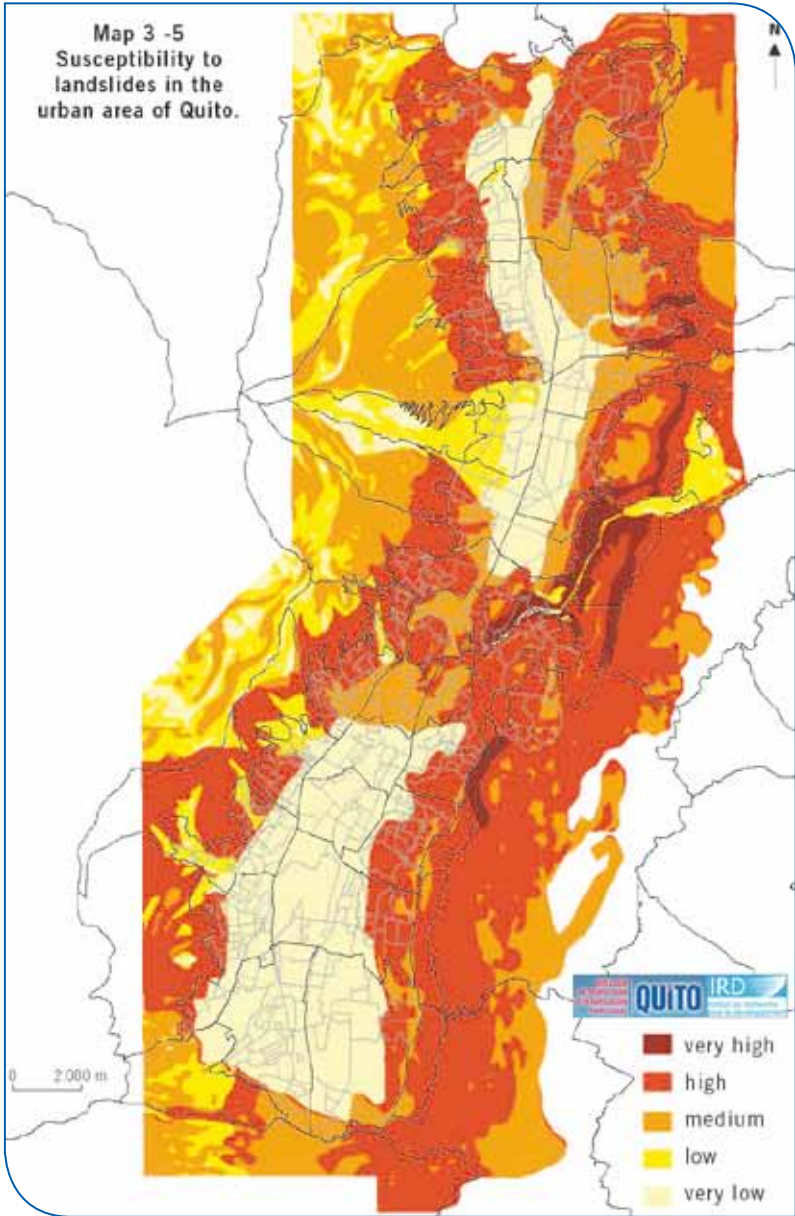
Urban Costs	Total Spent (\$US)	Time	Cost per year (\$US)
Atmospheric costs (1991-2000)	34,385,815	9 years	3,820,646
Water treatment (January-June 2009)	10,650,659	6 months	21,301,318
Waste treatment (1998-2009)	160,766,343	11 years	14,615,122
Cost of compensation for communities located near landfill (2009)	185,926	1 year	185,926
Heritage revitalization (2001-2008)	232,047,326	8 years	29,005,916
Total yearly cost			68,928,928

Source: Adapted from FLACSO ECCO-Q, 2011.

Vulnerabilities to Natural Disasters

Quito's physical geographical location exposes it to several natural risks including earthquakes and volcanic eruptions. In 460 years, 25 earthquakes measuring 4 or higher on the Richter scale have been registered in the city, two of which occurred in 1987 (6.9) and 1990 (4.9). Quito's natural vulnerability to earthquakes is exacerbated by the poor housing settlements in high-risk areas such as steep slopes. The city is also very susceptible to landslides as Figure 14 clearly demonstrates with the dark red areas being the most vulnerable.

Figure 14. Quito's Vulnerability to Landslides



Source http://www4.quito.gov.ec/spirales/9_mapas_tematicos/9_13_exposicion_del_dmaq/9_13_3_2.html

There are 12 active volcanoes located in proximity to the city. Volcanic eruptions and the resulting layer of ash may affect the provision of basic services especially potable water. Atmospheric ash may alter the local climate and have consequences for human health causing respiratory problems such as asthma and bronchitis. The most dangerous volcano in Ecuador, Cotopaxi, sits just outside of the city's boundaries exposing 18 neighborhoods and 3,855 people to the impacts of a possible eruption.



Chapter 5: Climate Change Vulnerability

Quito is the first city to carry out the GEO Cities assessment with the new climate change vulnerability module. This part of the evaluation follows the same DPSIR framework, using climate change as the main driver to assess the state of the environment and to identify key areas of vulnerability. The results are summarized in Table 7.

Table 7. Results from ECCO-Q Climate Change Module

Drivers	Climate related	Findings from the analysis
	<ul style="list-style-type: none"> - Global climate change - Rising local GHG emissions (traffic) - High methane emissions from waste - Loss of vegetation 	
Pressures	Climate related	Findings from the analysis
	<ul style="list-style-type: none"> - Rising temperatures 	<ul style="list-style-type: none"> - Observed rise in 1.4 C (climate - change/urban heat effect) - Melting glaciers
	<ul style="list-style-type: none"> -Changes in precipitation 	<ul style="list-style-type: none"> - More frequent precipitation in the rainy season (due to warming of surface) - Effects on drinking water supplies and energy production
	<ul style="list-style-type: none"> - Extreme events 	<ul style="list-style-type: none"> -Exposure to more frequent and intense rains and dry spells
Pressures	Non-climatic related	Findings from the analysis
	<ul style="list-style-type: none"> -Deforestation and unplanned land-use change 	<ul style="list-style-type: none"> - Changes in land-use due to urban expansion and agriculture
	<ul style="list-style-type: none"> -Education 	<ul style="list-style-type: none"> - Lack of environmental and climate change information and education

Impacts	Threats	Relation to other pressures
Water	<ul style="list-style-type: none"> - Reduction in drinking water supplies from glacier loss and rising temperatures -A possible 15% reduction in river flows may cause water conflicts -Threats to electricity production 	- Exacerbated by population growth and unplanned settlement
Agriculture	<ul style="list-style-type: none"> -Reduced production of crops i.e. rice, potatoes requiring an increase in importation -Loss of crops from pests and disease 	-Intensified by soil erosion from urbanization
Biodiversity	<ul style="list-style-type: none"> -Changes in species range -Spread of diseases 	-Exacerbated by the current loss of species from land-clearing
Health of population	<ul style="list-style-type: none"> - Increase of diseases from water borne vectors and threats of malaria expanding into higher elevations 	-Exacerbated by rapid and unplanned urbanization
Increased vulnerability to extreme events	<ul style="list-style-type: none"> -15 neighbourhoods identified as having a high susceptibility to impacts from climate change 	-Aggravated by current socio-economic conditions and informal settlements

Drivers

Scientific consensus points to rising anthropogenic greenhouse gas emissions (CO₂, CH₄, N₂O) as the key driver for climate change. Developing countries, such as Ecuador, are especially vulnerable to the effects of climate change due to their limited adaptive capacity and the fact that many of these countries already suffer from several environmental and social pressures.

Ecuador contributes 0.1% of the world's global GHG emissions (PNUD, 2009). CORPAIRE was the entity responsible for taking inventory of Quito's GHG emissions. In 2007, they measured CO₂ emissions at 3,472,327 t/year or 1.68 t/year/inhabitant, with almost 60% derived from vehicular traffic. Between 2003-2007 CO₂ emissions increased by 49%.

Methane emissions were measured at 11,720 t/year with 93% the result of waste decomposition in the landfill and N₂O emissions were 197 t/year mostly from the use of fertilizers and burning of combustible fuels.

