EXECUTIVE SUMMARY[1]

1 THE NATIONAL SITUATION

Colombia has been characterised by its environmental policy and conservation initiatives, which involve all parties, from civil society to senior levels of public administration, strengthened by the 1991 Constitution, which establishes an obligation on the part of the State to protect the Nation's natural wealth.

With the creation of the Minister for environment and of the National Environmental System (SINA), in Law 99/1993, a set of guidelines, regulations, activities, resources, programmes and institutions was established to enable the general principles of environmental management to be implemented. In this legal framework, research institutes were also established as necessary to support formulation of policy, regulation and directives.

In terms of climatic change, Colombia has approved the United Nations Framework Convention on Climate Change (UNFCCC), in Law 164/9094, and approved the Kyoto protocol in Law 629/2000. Subsequently, Ideam was designated as the coordination agency for the preparation of national communications, and the policy document CONPES 3242/2003 was issued, as "The national strategy for the sale of environmental services for the mitigation of climate change". Finally, the mechanisms for national approvals of projects to reduce greenhouse gas emissions and favour Clean Development Methods (CDM) were modified, and the Intersectoral Technical Committee for the Mitigation of Climate Change was created as part of the National Environmental Council.

Colombia's total area is 2,070,408 sq.km, including 1,141,748 sq.km of mainland, and 926,660 sq.km of territorial waters. The continental mainland area is divided into five natural regions, Caribbean, Pacific, Amazonia, Orinoco and Andes, and there is an island region in the territorial waters of the Caribbean. In political terms, the territory is divided administratively into 32 Departments, which are in turn are subdivided into municipalities.

The physiographical characteristics of Colombia are diverse and complex, one outstanding feature being the cordilleras (ranges) of the Andes, in three major divisions - west, central and east - with each with their own genesis, ages and lithologies, separated from each other by their valleys of the Cauca and Magdalena rivers, with maximum altitudes between 4,700 and 5,400 m above sea level.

Colombia is located on the equatorial/under the influence of the intertropical confluence zone (ITCZ). This is a decisive factor in the distribution of rainfall in space and time, nubosity, and other parameter variables in Colombia. Its location to the north-west of South America also is also favourable to the influence of processes which occur in the tropical Atlantic, the Caribbean, and the tropical Pacific.

Average annual rainfall in Colombia is 3000 mm, with real evapotranspiration of 1,180 mm, and annual average run off of 1,800 mm (Ideam *et al.*, 2004). Approximately 61% of this is converted into surface run-off, generating an average flow of 67,000 cu.m/sec, equivalent to an annual volume of 2,084 cu. km. running of the five major hydrological regions on the in the mainland, as follows: 11% in the Magdalena, 5% in the Caribbean; 18% in the Pacific, 34% in Amazonia, and 32% the Orinoco basin.

In terms of the map of continental, coastal and marine ecosystems in Colombia (Ideam et al., 2007), the territory is divided into three major by biomes: the grand biome of the tropical desert, in the Department of La Guajira; the grand biome of the tropical dry woodland in the Caribbean region, upper Magdalena and Valle del Cauca; and the grand biome of humid tropical forest, which covers the rest of mainland Colombia. Each of these has their respective

1 Sources and references cited here may be consulted in the main document reference section for each chapter.

zonobiomes, orobiomes or pedobiomes. Within the three grand biomes there are 32 types of biome identified, and 311 continental and coastal ecosystems.

The largest mainland ecosystem in this total is the natural humid tropical forest of the Amazon-Orinoco basins (29,388,782 ha), followed by the grasslands of the Orinoco-Amazon basins (6,972,311 ha), natural woodland in the litho biomes of the Amazon-Orinoco basin (6,545,016 ha), natural woodland in the helobiome of the Amazon-Orinoco basin (6,167,279 ha), and natural Andes orobiome (5,180,863 ha).

The four marine ecosystems identified are distributed along the coasts of two oceans, including island systems, and consist of coastal lagoons and mangroves, as coastal ecosystems; and the sea meadows and coral areas, as marine bentic ecosystems (Ideam et al., 2007).

According to the statistical bureau DANE, the population of Colombia in 2008 was 44,450,216, being the second most populous country in South America and the fourth in the Americas. The Andean region is home to 75% of the population, and the Caribbean region to 21%. The seven largest cities hold 34% of the total population, and they have higher demographic growth rates than the rest of the country.

Life expectancy at birth has gradually increased between 1985 and 2005, for both men and women. The infant mortality rate has shown on a downward trend in that period (DANE 2007a). Fecundity has fallen by 27.5% in the last 20 years (DANE, 2007b).

The structure of the population is as follows: mestizo, 51.51%, white 35%, back 10.6% and indigenous 3.4% (DANE, 2005). Some 31 million ha have been turned into indigenous reservations and 5.5 million ha into black community territory.

In structural terms, GDP is largely represented by the service sector, in which there has been constant growth since the 1950s, principally in financial services, and with an expansion of public service coverage. The service sector rose from 27% of GDP in 1970 to 42% in 2003 (Cárdenas, 2007). The share of primary production and manufacture has decreased, and stabilised within the structure of value generation in Colombia (Ortiz *et al.*, 2009).

The production of primary goods from agriculture, forestry, hunting and fishing has steadily lost its relative weighting in the structure of GDP, while mining has grown steadily, over the last 20 years.

After a negative annual variation of 4.2% in 1999, GDP began a slow recovery from 2000 onwards, and in 2001 reported the same GDP as for 1998. In 2006, there was growth of 6.84%, which was evidence of a phase of expansion, principally driven by exports (GNP, 2006).

According to DANE and the central bank, (Banco de la Republica), the economy achieved recovery in GDP growth since 2000, from COP 89,968 million (constant 1994) to COP121,924 million for 2007, corresponding to per capita GDP increases (1994 prices), of US$2,126 (2000) to US$2,566 (2007)[2]. Nonetheless, 2009 was characterised by a reduction in growth, after an important period of economic expansion, making this possibly the first year of a downturn in the cycle caused by the world economic crisis.