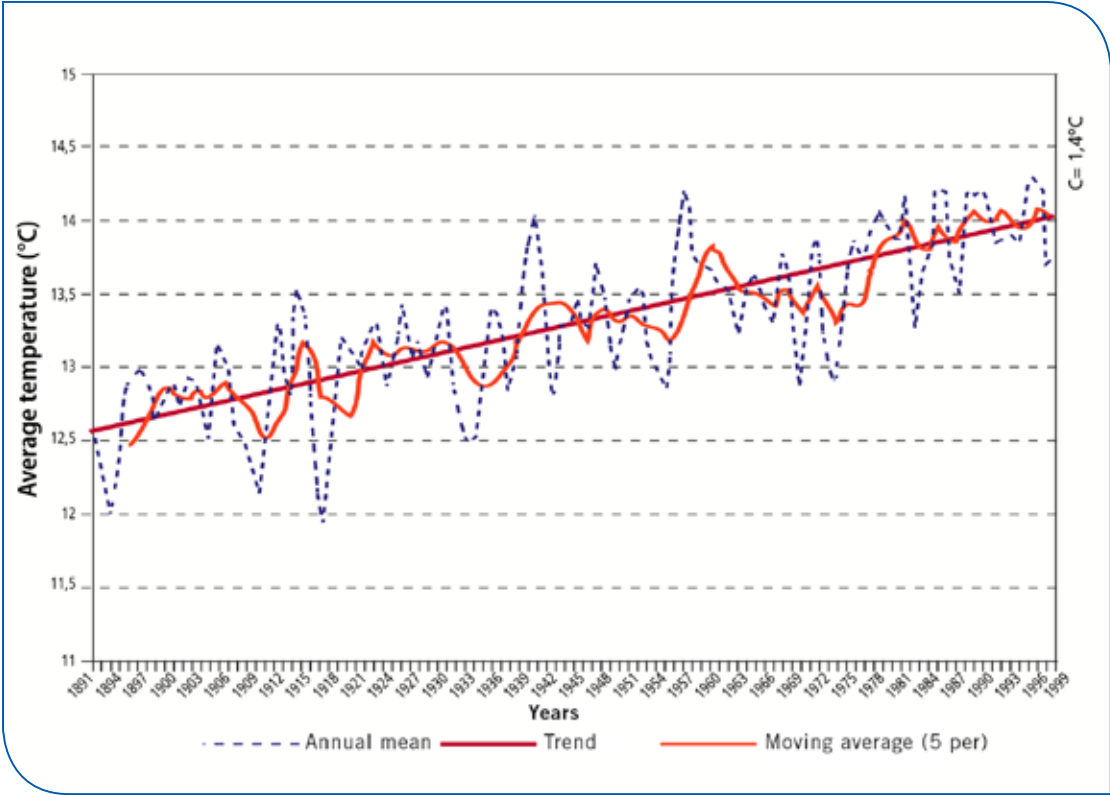
Additional drivers influencing Quito’s vulnerability to climate change are similar to the ones identified in the previous section: its geographical location, growing demand on resources, poverty and inequality among the population and a lack of environmental prioritization in decision making.

Pressures

Climatic Variability

The National Institute for Weather and Hydrology has observed that between 1891-1999 the average temperature rose by 1.4 degrees Celsius (Figure 15).

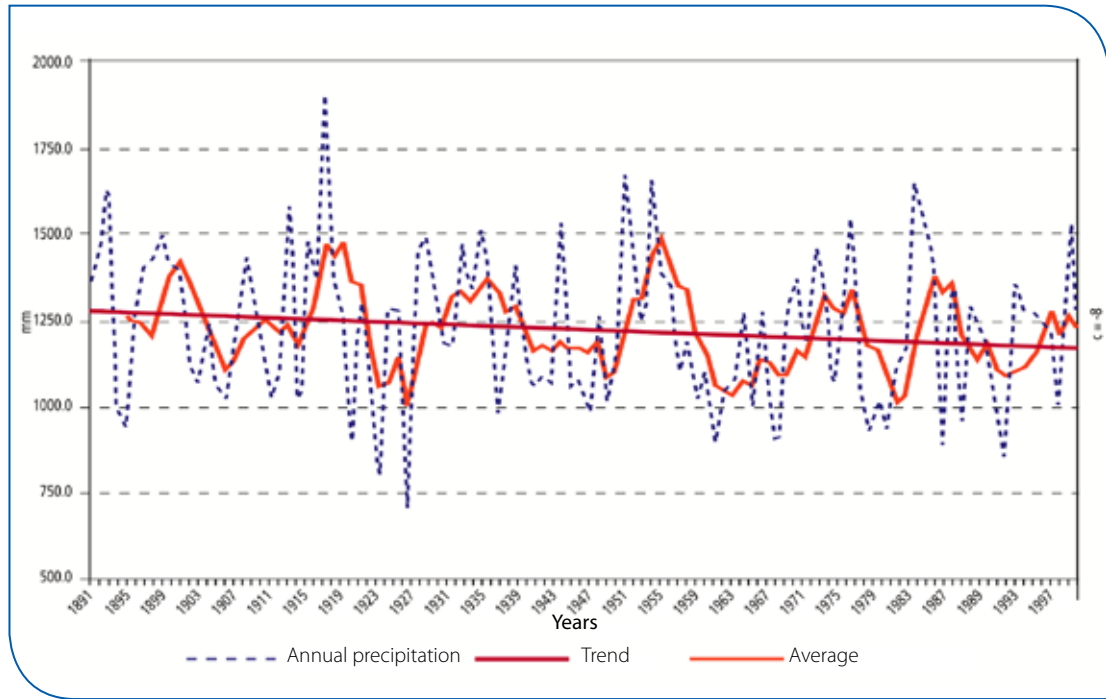
Figure 15. Changes in the Average Temperature between 1891-1999



Source: INAMHI, as cited in MDMQ, 2009.

A 100-year period analysis of precipitation in the city by the Quito Observatory registers a decrease by 8% in the average precipitation in more recent years (Figure 16). However, there is a large uncertainty associated with the predictions in the future changes in precipitation patterns, especially since 2006 and 2007 received much larger quantities than previous years.

Figure 16. Temporal Distribution of Precipitation (1891-1999)



Source: MDMQ, 2009.

Hydrometeorological

The city has access to several natural sources of water including surface, subterranean and heavy precipitation especially in the northern part of the city. However, the sources of water also increase the city’s vulnerability to flooding events, especially since 80% of the 85 canals have been filled or replaced with pipelines. Some recent figures include:

- 226 floods between 1900-1988
- 62 floods registered between 1999-2009
- 2007-2008 suffered the greatest number of severe hydrological events with the death of 7 people and high economic losses

Morphological Changes

Approximately 50% of the metropolitan area is susceptible to morphological changes in the earth, of which 6% of the city is classified as having extreme risk and the majority of the territory, 71% as moderate. The natural risks of the landscape such as its steep slopes and sharp peaks are aggravated by soil degradation and inappropriate land settlements from the local population.

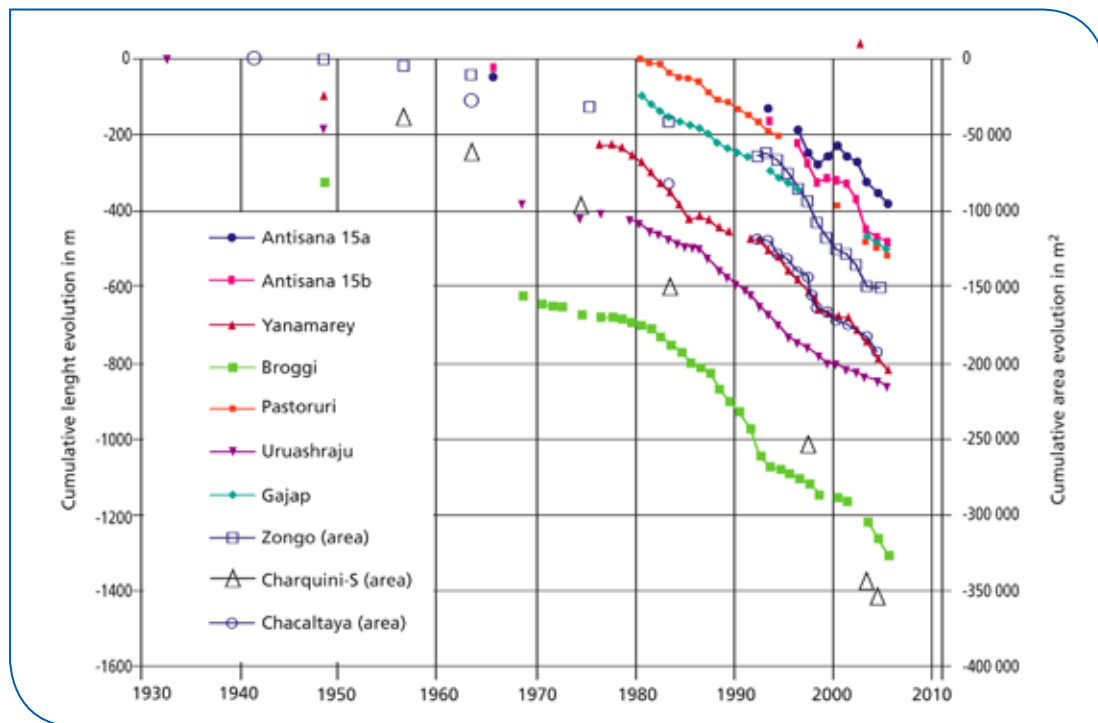
Forest Fires

Forest fires are mainly caused by the intense and prolonged summers, the traditional practice of burning waste and irresponsible and inadequate fire management from the residents. There was a marked increase in the number of fires during 2009 burning almost 1,060 ha of protected forest.

Retreat of the Glaciers

Aerial photos of Quito’s glaciers taken since 1956 show a rapid retreat of the ice caps, especially between 1995-1999. For instance, the *Antisana 15* has retreated by 36% of which 23% has occurred since 1993 (Figure 17). The rivers surrounding Quito are fed by the glacier melt with some such as the Humboldt and Crespo dependent on 24% of their water source from the Antisana 15. The reduction in glacier cover has implications for the replenishment of the aquifers.

Figure 17. Changes in Area and Ice Cover of the Antisana and Other Andean Glaciers (1930-2005)



Source: Vuille et al, 2008

Other Non-Climatic Pressures

Previous sections of this analysis identified other pressures that have implications for climate change such as deforestation and changes in land-use due to urban and

agricultural expansion. The lack of local experts knowledgeable in climate change may also be considered a non-climatic pressure.

Impacts

Water Resources

A reduction in water resources may be one of the most significant outcomes of climate change for the city. This may first be related to the increase in temperatures, which will cause rapid evaporation and a reduction in the glaciers, but will be further aggravated by other pressures such as the expanding population, deforestation and land degradation, high levels of poverty and low investments in water infrastructure. Reduction in water resources will also have implications for hydroelectric power, as currently 44% of the country's electricity is derived from this source. As a result, the costs from thermal production will rise and so to will the country's dependency on importing energy from outside sources, such as Colombia. Flooding from hydrologic events is likely to increase and in particular poses risk to 15 neighborhoods.

Agriculture Production

Changes in temperature, precipitation and increased incidences of pests and disease will have implications for agricultural production. This may manifest in the reduction of the production of some crops such as corn, wheat, barley and grapes. Many farmers in the Andean region will be forced to cultivate their crops at higher altitudes.

Impacts on Biodiversity

Climate change has been identified as a key factor leading to the reduction and extinction in amphibians due to the spread of the fungus, *Batrachochytrium dendrobatidis*. Also, a reduction in water resources and the expansion of species into new territories may likely cause many flora and fauna to be water stressed.

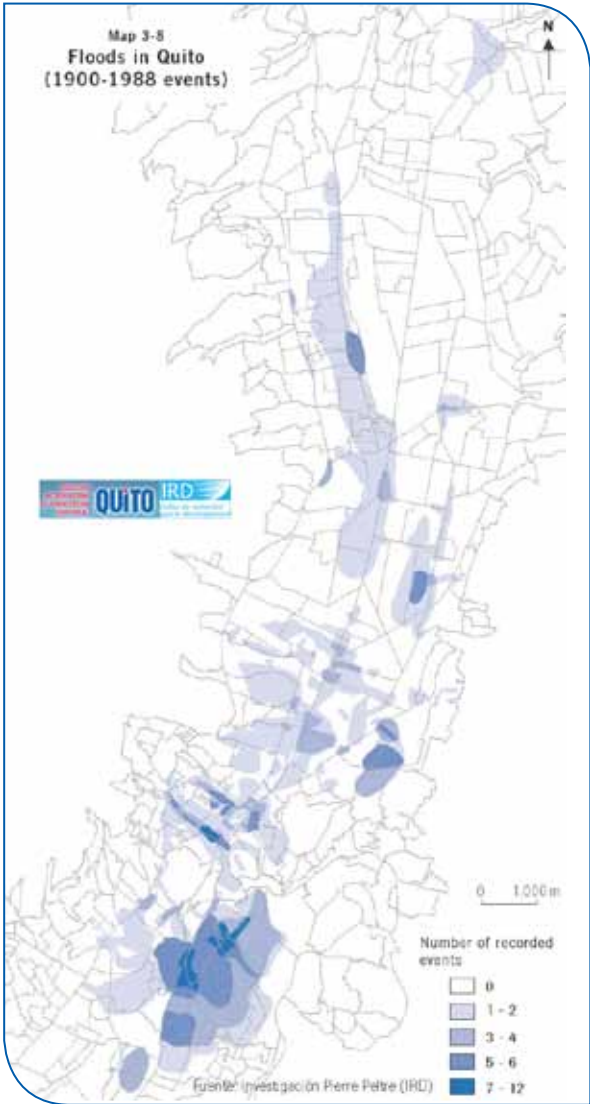
Impacts on the Health of the Population

Heavy precipitation and high temperatures will likely facilitate the transmission of water-borne diseases combined with frequent and intense heat waves may increase the incidences of deaths in the city, especially among the vulnerable segment of the population: the poor, elderly and infants. Cities at high altitudes, such as Quito, are expected to be exposed to a greater number of diseases from the spread of vectors such as malaria into higher elevations.

Vulnerabilities to Extreme Events

Climate change will likely result in an increase in frequency and intensity of extreme events, in particular flooding in particular flooding will threaten the quantity and quality of water resources and dry spells will enhance the risk of forest fires. The city's vulnerabilities to these extreme events will be exacerbated by the additional pressures from population growth, lack of urban planning and regulation, poverty and rural migration and low levels of investments in infrastructure. The most susceptible are the poor communities, especially those located in zones identified as high risk due to their locations on steep slopes, unstable land or low lying areas. Figure 18 displays past flooding events in Quito between 1900-1988. By identifying where past events occurred the city may be better able to prepare for the expected increase in inundation events.

Figure 18. Flood Events from 1900 -1988



Source:http://www4.quito.gov.ec/spirales/9_mapas_tematicos/9_13_exposicion_del_dmq/9_13_3_2.html

Chapter 6:

Responses: Policies and Tools for Managing the Urban-Environment

The purpose of this section is to highlight the actions and policies that have been developed and implemented in the city that focus on environmental management and reduce the impacts of some of the pressures identified in the ECCO-Q analysis. Although many of these policies were not necessarily developed with the aim of addressing climate change they often contain an aspect that may help the city mitigate or adapt to it.

Options for adaptation to environmental changes, and in particular to climate change may include technical (constructing a sea wall), behavioural (changes in transportation use), managerial (land-use practices) or political (zoning regulations) responses. Increasingly, using ecosystem services to adapt to climate change is also being promoted since it is often less costly to implement and provides superior environmental and social benefits than other response mechanisms. Ecosystem-based adaptation (EbA) considers the ecosystem services that people depend on and focuses on protecting, maintaining or rehabilitating them in order to adapt to climate change. Examples of EbA may include a number of activities such as restoring wetlands to mitigate from flood events or urban reforestation to reduce the impacts from heat waves (IUCN, 2009). Several of the city's local plans and programs encompass elements of EbA.