2 NATIONAL INVENTORY OF GREENHOUSE GASES (GHG)

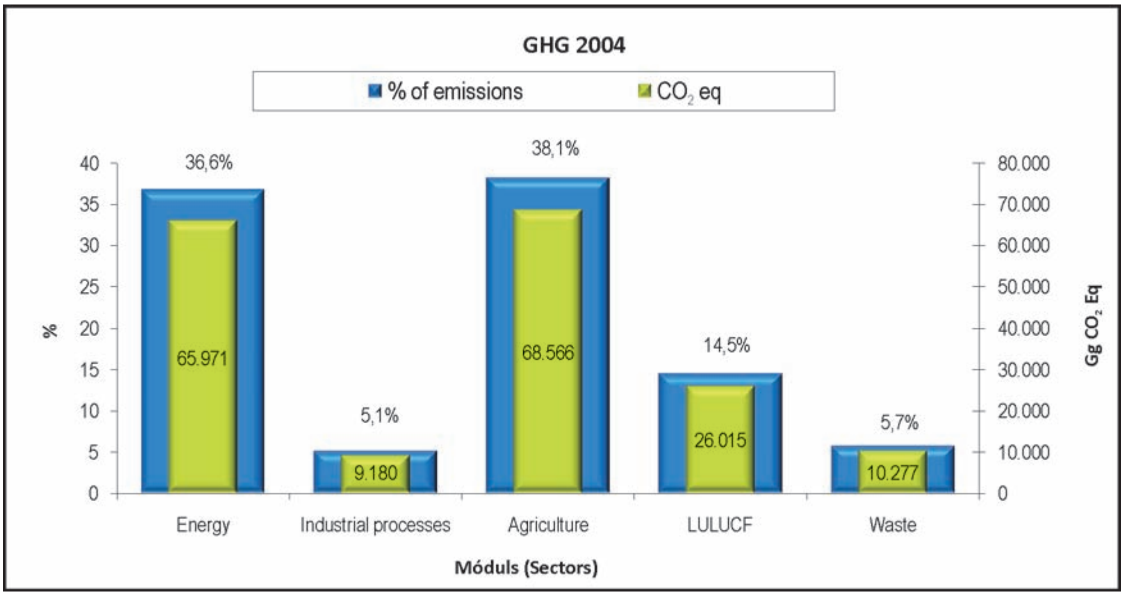
Colombia made its national inventory of GHG for 2000 and 2004 following IPCC directives on Good Practices, and the management of uncertainty.

The results of the inventory show that the contribution of greenhouse effect gases is composed as follows: carbon dioxide 50%, methane 30%, nitrogen oxide 19%, leaving 1% for the remaining GHG, which are not in the Montreal protocol, such as HFCs, CFCs, and halocarbons and sulphur hexafluoride (Ideam, 2008c).

In whole numbers, the sectors which caused most GHGs in 2004 were agriculture 38%, energy and 37%; land-use, land-use change and forestry - LULUCF - 42%. These were followed by solid waste, 6%, and industrial processes 5%. When the total emissions of the modules for agriculture added to those of LULUCF, it is evident that the sector in general makes a significant contribution of some 50% of total emissions in 2000 and 2004 (see Figure 2.1).

2 Provisional figure.

Figure 2.1. The share of each module (sector) and total GHG emissions, 2004



Source: Ideam, 2009.

Table 2.1 shows details of the activities or categories which contributed most GHG in terms of CO2 equivalent in 2004, corresponding to 80% of all GHG.

Table 2.1. Principal modules and categories/activities contributing GHG, 2004

Main modules and categories		% de CO_2 eq.
Energy	Transport	12.1
	Energy industries	8.5
	Manufacturing and construction	7.3
Agriculture	Enteric fermentation	18.5
	Agricultural soils	18.1
LULUCF	Soil CO_2 emissions	4.1
	Conversion of woodlans and pasture	9.2
Waste	Solid waste disposal in the ground	5.0
Other	**Accumulated main sources:**	**79.8%**

Source: Ideam, 2009.

According to the GHG inventory for 2004, Colombia contributes 0.37% (180,010 Gg) of world total emissions (49 Gigatonnes), and individual emissions per capita are below the world average, and very far below values recorded by Europe, western Asia and North America.

3 MITIGATION

Mitigation is defined by IPCC as human intervention to reduce man-made stresses on the climatic system, through strategies designed to reduce GHG sources and emissions, and to potentiate sinks. Although Colombia has no commitments to reduce emissions, and plays only a marginal part in GHG emissions (0.37% of global totals), it has developed and implemented a number of policies which promote sustainable development associated with low emissions of such gases, as the result of an evolution of mitigation on a national scale.

3.1 NATIONAL POLICIES AND PLANS ASSOCIATED WITH MITIGATION

Mitigation actions in Colombia are coordinated by the Mitigation Group for Climate Change in the Ministry of Environment, Housing and Tourism (MAVDT), as a specific institutional instance which concentrates and articulates action taken by various production sectors. According to the guidelines for climate change policy and the National Development Plan (PND) 2002-2006 (DNP, 2002), which set targets for reduction of GHG emissions, an institutional strategy was established for the sale of environmental services derived from mitigation of climate change (CONPES

3242), to encourage greater participation by Colombia in Clean Development Mechanism (CDM), and establish the generation of an institutional framework required for the efficient development of emission reduction activities.

3.1.1 National development plan 2002- 2006 and 2006-2010

The PND 2002-2006 established a number of actions to be implemented with reference to the mitigation of climate change. In particular, there were a) development of a national project for GHG capture, with a target to reduce 200,000 tonnes of carbon dioxide; b) support for sector initiatives with CDM and other mechanisms, to promote the participation in the carbon market.

With regard to the national project for GHG capture, the first forestry project has been approved in Colombia, for the reforestation of the 15,000 ha, which it is estimated will reduce will make a reduction of 5,000,000 tonnes of CO_2 eq, over a period of 20 years (MAVDT, 2009).

In sector terms, the final target mention established a reduction of 1,000,000 tonnes of CO_2 equivalent, for the energy sector; to project to project for less contaminating mass transit, with reductions of 800,000 tonnes of CO_2 equivalent, and a project to take advantage of methane in waste infills, with a reduction of 10,000 tonnes of CO_2 equivalent. In total, it has been calculated that Colombia may generate some 2 million tonnes in Certified Emission Reduction (CER), with a potential value in the carbon market of US$ 8 million (DNP, 2002).

In terms of projects for reduction in emissions, in the period 2000-2006 four projects were approved for energy with an estimated reduction of 233,000 tonnes of CO_2 equivalent. A project was approved in the transport sector with potential mitigation of 246,563 tonnes of CO_2 eq per year. These projects may generate some 872,655 Certificates, and income of some US$ 3 million. If the forestry project is included, generation could reach 1,123,000 tonnes in CO_2 eq of CER, with approximate earnings of US$ 4.5 millions (MAVDT, 2009).

The 2006- 2010 plan specifies the need to provide support the current portfolio of CDM projects, in order to strengthen the offer of environmental goods and services, and to promote options for the reduction of GHG emissions (DNP, 2008). At present, five projects have brought CER for 2007-2009, making total income of US$55.8 million (MAVDT, 2009). This strategy provides for the design of tools to overcome technical, commercial, institutional and financial barriers which limit the development and formulation of these project projects.

In the component for biodiversity conservation, the latest National Plan proposed development of a policy document (complex), to define and regulate the national system of protected areas (SInap), instruments of financial sustainability, and an expansion of an additional 200,000 ha. Further, it established the need to develop plans for land-use regulation and management of 2,000,000 ha of natural forest (DNP, 2007).

The following new protected areas have been created since 2006: Serranía de los Churumbelos Auka Wasi Nature Park, Doña Juana Vascabel Volcanic Complex, Yaigoje-Apaporis Nature Park and the Orito-Ingi Ande Medicinal Plant Sanctuary. This was in excess of targets.

3.1.2 Multilateral cooperation agreements

Colombia has ratified multilateral strategic alliances in response to the need to reduce GHG concentrations, giving priority to CDM as an instrument for effective mitigation and sustainable development in Colombia.

Among the most important MOUs are the World Bank Prototype Carbon Fund, the CAF Latin American programme for carbon and alternative energy; the MOU between the government of the Netherlands and the Republic of Colombia (2002-2012), and the MOU between the Government of France and the Republic of Colombia (2003-2012)

3.2 SECTOR STRATEGIES AND PLANS

3.2.1 The energy sector

The energy sector has a number of plans and programmes designed to contribute to GHG emission reductions, such as: the National Energy Plan 2006-2025 (MME and UPME, 2006), the programme for Rational Energy Use and Non-Conventional Energy Sources (MME, 2001), the programme for rational energy use and other forms of non-conventional energy - PROURE- (MME, 2001 and 2003); subprogrammes of non-interconnected zones (IPSE, 2005), and the Methane Market Programme, with US-EPA and MAVDT.

In the oil sector, Ecopetrol has structured a strategy to reduce GHG emissions under a collaboration agreement with IDB, signed in 2008. This action has identified 38 initiatives for mitigation in production, transport and refining, with a potential of some 2,000,000 tonnes of CO_2 equivalent/year, focusing on the exploitation of gas, fuel substitution, the generation of electricity with less GHG -intensive technologies and fuels, and energy efficiency.

In research conducted on potential reductions in the energy sector emissions, Universidad de los Andes (Cadena et al., 2008) has identified a position in which the change in carbon fuels for gas fuels in industry over a 20-year horizon is the measure which will have the greatest potential for GHG emission reductions, even if the cost is high (US$ 35 per tonne/CO_2). With the introduction of more efficient boilers, there will be important potential reduction (37.6 million tonnes of CO_2), at a cost of US$3.6/tonne of CO_2, and the savings generated by a reduction in the excess of urban buses as potential reduction estimated at 30.4 million tonnes of CO_2.

3.2.2 Transport

Integrated mass transit systems are currently under construction or in operation in Bogota, Soacha, Barranquilla, Cali, Cartagena, Medellin (Valle de Aburra) and Pereira (Dos Quebradas), with an average potential reduction of around 810,726 tonnes of CO_2 equivalent per year[3].

According to the monitoring report for Phases 2 and 4 of the Transmilenio mass transit system in Bogotá, GHG reductions of 128,905 tonnes of CO_2 equivalent were generated during 2006 and 2007. This brought about greater fuel consumption efficiency, at 6.1 km/gallon, on average ,for those years.

In terms of the use of natural gas as an alternative for clean mobility, MME and UPME (2002) evidence the importance of using that fuel in the transport sector, in the context of proven reserves of natural gas.

The use of cleaner fuels, specified in the MME Resolution 180158/2007 in accordance with the Law 1083/2006, established that as of January 1, 2010, public passenger transport operators in urban areas would have to use vehicles operating on clean fuels such as hydrogen, alcohol, natural gas, LPG, biodiesel, diesel with less than 50 ppm of sulphur, reformulated motor gasoline and electricity, as expressed.

The Government is using MAVDT to promote the use of electric cars, and has introduced duty exemptions (the current duty is 35%). In 2010, the Customs and Duties Affairs Committee (AAA) approved and initiative of MAVDT, for this duty to be cut from 35% to zero, and it is expected that the measure will come into force this year, with the publication of the related decree.

3.2.3 Industry

According to a joint industry opinion survey[4] made with ANDI[5] (2009), the perception of climate change shows a high level of concern, reflected in the fact that 69.7% of Colombia and businessmen consider that their business will be affected by it.

Among the measures to be taken by business in the next five years to mitigate climate change, there was particular emphasis on energy efficiency (18.3%), education and awareness campaigns among personnel (17.4%). Further, 47.4% will be making changes in their production processes, and 29.1% in their products. At the same time, 38% intend to extend their requirements to their supply chains, 24.9% will make contributions for the protection of ecosystems, and 24.4% plan to take specific actions to neutralise carbon emissions.

3.2.4 LULUCF

The Government is designing forestry programme with policy instruments which indirectly involved measures for mitigation, such as its forestry programme (DNP, 1996), Plan Verde (DNP and MMA, 1988), and the National Forestry Development plan (DNP *et al.*, 2000)

A working plan was set up for mitigation on in the forestry sector, based on the intention to build up the generation and recognition of environmental services provided by forests in the removal of carbon dioxide, and actions proposed include 1) Definition of areas with potential for the execution of mitigation forestry projects, based on the definition

3 MAVDT Colombia´s CMD project portfolio, October 2009.
4 The survey included for the first time a special module on the issue of climate change and its impact on Colombian industry
5 Asociación Nacional de Industriales, the industrialists´ association.

of forests in the context of CDMs (MAVDT and Ideam, 2005); 2) The establishment of principles, requirements and criteria for the approval of CDM forestry projects; 3) Preliminary formulation of the National CDM Forestry Project, with potential for reduction of emissions of 26 million tonnes of CO_2 equivalent[6] in 25 years.

During the period 2002-2008, MAVDT encouraged the introduction of 151,801 ha of protective reforestation, to support the integral management of water resources. It is estimated that this reforestation will have a potential for reducing emissions of up to 13,175,937 tonnes of CO_2 equivalent in 20 years. For its part, the Ministry of Agriculture and Rural Development (MADR) has promoted the commercial reforestation with the planting of 260,287 ha. This reflects a particularly positive trend in the growth of forestry plantations in Colombia.

In a 20 year horizon, it is estimated that emissions of 42,640,216 tonnes of carbon equivalent could be reduced by these commercial plantations, and 1,627,773 tonnes of carbon equivalent by rubber plantations[7].

Further, the Forest Warden Families programme of the Office of the President, has engaged 88,488 families in mitigation activities, protects 282,588 ha of woodland, scrub and pàramo, and has made it possible to recover 53, 477 ha, according to UNODC and Acción Social, 2007a). Further, there are 49,845 families with legal planted crops over 87,748 ha, who have been engaged in production projects.