The following section presents the environmental policies in place and identifies the plans that address an aspect of climate change or EbA. The significance of this analysis is to demonstrate that in order to address climate change the city does not necessarily have to develop a wide range of new plans since many that are already in place may simply need to be strengthened or adjusted.

National and Local Responses

Tables 8 and 9 present national and local environmental policies, with a brief description of how they address the environmental priorities of Quito's metropolitan area.

Several of Ecuador's national policies such as the Constitution of the Republic of Ecuador, the Law of Forest and Conservation of Natural Areas, the Unified Book of the Legislation of the Secondary Environment contain components of climate change mitigation, adaptation and/or EbA. For instance, the Constitution outlines provisions to establish a system of protected areas, which may reduce deforestation in the country and therefore greenhouse gas emissions. Similarly, the Law of Forest and Conservation of Natural

Areas may include land management plans such as reforestation. Reforestation reduces greenhouse gas emissions and is an example of EbA as it can be used to regulate water services and reduce soil degradation. Finally, the Unified Book of the Legislation of the Secondary Environment provides provisions to control emissions from fuel sources (mitigation) and land management practices (mitigation, EbA).

Table 8. National Laws that Address Environmental Management

<p>The Constitution of the Republic of Ecuador (La Constitucion de la Republica del Ecuador, 2008) (*, **, ***)</p>	<ul style="list-style-type: none"> -Right to live in a healthy environment -Right to have access to safe drinking water -Right for nature to exist -Precautionary principle -Establishment of a system of protected areas -Land areas effected by desertification the state will implement reforestation projects -The responsibility of the state to protect citizens and nature from climate change
<p>Law of Environmental Management (Ley de Gestion Ambiental)</p>	<ul style="list-style-type: none"> -Requires environmental impact assessments for all projects
<p>Law of Forest and Conservation of Natural Areas (Ley Forestal y Conservacion de Areas Naturales y Vida Silvestre) (*, **, ***)</p>	<ul style="list-style-type: none"> -Ministry of Environment plans, manages and controls forested areas that are part of the patrimony of the state
<p>Law of Decentralization and Social Participation (Ley de Descentralizacion y Participacion Social)</p>	<ul style="list-style-type: none"> -Introduces elements that permit local management of protected areas and use of natural resources and allows the participation in decision-making
<p>The Unified Book of the Legislation of the Secondary Environment (El Texto Unificado de Legislacion Ambiental Secundaria (TULASMA)) (*, **)</p>	<ul style="list-style-type: none"> -A legal compilation of books that describe the authority over the environment, its management, forest regimen, and policies and tools for environmental management -One book describes laws to prevent pollution and contamination such as the management of hazardous waste and control of emissions from stationary combustion sources

Note: contains elements of climate change mitigation (*), adaptation (**), and/or EbA (***)

Quito also has in place local laws and programs that address environmental management in the city with some incorporating a climate change mitigation, adaptation and/or EbA

component. In particular the Metropolitan Order No.213 is divided into eight sections with each part addressing an environmental element such as the management of waste, which could reduce methane emissions from the landfill. Also, the Plan of Land Use and Occupation No.031 has the potential to reduce or avoid GHG emissions as its main objective is to limit urban expansion.

Table 9. Local Laws and Programs Addressing Environmental Management

<p>The Metropolitan Order No.213 (<i>La Ordenanza Metropolitana No. 213</i>), sections: (*1,3,6,7,8; **7,8)</p>	<p>-This order incorporates principles relevant to participation, prevention and advocates the “polluter pays principle”. It is divided into 8 sections addressing a different element of the environment.</p> <ol style="list-style-type: none"> 1) Management of solid waste 2) Noise pollution 3) Vehicle pollution 4) Environmental impact assessments 5) System of environmental authority and environmental practice guidelines 6) Control of the quality of fuels used in vehicles and the regulation of their sale 7) Protection of the hydrologic sources that provide water to the city 8) Protection of nature and establishment of a system of protected areas in lands that are not developed
<p>Law of the Administration of the Metropolitan District (<i>Ley de Regimen del Distrito del Metropolitano</i>)</p>	<p>-Grants legal authority for the use and management of the land</p>
<p>(*) Plan of Land Use and Occupation No.031 (<i>Plan de Uso y Ocupacion del Suelo No. 031</i>)</p>	<p>-Manages the physical urban growth of the city and establishes regulations on the construction of new buildings</p>
<p>General Plan on the Territorial Development (<i>Plan General de Desarrollo Territorial (PGDT)</i>)</p>	<p>-Agreements with neighboring municipalities to improve infrastructure services and carry out projects in collaboration</p> <p>-Revitalize the historical centre</p> <p>-Limit urban expansion</p>

<p>Master Plan of Environmental Management (<i>Plan Maestro de Gestion Ambiental (PMGA)</i>), sections: (*,2,4,5;**1,3,4)</p>	<p>-Establishes principles and criteria on how the urban and rural environment should be managed and the conservation of land areas and biological diversity</p> <p>Developed management plans for</p> <ol style="list-style-type: none"> 1) Water Quality 2) Air Quality 3) Biodiversity 4) Land Resources 5) Urban Solid Waste 6) Hazardous Waste
<p>Quito's Plan 21st Century (<i>el Plan Quito siglo XXI</i>)</p>	<p>-Municipality's plan of the administration of Paco Moncayo 2000-04</p> <p>-Develop a new political ethic, social solidarity, encourage citizen participation, promotion of the economy and decentralization</p>
<p>Strategic Plan of the Equinox 21-Quito towards 2025 (<i>Plan Estrategico Equinoccio 21- Quito hacia el 2025</i>)</p>	<p>-The Second municipality plan of Paco Moncayo (2004-09)</p> <p>-Advance the process of decentralization, build a culture of citizen participation, promote competitive production and generate employment, implement a social justice system that is equal and universal and strengthen the territory as a resource and support sustainably and equality.</p> <p>-Established three new administrations: Economic Development, Social and Political Development and Territory Development</p>

Note: contains elements of climate change mitigation (*), adaptation (**), and/or EbA (***)

Key Stakeholders and their Role in Environmental Management

In every city a vast array of stakeholders can be identified for their direct or indirect role in environmental management including public sectors, private companies, non-government organizations (NGOs), community groups, academic and research institutions and professional associations. Quito's key stakeholders and their primary roles or influence in environmental management are presented in Tables 10 and 11.

Table 10. National Stakeholders and their Environmental Responsibilities

National Level	Responsibilities
National Secretary of Planning (SENPLADES)	Planning and organization of the territory
National Secretary of Water (SENAGUA)	Administration and management of water resources
Ministerial Level	
Ministry of Environment	National authority of environmental management, of protected areas and forests
Ministry of Health	Environmental health
Ministry of Agriculture, Livestock, and Fishing	Management of the land and soil resources
Ministry of Non-renewable Energy	Management of fossil fuels
Ministry of Electricity and Renewable Energy	Management of renewable resources
Ministry of Natural and Cultural Sites	Management of cultural and natural sites
Legislative Level	
National Assembly	Participation in environmental discussions related to biodiversity and natural resources
Other Levels	
Defense of the State (Defensoria del Pueblo)	Works to protect and enforce civil rights related to the environment
District Attorney's Office	Defends and protects the rights of the environment
General State Control (Controlaria General del Estado)	Audits the commitments to environmental laws on the part of public entities

Table 11 presents the stakeholders from the private sector and NGOs involved in environmental management. Following the passing of the 1993 law Regime for the District of Quito (*Regimen para el Distrito Metropolitano de Quito*) several private entities were established with the responsibility of managing public services such as waste and water resources.

Table 11. Private Companies and NGOs and their Environmental Responsibilities

Metropolitan Public Waste Management Company (EMASEO)	Collection and management of waste
Metropolitan Public Water Distribution and Treatment Company (EPMAPS)	Designing, planning, constructing and maintaining water services and infrastructure

Metropolitan Transportation and Infrastructure Company (EPMMP)	Management of public space and transportation
The Environmental Fund	Established as the technical-administrative entity responsible for managing resources to fund project proposals that aim at improving the environmental quality of the city
Private sector	A wide range of companies involved in environmental consulting, implementation of systems for protection and prevention of pollution and generating information and data
NGOs	Local and international NGOs promote projects related to biodiversity protection and sustainable use of resources
Academic and research institutions	Distribution of environmental policies, training and education of citizens in the environment, space for discussion of environmental problems and solutions
Professional associations	Several professional associations such as the Forest Engineers Association of Pichincha participate in development of environmental plans and policies

The public and private entities that are primarily responsible for implementing the city's Master Plan of Environmental Management are presented in Table 12.

Table 12. Stakeholders and their Role in Implementing the Quito's Master Plan of Environmental Management

Land management	Secretary of Environment
	Secretary of Territorial Environment and Housing
	Secretary of Security and Governance
	Metropolitan Water Distribution and Treatment Company (<i>Empresa Publica Metropolitana de Agua Potable y Saneamiento (EPMAPS)</i>)
Management of solid waste	Secretary of Environment
	Former Territorial Coordination
	Quito Life Corporation
	Metropolitan Public Waste Management Company (<i>Empresa Metropolitana de Aseo (EMASEO)</i>)

Management of industrial hazardous waste	Secretary of Environment
	EMASEO
Management of biodiversity	Secretary of Environment
Management of air quality	Secretary of Environment
	Municipal Corporation to Improve Air Quality in Quito (<i>Corporacion Municipal para Mejoramiento del Aire de Quito (CORPAIRE)</i>)
	Former Secretary of Territorial Development (<i>Antigua Secretaria de Desarrollo Territorial</i>)
Management of water quality	Secretary of Environment
	EPMAPS

Policies and Programs Addressing a Specific Environmental Element

This section identifies the policies that have been implemented in Quito that address a specific environmental component: air, water, land, biodiversity, waste, vulnerabilities to extreme events and climate change. Similar to the general national and local policies several of these plans may also contain a mitigation, adaptation, and/or EbA element. Also, some of these measures act as mechanisms to regulate other ecosystem services, especially water regulation.

Air Quality

Quito has a number of policies and programs in place that aim to improve air quality in the city and several of them also have implications for climate change such as reducing greenhouse gas emissions by investing in public transportation and promoting the use of bicycles as a mode of transportation. The air quality management plans are summarized in Table 13.

Table 13. Air Quality Environmental Policies

Master Plan of Transportation 2009-2025 (Plan Maestro de Movilidad 2009-2025) (*)	Aims to improve mobility in the city. Projects developed to improve public transportation and encourage bicycle use, which will facilitate the improvement of air quality
Economic responses and fiscal investments (*)	Between 2003 and 2008 \$US 12,982,010 were invested in equipment and activities to reduce atmospheric emissions, monitor air quality and develop public education campaigns

(*) Permanent bike paths in Quito	Between 2003 and 2008, 45 km of bike lanes have been introduced in the city
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Note: contains elements of climate change mitigation (*), adaptation (**), and/or EbA (***)

Water Quality

Table 14 presents the policies and programs that specifically address the management of water resources. Protecting and regulating water services is critical, especially under future climate change conditions. Several of the water resource plans contain components that may be considered EbA. For instance, protecting wetland sites under the Ramsar Convention may act as a flood regulation mechanism and provides additional ecosystem service benefits such as water purification. In 2006, the Ñucanchi-Turupamba Wetlands situated in the Quito area were established as a Ramsar site. These wetlands have important hydrological functions such as recharging the subterranean aquifers, and they also provide irrigation and electricity generation for 1,500,00 people. Another example is the “Program to Decontaminate the Rivers of Quito”, which has several structural measures in place to reduce pollution in the rivers but the project also includes an EbA component since the establishment of vegetative cover was also carried out to facilitate the decontamination of the rivers.

Table 14. Water Resource Policies

Ramsar Convention (**, ***)	-Ecuador is a signatory of Ramsar which protects mangrove and wetland sites, of which the Ñucanchi Turupamba falls within the borders of Quito and is a important water resource for the city
Program to Decontaminate the Rivers of Quito (**, ***)	-Technical studies to define and design a system to manage liquid waste that minimizes its impacts in the rivers. Part of this project was the restoration of the Machangara river which involved the establishment of 12,872 hectares of vegetative space, 4,070 metres of linear metal enclosures and 2,440 km of collectors and the Monjas river now has collectors on the western side of the river which captures 70% of the incoming wastewater
Project of the Eastern Rivers	-This is Quito’s largest project to address access to potable water. The project has constructed treatment facilities and service and distribution infrastructure, which encompasses 31 rivers

Establishment of the Assembly to Manage the Guayllamba watershed	-Program to manage the water resources of the watershed in a participatory manner and the development of technical tools to provide decision makers with the necessary information to formulate plans
FONAG (fund for the protection of water) (**, ***)	A fund established for the payment of water resources that help finance projects for conservation, rehabilitation, and maintaining natural water resources
Economic responses	-Implementation of a system of tariff fees based on the type of water usage and consumption -Donation of 25% of income taxes to water resources

Note: contains elements of climate change mitigation (), adaptation (**), and/or EbA (***)*

Land-Use

Table 15 presents the programs related to land-use activities. Land management practices have direct implications for climate change. It may be a driver through the emission of greenhouse gases, a mitigation measure through reforestation or an adaptation strategy by protecting urban green spaces in order to reduce the impacts of urban heat waves. Protecting and regulating land-use is also a clear example of using EbA to reduce vulnerabilities to climate change and other environmental pressures. For instance, enhancing or protecting tree cover has the multiple benefits of restoring degraded soils, regulating water services and protecting biodiversity.

Table 15. Land-Use Environmental Programs

Ecuador’s National Law Third Book on Forest of the TULASMA (Libro tercero del régimen forestal del TULASMA) (*, **, ***)	Development of a program that defines zones of forest usage including conservation
Local Law- Law of the Metropolitan District of Quito (Ley de Régimen del Distrito Metropolitano de Quito) (*, **, ***)	Regulates the use and occupation of land and controls the construction and building conditions

Note: contains elements of climate change mitigation (), adaptation (**), and/or EbA (***)*

Biodiversity

Table 16 presents the international and national policies that address biodiversity protection and management. These policies outline measures that may be taken to protect biodiversity, which often involve establishing conservation sites and/or restoring degraded areas, all of which encompass ecosystem-based adaptation.

Table 16. Biodiversity Management Policies

International policies (**, ***)	-Rio Declaration -Agenda 21
Regional policies (**, ***)	-Regional Strategy for Biodiversity of the Tropical Andean Countries -Andean Environmental Agenda
National policies (**, ***)	-Environmental Policy (1994) -Sustainable Development Strategy (2000) -National Biodiversity Strategy of Ecuador (2001-2010) -Strategy for Sustainable Forestry Development -National Forestry and Reforestation Plan -National Development Plan (2007-2010) -Environmental Agenda 2009-2019 -Policies and Strategic Plan of SNAP 2007-2016 -Policies and Strategies for High Andean Ecosystems 2008
Local policies (**, ***)	Strategy of the District of Quito's Natural Resources 2009-2015

Note: contains elements of climate change mitigation (*), adaptation (**), and/or EbA (***)

Management of Waste

Table 17 presents the plans that address waste management in the city.

Table 17. Waste Management Plans

Plans for waste management	-Urban Solid Waste Management Plan -Industrial Hazardous Waste Management Plan
Economic investments	-Establishment of waste disposal fee in the landfill (\$6.22/tonne) -Investments in infrastructure to manage waste and production of leachates

Built Environment

Table 18 describes the plans and programs in place that address the built environment. Plans under the built environment can have important implications for mitigating and adapting to climate change since limiting urban expansion could reduce pressure on

surrounding forests and reduce vehicular traffic. Also, some of the measures under the PGDT plan outline provisions to rehabilitate green spaces such as the Carolina Park, which serves as an example of “EbA”.