For their part, MAVDT and Ideam have drawn up a plan for "Scientific and technical institutional training to support REDD projects". REDD in Colombia began in 2009, and will be developed over two years by Ideam with the support of Fundación Natura, as a result of a donation from the Gordon and Betty Moore Foundation. The project will develop subnational and national procedures for the processing of images to monitor deforestation, estimate carbon levels in woodlands and other vegetal cover, and monitor biomass. The project produced a preliminary quantification of the rate of deforestation for the period 2000-2007

3.2.5 Agriculture

Environmental management in agriculture uses two instruments which bring together certain measures relating to the mitigation of climate change. The first is the interministerial environmental agenda, involving MAVDT and MADR; and the second is the environmental strategic plan for the farming sector (PEASA).

The interministerial agenda set lines of action which integrate mitigation measures such as 1) conservation and sustainable use of environmental goods and services such as climate regulation and water offer, which is working for the integral management of forestry resources, strategic systems and agro-biodiversity, management of climate change, mitigation services and support for CDM, and 2) Environmental sustainability in national production, which seeks to develop management aspects in all alternative systems for sustainable farm production and the development of ecological production, environmental management for farm production, and encouragement for the efficient use of soil and irrigation.

PEASA encourages integral management of natural resources, to bring sustainability to environmental goods and services supporting production, and strengthening the sector's capacity to face the challenges implicit in a threat to the productive base, such as desertification and climate change. PEASA contains activities for emission reductions, such as the development of productive systems with schemes for 1) Agro-forestry and woodland-pasture systems, 2) Integral management of the soil, 3) Good agricultural practices (GAP), 4) Ecological agriculture, 5) Precision agriculture (evaluation of inputs required per unit of producing soil), and 6) vegetal germplasm banks for plants, cattle and microorganisms.

Further, there is a strategic plan for Colombian cattle-breeding (FEDEGAN, 2006), which is concerned with a range of targets which are articulated to mitigation.

MADR designed a research strategy linked to productive chains, called "Agriculture and climate change", financing programs and projects in research, and technological development and innovation with the farming sector, by production chains. The research programmes proposed develop and evaluate a range of technologies for mitigation at all and indeed affectation, in four themes: 1) Evaluation of levels of removal or capture of carbon dioxide, with different production systems, 2) options in soil management, 3) measures and technologies for cattle production, 4) evaluation of the impact of climate change on farming, fisheries and forestry production.

With the alliance between Ideam, Corpoica and other institutions[8], work is being done on the following research areas for animal and Plant health management in regard to climate change, to be completed in 2011. 1) Climate

6 Data adapted from MAVDT in which CDM forestry projects offer a potential annual reduction of 1,247,919 tonnes of CO_2 equivalent.

7 Carbon increases for plantations of *Hevea Brasilensis* in Colombia, reported by Buitrago *et al.*, 2005.

8 Including Cenicafe, Corpoica, Alexander von Humboldt Institute, ANALAC, Universidad de Cundinamarca, the Ubaté milk producers association, the Boyacá cattle-breeders federation FABEGAN, the Zipaquirá cattle-breeders aassociation etc.

exchange fluctuations in pathogens associated with the soil (clostridiums); 2) Development of an early warning system for the chinche in pasture and relationship to climate change; three) modelling of the effects of climate change on the Rhipicephalus (Boophilus) microplus tick, in high tropical lands in Colombia; 4) The effects of climate change on altitude distribution of pests and their natural enemies, in the context of the coffee industry in Colombia

Two cattle raising projects, with support of GEF and the World Bank, seek to implement silvo-pastoral systems (SPS) in the sector, with a series of good management practices, to achieve profitable reduction of GHG emissions and to reduce vulnerability to climate change. The first of these is the project for Integrated Silvo-pastoral Focus in Ecosystem Management, completed in 2008. The second is "Colombia mainstreaming sustainable cattle ranching project"[9], due to start in 2010.

3.2.6 Waste

Based on the annual reports of the Superintendency of Household Public Services, it is noted that, of 1085 municipalities that reported information for their public services systems in 2002, 68% disposed of their waste in 604 inappropriate sites (open-air dumps, burning, burial, and discharge into bodies of water), and 32% disposed of their waste appropriately, in 32 integrated plants and 143 infills. After resolution one to 90/05 of MA BET came into force, these figures were inverted for 2008. 31% of municipalities now dispose of their rate waste inappropriately, and 69% appropriately, in 59 integrated plants and 285 infills.

Within the technological strategies proposed to improve public health and safety in urban and rural communities through the integral management of solid waste, some contributed indirectly to the mitigation of climate change. According to the Superintendency report for 2008, 225,079 tonnes/day of solid waste are generated every day, of which 92.8% (23,283.5 tonnes) are disposed of in infills or integral treatment plants, notoriously contributing to an improvement in the systems of elimination, treatment and final disposal of waste, through a transformation of open-air dumps into infills.

This change reduces CO_2 emissions, given that the organic fractions decompose aerobically, and presents an increase in methane emissions (CH_4), so, when implementing technologies for recovery and use of the methane generated, the conversion into infills contributes to the reduction in emissions.

With the financial support of IDB (Eteisa, 2006), a study was conducted on a national scale of the potential for recovery of methane in 20 infills around the country, close to large urban centres, in order to obtain in-depth knowledge of the potential for GED emission reductions derived from the management and disposal of waste. Results of the analysis showed that of the 20 infills analysed, there is a potential methane generation of some 48.8 million cu. m. per year, base year 2006. This would give an annual average of 2,.5 million, and 788.8 million cu. m. by the year 2021.

The study concludes that the magnitude of reductions in terms of emissions avoided will depend on the facility with which the final disposal sites can improve their collection capacity and burning off of biogas, and this in turn depends on existing incentives for the sector in this activity, some of which can be obtained through CDM.

According to studies contracted for the Bogotá city administration, the potential for permission reduction of GHG is 5,000,000 tonnes of carbon dioxide equivalent for a period of 12 years.

3.3 COLOMBIA'S PART IN THE CLEANING DEVELOPMENT MECHANISM (CDM)

One of the objectives of the Climate Change Mitigation Group of MADVT is the promotion of development of high-quality CMD projects in Colombia. Up to December 2009, the Group´s activities have enabled a national portfolio of 144 projects to be consolidated, 49 of them with approval at national level by direct request of the proposals, 20 been registered with UNFCCC, and six with CER.

The distribution of these projects by sectors can be summarised as follows: energy (31.25%), transport (8.3%), forestry (11.8%), industry (31.25%), and waste (17.36%). The annual potential for the GHG emission reductions in CDM projects which are part of the national portfolio is approximately 16,402,496 tonnes of CO_2 equivalent, which could generate potential income for Colombia of some US$152 million.