Table 18. Plan and Programs for the Built Environment

Programs that complement the Territorial Development Plan (PGDT) (*, **, ***)	<ul style="list-style-type: none"> -Redefining urban land classification -Redefining the Land Use and Occupation Plan which assigns land use and building requirements -Restructuring of the central urban area
Urban land management (**)	<ul style="list-style-type: none"> -Metropolitan Land Regime -Architecture and urbanization regulations -Territorial management and control -Regulation of construction -Regulation and legalization of neighborhoods -Creation of the “Regula tu barrio”-program to legalize the 439 illegal neighborhoods -New policy of environment and housing
Fiscal and economic responses	<ul style="list-style-type: none"> -Financing for the historical centre -Restoration of significant buildings and public spaces, construction of parking spaces, program of “Pon a punto tu casa” which offers incentives for the residential and commercial sectors to restore their buildings

Note: contains elements of climate change mitigation (), adaptation (**), and/or EbA (***)*

Risk and Vulnerability

The ECCO-Q analysis has identified that the city is vulnerable to events such as floods and landslides, which may likely be intensified under future climate conditions. As such, many of the plans presented in Table 19 may also serve as climate change adaptation strategies. For instance, establishing an entity responsible for risk management- the Metropolitan Emergency Operations Committee- is an important step in reducing impacts from extreme events and managing or adapting to climate change. Similarly, the city’s “Relocating Families in High Risk Areas” program, which moves families that are settled in vulnerable areas along the riverbanks is a project that may need to be replicated in the future in other zones as a greater number of areas are identified as being vulnerable to climate change. Examples of EbA can also be identified such as the city’s goal to plant one million trees in the urban centre, which may serve as an adaptation strategy to extreme temperatures and intense precipitation.

Table 19. Plans for Natural Risks and Vulnerability

National level	-2008 Constitution (*, **) -Creation of the Secretary for Risk Management and the adoption of the National System of Decentralization of Risk Management (**)
Local level	-Establishment of the Metropolitan Emergency Operations Committee (**) -Plan of Prevention- aims to reduce vulnerabilities of high risk zones to flooding and earthquakes (**) -Plan of Forest Fire Prevention (**) -Plan of Land use and Occupation (**, ***) -Process of legalizing the informal settlements -Program to minimize the vulnerability of the population settled along riverbanks (**) -Program of "Relocating Families in High Risk Areas"-identifies families living in high risk areas and relocates them providing financial assistance to facilitate the process (**) -Project of Forestation and Reforestation that aims to forest the city with one million trees (*, **, **) -The development of maps of areas at risk to volcanic eruptions
Academic and technological responses	-Project of "Prevention of Risks Associated with Volcanic Eruptions from Cotopaxi" -Project of identifying and determining areas of seismic activities and develop response mechanisms
Community participation in risk reduction	-Development and promotion of programs to encourage citizen participation in risk reduction -"Mi barrio seguro y solidario- Capítulo Gestión Barrial de Riesgos 2009"- Program that facilitate the exchange of information and experiences between neighborhoods to reduce risks to natural disasters (**)

Note: contains elements of climate change mitigation (*), adaptation (**), and/or EbA (***)

Climate Change

Ecosystem-based adaptation is increasingly being advocated and implemented as a mechanism to adapt to climate change. Projects established to-date have identified seven principles that are considered essential in order to effectively develop EbA, which Quito and other cities can learn from. These principles are as listed below (IUCN, 2009).

1. Reduce non-climatic stresses on the environment such as unsustainable harvesting practices or pollution

2. Involve local communities so that they feel a sense of ownership over the project
3. Establish a multi-partner strategy that involves the cooperation and funding from both the private and public sectors and includes the participation of specialists from a wide range of fields i.e. water resources, poverty alleviation
4. Build upon existing projects in natural resource management
5. Adopt adaptive management approaches since climate change presents significant uncertainties EbA measures may need to be adjusted to respond to changing and unexpected conditions
6. Integrate EbA with wider adaptation strategies such as early warning systems, public education and even infrastructure developments (such as Quito’s Program to Decontaminate the Rivers of Quito).
7. Communication and education on climate change and the benefits of EbA

Although climate change is a new issue for Quito, the city already has several policies in place; these are presented in Table 20. Several of these policies include some of the principles identified for effective implementation of EbA, which are highlighted in the table based on their number (1-7).

Table 20. Quito’s Policies for Climate Change

International conventions	<ul style="list-style-type: none"> -Ecuador has ratified the UNFCCC and the Kyoto Protocol -Ecuador has 25 projects registered under the CDM
Local government international response	<p>Quito is a member of Cities and Local Governments United and Local Governments for Sustainability which implement activities addressing climate change and maintain a common position on climate change</p> <ul style="list-style-type: none"> -In 2007 the city ratified the “World Municipal Agreement and Local Governments for the Protection of the Climate
Local government responses	<ul style="list-style-type: none"> -National Plan for Better Living- Reduce the use of thermal production for energy by investing in renewable sources such as geothermal or solar power (1,4). Incentives for research in technology for alternative housing construction in regards to climate and energy saving (1, 4). -The plan suggests the need to carry out an economic impact study of climate change, develop activities to raise awareness among the public (7), develop models to predict the effects of climate change, encourage the international community to meet their commitments to Kyoto

<p>Response from the Ministry of Environment of Ecuador</p>	<ul style="list-style-type: none"> -2010 publication of the Second National Communication of Ecuador to the UNFCCC -2010 launch of the system of RClmDex- a software of weather data from the last 30 years which will enable more precise modeling of future climate change in the country -2007 in collaboration with Bolivia and Peru developed the “Design and Implementation of Pilot Projects for Adaptation to Climate Change in the Andean Region (1, 3) -Study on “The Vulnerability of the Rivers and Adaptation Measures for the Consumption of Water, Hydro generation and the <i>Paramos</i> (1, 4)” -The development of a project known as “Social Forests” which aims to be compatible with REDD but more ambitious as its objectives are to reduce poverty in areas with the highest deforestation rates (1,3, 4) -Project of Adaptation to Climate Change for Governing Water (PACC). Project Aims to improve management of water resources in light of future climate change and to include all stakeholders in decision making (3,4) -Project of Adaptation to the Impacts of the Retreat in Glaciers. The objective of the project is to strengthen the capacity of the resiliency of the ecosystems and local economies to the impact of the retreating glacier through the implementation of adaptation activities (4)
<p>Local government response Quito</p>	<p>The Quito Climate Change Strategy</p>



Figure 19. The Quito Climate Change Strategy

The Key Components

Between 2007 and 2009 the Quito Climate Change Strategy was developed as the city's plan to mitigate and adapt to climate change. It aims to strengthen the institutional capacity of the city to address climate change and to reduce the current and future vulnerability to climate change. Some of the key areas of the document include sensitizing and educating the public on climate change, carrying out studies on the impacts of climate change on basic services, research on the prevention of extreme events and promoting conservation and restoration of the natural environment.

The plan has four main strategies to facilitate achieving the overall objective, which is to successfully integrate climate change mitigation and adaptation into all sectors of society. These are:

- 1) The Municipality of Quito as a whole has access to adequate information to mitigate vulnerability and achieve planned adaptation to climate change in the areas of intervention
- 2) Use of technologies and good environmental practices to reduce emissions, capture GHG, and improve adaptation to climate change
- 3) Communication, education and citizen participation regarding climate change
- 4) Strengthening the institutional capacity of the city to meet the objectives of climate change, led by the Municipality of Quito

The QCSS is the first of its kind in Ecuador and even among many developing countries. Challenges that now remain are its dissemination, institutionalization and implementation. Strong support from the staff at the municipality and strategic partners will be needed to see that the QCCS moves forward in its implementation.

Source: Estrategia Quiteña de Cambio Climático, (Municipality of the Metropolitan District of Quito, Secretariate of the Environment, 2009).

Additional Adaptation Strategies to Address a Changing Climate

Table 21 presents additional adaptation plans and strategies that the city has established or is in the process of implementing. These have been divided into technical, behavioural, managerial, political and EbA in order to demonstrate the wide range of options available to decisions makers to address climate change adaptation. Additionally it reinforces the argument that a combination of tools should be used to develop a strong adaptation plan rather than relying on one type of mechanism.