In 2009 Colombia became the fifth Latin American country and the 12th country in the world in projects available for eligible for CDM treatment in the Kyoto protocol, after the Doña Juana infill in Bogota (estimated income US$9 million), and the waste water treatment plant in Cañaveralviejo in Cali, obtained United Nations registration, and

9 This project has been led by FEDEGAN with the participation of CIPAV, Fondo para la Acción Ambiental y la Niñez, and The Nature Conservancy, and support from GEF and the World Bank.

contributed with a reduction of more than 827,384 tonnes per year of carbon dioxide equivalent. Colombia therefore has 20 projects registered.

In the context of financial instruments to encourage the acquisition in technologies and equipment to contribute to the reduction of GHG emissions, Colombia has passed Law 788/2002, and amended its Tax Code to provide an incentive for the purchase and implementation of equipment and technology as that have a demonstrable in direct impact on mitigation.

The incentives including tax exemptions were established for 15 years for the sale of energy produced from renewable sources such as wind, biomass or farm waste. The generating companies can benefit from this, provided that they obtain and sell certificates of GHG reduction, and use 50% of the funds obtained for this activity in social works. In addition, it was established that the importation of machinery and equipment for the project which generate GHG reduction certificates will be exempt from sales tax (IVA), both on the product and on related services.

3.4 PRIORITIES IN MITIGATION BASED ON THE GHG INVENTORY

Based on the results of the National GHG Inventory, an analysis was made of mitigation measures on a sector basis, as follows:

3.4.1 Animal husbandry

Essentially, practices in this sector are concentrated on cattle-breeding, for which alternatives in the management of diet are one of the principal measures of mitigation in the sector, to reduce methane emissions are due to the fermentation of the animals´ intestines. But these practices seek to improve the quality of pasture, and the incorporation of trees into production systems.

Although no methods have been approved by the Executive Board of CDM for the development of mitigation projects associated with improved diets for cattle, responding to a reduction in the methane emissions due to fermentation in intestines, this a the research line which remains to be developed.

3.4.2 Agriculture and forestry

The measures of mitigation in agriculture refer principally to the efficient use and management of nitrogen-content fertilisers. In the forestry sector, this essentially requires priorities to be set in the management of woodland and reduction of emissions due to deforestation and degradation avoided, and an increase in biomass with the range of productive systems.

There has been a proposal in the agricultural sector to reduce the consumption of nitrogen-content fertilisers per hectare, and to increase the use of biofertilisers. For example, with Rhizobium genus bacteria, which possess the ability to form symbiosis with the leguminous species, from nodules which form in their roots.

3.4.3 Energy

In the energy sector, it is important to give priority to manufacturing industry with regard to energy efficiency and changes of fuels used. In relation to the electricity generating industry, mitigation should be approached from the areas which form part of the National Grid (SIN), and non-interconnected areas (ZNI).

One of the alternatives is to secure supplies of electricity through an increase in generating capacity from hydro plants, taking account of limiting factors of a technical nature and socio-economic and environmental impact. However, it is important to note that the significant participation of hydro generation in the Colombian energy industry in terms of low GHG emissions, but a high risk for the country due to the adverse effects of reduced rainfall derived from climate change.

In non-interconnected zones, energy generation from renewable sources is one alternative, since it can generate employment and be a tool for rural development.

4 VULNERABILITY

4.1 EVIDENCE OF CLIMATE CHANGE

Based on the comportment of rain and temperature, Ideam has generated indicators for some evidence of climate change in Colombia, based on the analysis of historical series of rainfall (daily accumulation), and daily extremes of temperature (minimum and maximum), using Rclimdex, which is a statistical program developed by US-NOAA, the national climate datacentre, which calculates indicators for climatic extremes in order to monitor and detect climate change.

In the paramos, there was an evident trend towards a reduction of extreme rain events (associated with downpours), contrary to the experience and at other levels of attitude, where regardless of whether total annual rainfall increases or decreases, in most stations at most levels (0-1000 m), warm; (1001-2000m) temperate, and (2001-2000 m) cold. There is a tendency towards an increase in high-intensity rainfall (Ideam-Benavides et. al, 2007). This is in agreement with the text of the fourth IPCC report (2007), which concludes that extreme rain events are on the increase.

In the high-paramo stations, there has been strong increases in maximum temperature (associated with the day), and of close to 1°C per decade, while in the subparamo and high Andean woodland, increases are between 2.3% centigrade or zero .and 0.6°C per decade. These relatively high increases may be associated with clean air and the thinner atmospheric layer which the rays of the sun must penetrate (especially ultraviolet radiation, which has a high energy content).

At a minimum temperatures (associated with night-time and early morning), the increases in paramo stations are very low,. Indeed, may be noted that in some stations - El Cocuy, El Cardón, El Paraiso and El Tunel - there are slightly negative trends (decreases).

With regard to the comportment of the snows or glaciers, it was found that there was a rapid loss of area from the end of the Small Ice Age (1850). The data for change in glacier areas of Colombia indicate rapid de-glaciations, particularly in the last 30 years, with losses of 3-5% of coverage per year and a retreat of the glacier front of 20-25m per year. Therefore, for the period 2002 - 2003, the total area of glaciers was 5.4 sq.km., while for 2006 - 2007 that surface had been reduced to 47.1 sq. km.

Further, and based on the records of the marine recording station at Cartagena, Bolivar, Valle del Cauca, there is evidence of an increase in sea level in the Caribbean of some 3.5 mm/year, possibly attributable to global climate change amongst other factors. Measurements made at the port of Cristobal (Colon) in Panama shows similar results to those of the higher levels, though on a smaller scale. The calculations for the trend in the coastal data series taken from Cristobal gives a value of 2.3 mm/year.

For the Pacific coast, the evaluation of historical data from measurements of levels at the Marine station at Buenaventura (Valle del Cauca), and other comparable stations, show similar values for a rise in sea levels (but they are greater in Buenaventura) The trend calculated for the data series at points off the coast of Panama and Ecuador showed increases of between 0.99 mm and 1.4 mm per year, while at Buenaventura the increase is 2.2 mm per year.

For an analysis of future conditions, Ideam analysed the principal changes and trends in rainfall and temperature for different periods (between 2011 and 2100), taking his reference the period 1971-2000, under the name "climate normality"[10] based on observations of more than 3840 rain stations, 680 temperature stations and 610 relative humidity stations, with the application of the method suggested by Jones et al. (2004).

Three regional models were used In order to generate the scenarios of climate change: the Japan GSM-MRI high-resolution global model with horizontal resolution of 20 km*20 km; Precis of the United Kingdom, with horizontal resolution of 25 km*25 km, and the WRF model, generating results at 4 km*4 km for the Andean region). The climate in the high-resolution studies was obtained with the initial conditions supplied by Reanalysis[11] ERA 40. While for the reference period 1979 out of 1998, analysis was made between the observations of Ideam and the high resolution global model developed in Japan. For maximum temperatures, the observed mean for the entire territory of Colombia recorded a rate of change of 0.11°C/decade, while the EIA 40 model produced 0.816°C/decade. For the average minimum temperature both the observations and ERA40 model presented an average increase rate for the country of 0.10°C/decade. The Japanese model did not produce any major changes for these extreme values.