Table 21. Type of Adaptation Response Mechanism

Type of Response Mechanism	Response Strategy
Technical	-Reduce water losses in the distribution systems
Behavioural	-Campaigns on efficient water consumption -Quito’s Youth Against Climate Change -The Quito Panel on Climate Change -Research at the universities -Campaigns to save energy and water -A local manual on climate change -A network of local environmental groups the work on climate change
Type of Response Mechanism	Response Strategy
Managerial	-Development of a system of climate risks and early warnings -Integrated approach to water management
Political	-The action plan of QCCS -Incorporation of climate change in the territorial planning -Plan addressing adaptation to rain, fire and landslides events
EbA	-Reforestation project -Identify and use vegetation that are better suited for drier conditions

Citizen Participation in Environmental Management

The Metropolitan Order No 213 (*Ordenanza Metropolitana No. 213*) gives rights to individual citizens and organizations to participate in environmental management and decision-making in the city. The law establishes four mechanisms in which citizens may participate including:

- 1) Participation in the evaluation of environmental impact assessments
- 2) Management of hydrological resources
- 3) Presentation of proposals for urban protected areas, and in particular, in their co-management, access to information, sharing of benefits and community monitoring
- 4) Preparation of management plans for natural protected areas that contain a subprogram, which outlines the different levels and areas of citizen participation

In 2009, the Quito Environmental Observatory was established to act as an area where citizens can democratically participate in environmental decision-making and develop proposals for local environmental management.

Communication and Environmental Education

Since 2003 Quito has implemented several programs and projects aimed at enhancing environmental awareness among the general public including:

- The Environmental Education Program
- The “*ciclopaseo*” whereby every Sunday 30 km of roads are closed off to vehicular traffic to be used freely by pedestrians and cyclists
- The campaign of “Quito without my car”
- The establishment of the “pedestrian only” area in the centre of the Magdalena neighborhood
- The “Agreement of Mobility in the District of Quito” a commitment from organizations to discuss and evaluate concrete measures to improve mobility in the city
- Campaign against noise pollution
- System of information on the Guayllamba River
- FONAG’s education and training programs
- Establishment of the Yaku Park-Museum of Water Resources
- Forest Protectors, the private sector’s initiative to establish conservation areas
- Campaigns to reduce waste generation and promote recycling



Chapter 7:

Areas of Action and Recommendations

The final section of the Environmental and Climate Change Outlook-Quito is to address the question, what can be done to reverse the situation? This section highlights the key recommendation policy and action items that were developed through a consultative and participatory approach with a wide range of stakeholders in the city. Table 22 first summarizes the key findings from the ECCO-Q evaluation.

Table 22. Summary of the State of Environment

Element	Pressure	Impacts	Responses
Air	<ul style="list-style-type: none"> -Vehicle traffic -Quality of fuels -Methane emissions from the landfill -Emissions from thermal electric plants 	<ul style="list-style-type: none"> -Under the WHO guidelines SO₂, O₃ and NO₂ exceed limits on emission levels -Carboxyhemoglobin in children and effects of particulate matter in the population living in proximity to mining areas -Economic cost of air pollution estimated at \$34,385,815 	<ul style="list-style-type: none"> -Plan of Air Management (*) -Control of Atmospheric emission from fixed and mobile sources (*) -Establishment of vehicle servicing centers (*) -Bike lanes (*)
Water	<ul style="list-style-type: none"> -Inefficient industrial waste water treatment resulting in high levels of pollution from fecal coliform, detergents, oils and fats -Exploitation and contamination of aquifers 	<ul style="list-style-type: none"> -Poorest population lack access to potable water -The use of contaminated water to irrigate crops -Illnesses due to the consumption of food products irrigated with polluted water -The Machangara, Monjas, and San Pedro rivers show levels of pollution from medium to very poor 	<ul style="list-style-type: none"> -Establishment of the National Secretary of Water -Ratification of Ramsar (**, ***) -FONAG educational activities (**) -The Yaku Park-Museum of Water Resources -Fees on water consumption -The Plan to Decontaminate the Rivers of Quito (**, ***)
Land	<ul style="list-style-type: none"> -High population growth and urbanization -Urban expansion 	<ul style="list-style-type: none"> -High rates of soil erosion and land degradation -High rates of waste generation (0.834 kg/person/day) -Land use activities in areas considered susceptible to soil erosion -Contamination of soils from fertilizers and pesticides 	<ul style="list-style-type: none"> Law of the Metropolitan District of Quito (*, **, ***)

Element	Pressure	Impacts	Responses
Biodiversity	-Population growth -Urban expansion	-Reduction in natural areas -Reduction and loss of flora and fauna	Strategy of the District of Quito's Natural Resources 2009-2015 (**, ***)
Natural risks and vulnerabilities	-Volcanoes -Settlements in zones at risk to flooding, erosion and earthquakes	-70% of construction do not meet building requirements -50% of areas at risk of earthquakes -Flooding due to the replacement and filling of the canals	-Quito Strategy Plan towards 2025 (*, **, ***) -General Development Plan 2006-2010 (**) -Architecture and Urban Development Rules -System of monitoring and early warning (**) -Network of earthquake seismic stations -Network of weather and hydrologic stations (**)
Built Environment	Unplanned urban development	-High level of informal settlements -Buildings constructed using inappropriate materials -Development in protected areas -Enhanced risks to natural disasters -Inequality in the distribution of services	General Development Plan of the Territory (PGDT) (*, **, ***)
Built Environment	Unplanned urban development	-Inefficient infrastructure and transportation -Limited housing availability -Deterioration of public space	General Development Plan of the Territory (PGDT) (*, **, ***)
Climate Change	Rising GHG emissions	-Increase in local temperature -Loss of alpine glaciers and impacts on water resources -Vulnerability of the poor settle in informal settlements to extreme events	-International agreements to reduce GHG emissions (*) -Integration of the various organizations responsible for climate change to design policies to reduce vulnerabilities (**)

Note: Responses that address mitigation measures are identified by (*), adaptation (**), and/or EbA (***)

Recommendations and Action Plans

The following plans and recommendations were developed through a participatory approach that involved a wide range of stakeholders from the public and private sectors, community groups and specialists in various fields.

Similar to the policies and plans that have already been implemented in Quito many of the following recommendations contain components that address climate change mitigation (*), adaptation (**) or EbA (***) principles.

Air

- Regulate transportation to improve air quality (*)
- Control atmospheric emissions from fixed and mobile sources (*)
- Develop an energy matrix composed of non-fossil fuel sources (*)
- Regulate the importation of vehicles, especially those that are second-hand, implement policies that favor public transit and policies that prioritize the use of renewable energy (*)
- Restrict vehicle traffic in the city, enforce the retirement of old vehicles and promote public transit and pedestrian friendly areas (*)
- Increase the km of bike lanes in the city and promote the use of bikes for work, study and recreational activities (*)

Water

- Implement measures to save water, rehabilitate the rivers and conserve water resources (**, ***)
- Avoid the privatization of water since it is considered a human right. A multi-sectoral approach involving stakeholders from the state, local government and communities is suggested for its management. (**, ***)
- Implement educational campaigns to change poor water practices among the population and promote sustainable uses, control leaks from pipelines and encourage water saving habits (**, ***)
- Reduce the water pollution in the Monjas, Machangara and San Pedro rivers through the implementation of wastewater treatment facilities and establish a river water quality monitoring system that involves the university, private companies and social organizations (**, ***)

Treatment of Solid Waste

- Provide incentives for the cleaning and treatment of solid and liquid waste
- Implement a system of tariffs based on type and volume of waste
- Implement a system of residential waste separation (biodegradable and non-biodegradable) (*), strengthen the management of bio-hazardous waste from the health and industrial sectors, and regulate the production of fertilizers
- Strengthen the capacity of the recycling companies and implement a citywide recycling program (*)
- Provide incentives to use packaging material that is biodegradable
- Ban informal dumping sites
- Stimulate environmental awareness among the general public and social incentives to recycle (**)

Biodiversity and Ecosystems

- Undertake a baseline study of the urban biodiversity. It is also important that these types of studies are distributed publicly and used in schools and universities (**, ***)
- Conservation and restoration of mountain ecosystems and surrounding canals, ridges and hills of the city (*, **, ***)
- Protection of green spaces, forests and ecologically significant areas, located in the surrounding valleys such as Pomoasqui, Tumbaco, Llano Grande and Los Chillos (*, **, ***)

Built Environment

- Implement a registration system on land use, which can be used to prevent and control informal settlements (**)
- Incorporate social housing development in the new programs of state owned housing (**)
- Train new professionals to incorporate innovative designing techniques and reduce the use of toxic materials in construction, promote the preservation of green spaces, reforestation and the use of alternative forms of energy in buildings (*, **, ***)
- Implement building regulations that control the types of materials used, the building's energy consumption and promote the generation of renewable energy to meet the building's own demands (*)

Climate Change

Many of the strategies recommended for climate change may act as both an adaptation and mitigation mechanism and often have additional social and environment benefits including strengthening other ecosystem services such as water regulation. These are presented in Table 23.