10 The normality is a baseline, being the information (multiannual averages amplitiude, maximum and minimum values, variance) of the climate-related variables for the reference period used.

11 ERA-40 of ECMWF

In sum, through the various studies made by Ideam, it was found that the analysis showed a linear trend in the immediate air temperature, which he is increasing at an average rate of 0.13°C /decade for Colombia; these values are consistent with those obtained with the ERA 40 (Precis), which obtained a values similar value of 0.12°C/ decade, while the MRI model produced a result of 0.32°C /decade, for the 1978 and 1998 series. This also explains that the final results are sensitive to the reference period taken.

Based on the results of running the high-resolution models prepared by Ideam-Ruiz (2010), in general terms the result is the conclusion is that on average the mean temperature would increase 1.4°C for the period to 2011-2040, 2.4°C for the period to 2041/2070, and 3.2°C for the period 2071-2100. Please see Figures 4.1 and 4.4.

Figure 4.1 Map of the mean temperature difference from the multimodel for the period 2011-2040, compared to 1971-2000.

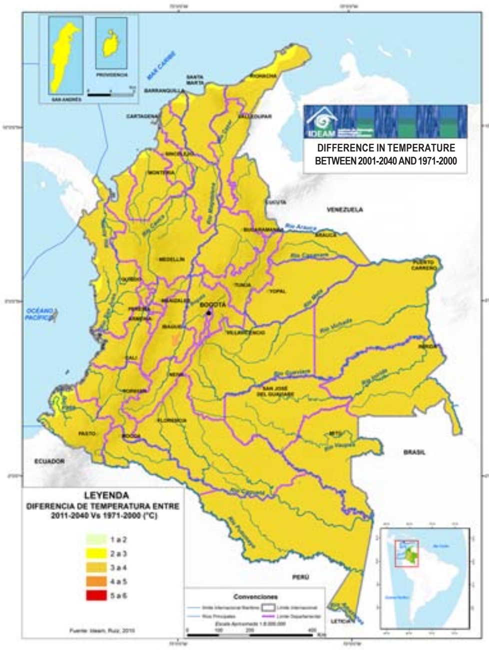
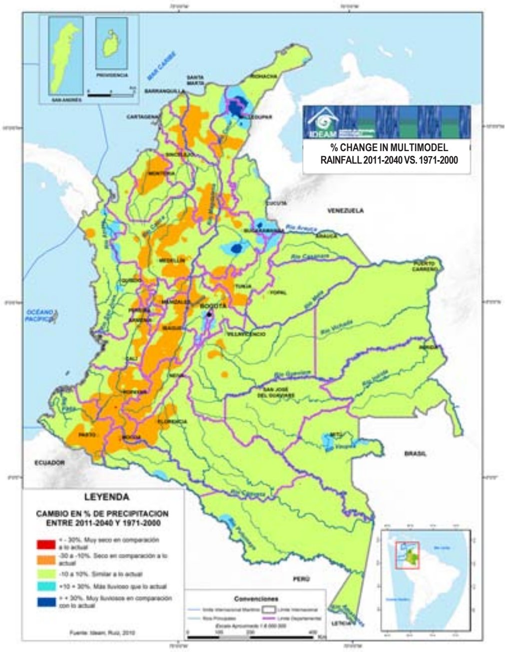


Figure 4.2 Map with the percentage change in rainfall from the multimodel in the period 2011-2040 vs 1971-2000.



Source: Ideam-Ruiz

Figure 4.3 (left). Map with median temperature difference in the multimodel for the period 2071-2100, vs 1971-2000

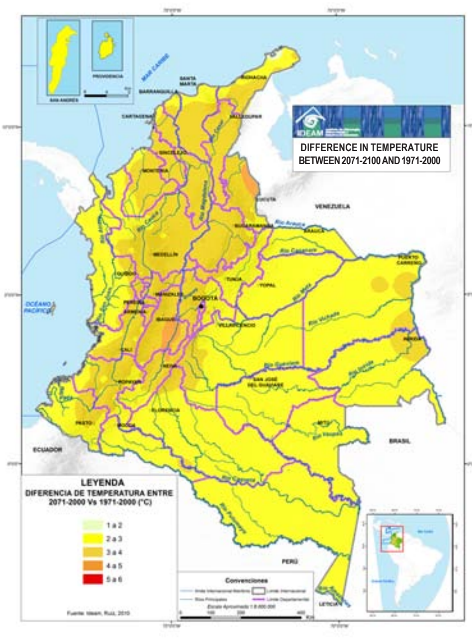
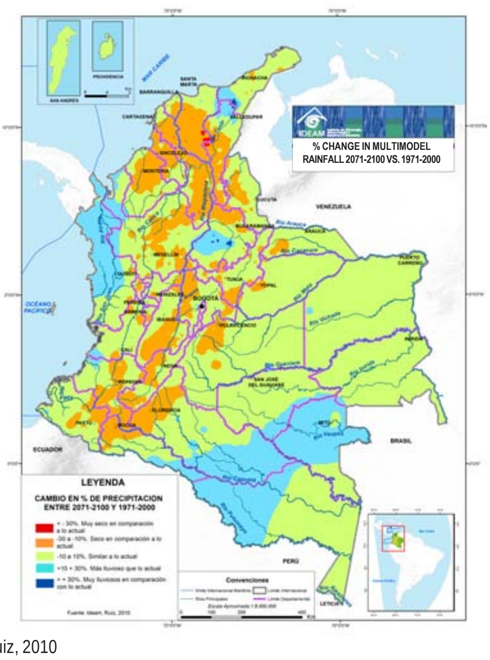


Figure 4.4. (right) Map with percentage change in rainfall for the multimodel for the period 2071-2100 vs 1971-2000.



Source: Ideam - Ruiz, 2010

4.2 COMPARISON OF CHANGES BETWEEN PERIODS

Scenarios for the analysis of vulnerability refer to the beginning and end of the century. The possible comportment of rainfall and temperature between these two periods is shown below.

4.2.1 Rainfall

Changes in rainfall which may occur during the different periods are analysed presented in Figures 4.5 and 4.6.