Table 23. Recommendations for Climate Change Adaptation and Mitigation

Strategy	Adaptation	Mitigation	Additional environmental and social benefits
Forest Conservation	-Protect from soil degradation -Enhance water regulation	-Reduce CO ₂ emissions from deforestation -Protect carbon storage in forest	-Protect biodiversity -Protection of water resources -Improve soil quality -Improve quality of life for the local population
Urban Forestry	-Protection from heat waves, strong precipitation, flooding and soil erosion	-Reduce CO ₂ emissions through reforestation	-Increase urban green space -Improve local air and water quality -Reduce the demand for energy
Restoration of the Paramos ³	-Enhance the recharging of aquifers and facilitate water storage -Provide protection from soil erosion	Reduce CO ₂ emissions through reforestation	-Ensure water supply in the region -Improve soil quality
Implement a composting system	-Improve soil quality and agriculture production	-Reduce methane emissions from the landfill and reduce N ₂ O emissions from the use of fertilizers	-Enhance soil quality and productivity -Reduce waste in landfill -Improve the quality of life in communities -Create new job opportunities

³ A neotropical ecosystem found in the upper Andean region formed by glacier valleys and consisting of lakes, peat bogs and grasslands.

Strategy	Adaptation	Mitigation	Additional environmental and social benefits
Renewable energy production	<ul style="list-style-type: none"> -Contribute to securing energy security -Diversify energy mix and reduce dependence on hydro-electric resources 	<ul style="list-style-type: none"> -Reduce CO₂ emissions from non-renewable electricity sources 	<ul style="list-style-type: none"> -Improve air quality -Transfer of technology and capacity building -New employment opportunities -Potential sale of carbon credits
Improve livestock production (i.e. grazing habits, adding tree cover to land)	<ul style="list-style-type: none"> -Reduce pressure on the vegetation and protect from soil degradation -Provide protection from dry conditions and droughts 	<ul style="list-style-type: none"> -Reduction in emissions (methane) from livestock production -Reduce N₂O emissions from reduction in soil degradation 	<ul style="list-style-type: none"> -Improve livelihoods -Create biological corridors

Environmental Management

- Develop an integrated vision to govern the environment in the city
- Environmental management in Quito requires a multidisciplinary perspective to redefine planning and environmental policies considering the activities between urban-rural areas and their impacts on the environment and that highlight the importance of poverty, social exclusion, environmental degradation, mobility and security
- Strengthen the institutional capacity for environmental management
- Promote active participation in environmental management among the public and private sectors that is democratic and inclusive
- The government must act as a leader to create the multi-sectoral links to mainstream environmental management in all sectors and services

Citizen Participation in the Environment

- Consolidate citizenship participation and develop an environmental culture within the general public
- Ensure environmental information is distributed and accessible to the population. For instance publish key environmental indicators such as air and water quality. Encourage citizens to take actions to improve these indicators and to incorporate environmentalism and sustainability into their individual lives
- Revise the environmental contents of school curricula and strengthen the content by incorporating real environmental problems and encouraging multidisciplinary teaching in the schools



Conclusion

This study and its recommendations are the first step for Quito to address the challenge of transforming the city in its current state to the sustainable city Quito would like to become. The next step is to take the recommendations and turn them into concrete actions in which environmental management is something shared among all sectors of society in order to finally obtain the ultimate goal of *“la ciudad del buen vivir”* (The City of Good Living).



References

Arango, Jorge (2009). "Calidad de los combustibles en Colombia". in *Revista de Ingeniería* No. 29: 100-108.

Corporación Municipal para el Mejoramiento del Aire en Quito (CORPAIRE) (2008). *Informe Anual 2007: la Calidad del Aire en Quito*. Quito: CORPAIRE and Municipio del Distrito Metropolitano de Quito.

CORPAIRE, (2009). *Informe Anual 2008: la Calidad del Aire en Quito*. Quito: Corporación para el Mejoramiento del Aire en Quito and Municipio del Distrito Metropolitano de Quito.

Dirección Metropolitana de Medio Ambiente, Fondo Ambiental and Corporación IFA (DMMA-FA-IFA) (2007). *Distrito Metropolitano de Quito Ambiente y Salud: Proyecto Piloto de Valoración del Impacto en la Salud en el DMQ*. Quito: Municipio del Distrito Metropolitano de Quito.

Empresa Eléctrica Quito (EEQ) (2010). *Oficio RAO- 417*. Quito. Mimeo.

Empresa Metropolitana de Alcantarillado y Agua Potable de Quito (EMAAP-Q) (2009). *Primera Entrega de Información para Elaboración del Estudio Sobre Perspectivas del Medio Ambiente Urbano*. Mimeo.

EMAAP-Q. (2010). *Revisión del Documento GEO-Quito. Observaciones*.

Empresa Metropolitana de Aseo (EMASEO) (2009). *Presentación Plásticos EMASEO Taller Fundas Plásticas*. Quito. Mimeo.

EMASEO (2010). *Oficio De Respuesta En Solicitud De Información 03/10. Información De Los Residuos Sólidos en el Distrito Metropolitano De Quito*. Quito. Mimeo.

Food and Agriculture Organization of the United Nations (FAO). (2011). *State of the World's Forests*. Rome. <http://www.fao.org/docrep/013/i2000e/i2000e00.htm>

Fundación Natura (2000). *Informe Final del Estudio: Incremento de Enfermedades Respiratorias en Escolares de Quito Por Contaminación Atmosférica de Origen Vehicular*. Quito: Fundación Natura – Municipio del Distrito Metropolitano de Quito.

Fundación Natura (2001). *Informe Final del Estudio: Incidencia de Enfermedades Respiratorias Altas en Niños Escolares de Quito, Según Areas de Contaminación Atmosférica*. Quito: Fundación Natura Municipio del Distrito Metropolitano de Quito.

IUCN. (2009). *Ecosystem-Based Adaptation: A Natural Response to Climate Change*.

UNDP (2009). "Capítulo 1: El desafío climático del siglo XXI". In *Informe sobre Desarrollo Humano 2007 – 2008. La Lucha contra el Cambio Climático: Solidaridad frente a un Mundo Dividido*. Madrid: Grupo Mundi-Prensa.

UNEP. (2009). *Methodology for the Preparation of GEO Cities Reports*. Training Manuel Version 3. Accessed from http://www.pnuma.org/deat1/pdf/Metho_GEOCitiesindddOK.pdf

UNEP. (2010). *IEA Training Manual Volume Two Themes. Climate Change Vulnerability and Impacts in Cities*. Accessed from <http://www.pnuma.org/deat1/pdf/VIA%20CC%20city%20module%20final%20draft%203%20Dec%202010.pdf>

Quito Environment and Climate Change Outlook, is the first comprehensive environmental assessment (physical, biotic and social) of the city, includes an analysis of vulnerability and adaptation to climate change and guides their proposals within the scope of *sumak kawsay* or "good life". The proposals of the report aim to build a new model of city and society to ensure rights, economic, environmental, social and cultural welfare of the people in harmony with their natural and built environment.

The text provides updated technical information for second level, to be used in terms of strengthening environmental management led by the municipal institution, providing elements that can be operationalized by the public entity, the general public and organizations involved in building the Quito good life: a city with smart mobility, safe, supportive and inclusive, with territorial equity, green space, with public space for work and culture; and most importantly, a city with solid democratic and sustainable bases arising from public participation and dialogue.