Figure 4.5 Percentage of variation in median annual rainfall (%)

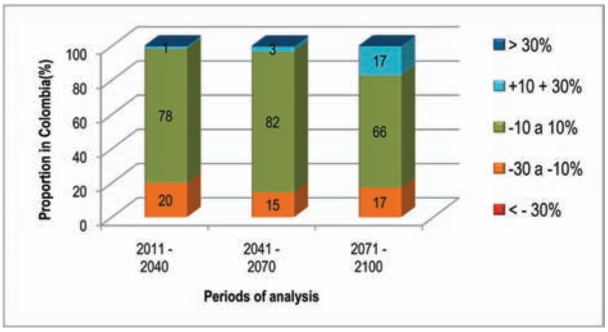
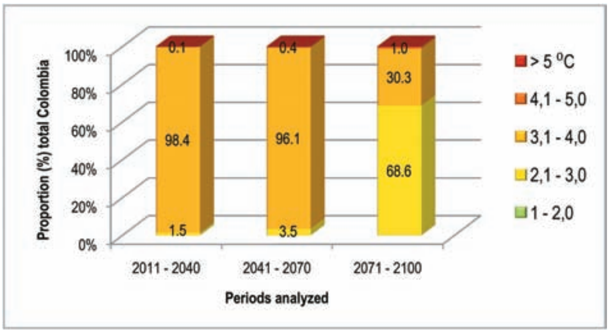


Figure 4.6 Rate of variation in rainfall (mm/year)



Source: Ideam-authors

In Figure 4.5, we can see that there is a higher percentage of occurrence or proportion of Colombian territory for the first period (2011-2040), in which there may be significant variations in the June annual median rainfall (30%-10%), compared to the other periods (2041-2070 and 2071-2100), based on the reference period 1971-2000.

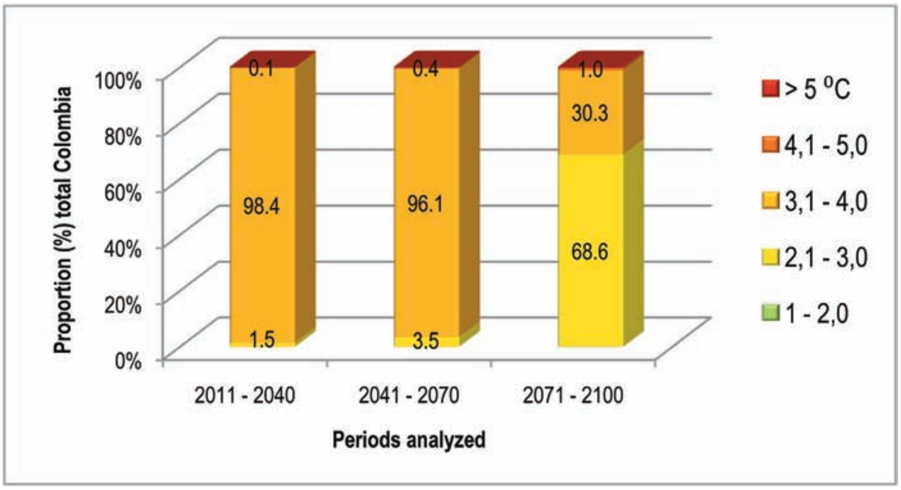
Figure 4.6 shows that 78% of the country, for the first period (2011-2040) would have a variation about 10%, which can be considered within the normal range of variability. Additionally, it is remarkable that the greatest reduction in rainfall (-30 to -10%) would occur in 20% of the country for the period 2011-2040.

Figure 4.7 shows how the median annual rainfall rate which would be used is shown in figure 4.7.decreases in proportion to territory (and 4%-256%), in the range of -3.1 to -4 mm/year. This deficit trend would be aggravated, if we take account of the fact that at the end of the century there may be reductions of more than -4 millimetres/ year, in approximately 20% of Colombia.

4.2.2 Temperature

The comportment of annual median temperature of the air, based on the multimodel

Figure 4.7. Variation in annual median temperature (Multimodel) for different periods, compared to 2071-2000



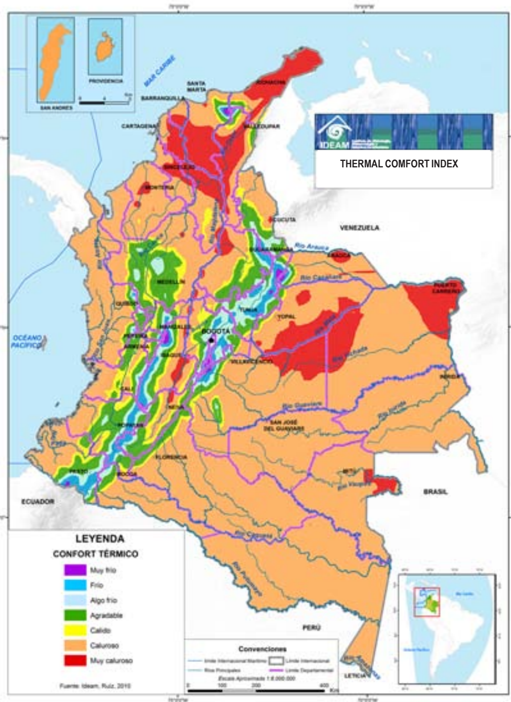
Source: Ideam-authors

From the foregoing Figure, it is evident that almost all the territory of Colombia (99.9%) would undergo increase in temperature of more than 2°C, principally towards the end of the century. The mapping of this comportment can be seen in Figure 4.1 and 4.3.

In the two periods at the beginning of the century (2011-2040 and 2041-2070), most of the country could be affected (more than 86%), by increases of more than 3.0°C. Figure 4.7 shows the coverage of each range of temperature for the period 2011-2100.

With regard to heat, temperature and humidity, variables were analysed to produce an average 43 climatological means for future climate (2011-2040, 2041-2070 and 2070 to 2100), and calculation was made of the thermal-comfort in index, using a cooling power adjusted equation of Leonardo Hill and Morikofer-Davos (Ideam, 2005), which considers the parameter of humidity together with variations in temperature with altitude to Council the classify thermal sensation in seven classes. The results show the variation which would be perceived from hot to very hot in the greater part of the Caribbean, Orinoco and Amazon regions, and along the valleys of the River Magdalena and Cauca in the Andean region, particularly in the period 2041-2070 (see Figure 4.8).

Figure 4.8 (left) Map with thermal comfort indicator, 2011-2040.



Source: Ideam-authors

In the high mountains of the eastern and central Andes cordilleras, there will be a slow shift from very cold, to cold, then to fairly cold. There will be no predominance of climates classified as pleasant to the human being.

4.3 METHOD TO CALCULATE VULNERABILITY TO CLIMATE CHANGE

Ideam, with the participation of a number of entities and actors related to the adaptation, developed a method to estimate and integrated and unified evaluation which would allow comparisons to be made and values to be assigned to the results of different sectors, ecosystems and institutions in the face of climate change. The methodology was based on IPCC structures and definitions, but is integrated into the structure and management of risk, based on the following relationship:

Risk = [threat (probability of occurrence of adverse climate effect event)]*[vulnerability].

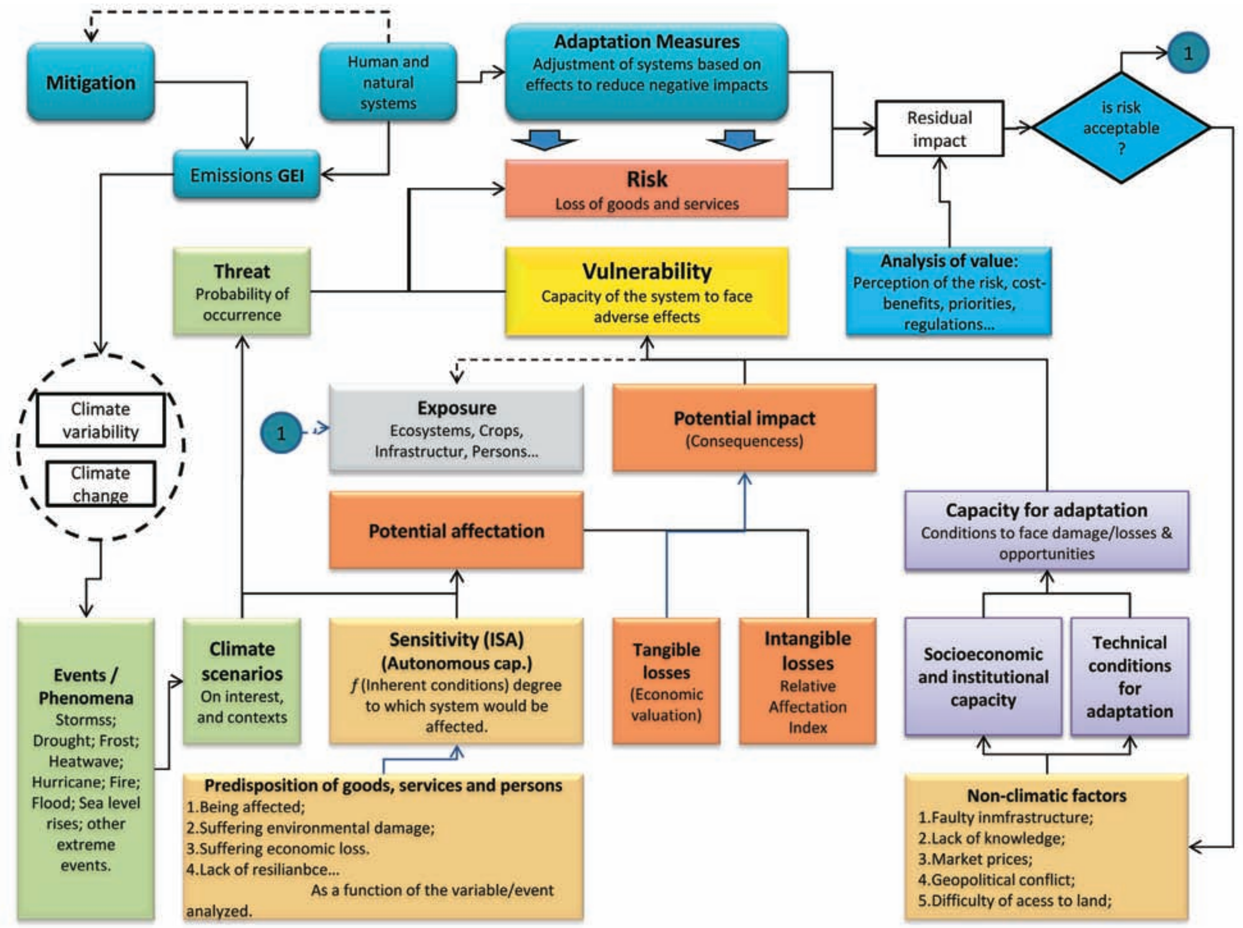
In other words, the probability of occurrence (threat) of an adverse event operated as a multiplier of losses (impact) or vulnerability, determines the risk of loss of goods, services or functionality.

Vulnerability is considered on the basis of residual impact of climate change, after considering the capacity for adaptation. The form adopted in this methodology is based on the expression:

$$\text{Vulnerability}=[\text{potentially negative climate impact}]-[(\text{potentially negative impact})*\text{Capacity for adaptation}]$$

The method used to evaluate vulnerability allows identification of regions, covering and the most vulnerable sector, or critical zones, after obtaining intermediate results. This will act as a support for design and evaluation of policies for adaptation, with the possibility of including mentioned criteria to reduce vulnerability. In Figure 4.9, we see the methodological structure followed

Figure 4.9. Methodological structure for evaluating vulnerability



Source: Ideam-authors. Adjusted of different models.

For the exercise of evaluation of the methodology the rainfall multimodel result was used for different periods generated by Ideam-Ruiz (2010)[12], 2011-2040 and 2070-2100. The potential effects on coverage and sectors were determined on the basis of results obtained by crossing the sensitivity index (ISA) to the relative affectation index (IRA), and the rainfall multimodel considered.

The ISA was structured on the basis of soil characterisation, vegetal cover, ecosystems transformed, aridity index, and erosion of dry zones. This indicator is defined as the degree and to which a system may be positively or negatively affected by climate-related stimuli[13].

The IRA was based on the discussion and consensus of more than 80 professionals in different sectors and specialties; the intention was to introduce priorities with using the judgement of experts to identify each of the coverage, ecosystems or territories which might suffer impact from adverse events in climate change in the worst scenario.

12 Ideam has run and valudated the regiuonal mcirculation model Precis (Providing regional climates for impact studies) with scenarios for GHG emissions SRES A2 and SRES B2 to generate predictions on changing patterns of rainfall and temperature throughout 2011-2040, 2041-2070 and 2071-2100.

13 Climate change, vulnerability and adaptation indicators. Mike Harley, Lisa Horrocks and Nikki Hodgson (AEA), Jelle van Minnen (PBL), European Topic Centre on Air and Climate Change.

The capacity for adaptation was determined on the basis of conditions of those involved in combating potential damage, affectation or loss, together with opportunities derived from climate change and climate variability. This capacity is composed of a technical conditions and capacities, and some current socio-economic considerations which might act as barriers or opportunities.

In order to facilitate the assessment of the socio-, economic and institutional capacity, the SISBENIII index was used, as supplied by the DNP Social Development Division (Quality of Life Group) for each municipality.

The current technical condition of adaptation (also associated with the willingness to adapt in the future) is a function of planning supported by an appropriate strategy, methodology and tools to allow objective follow-up to be pursued in the implementation of works and actions to reduce vulnerability to climate change and climate variability- A national average was obtained from workshops with experts in different areas.

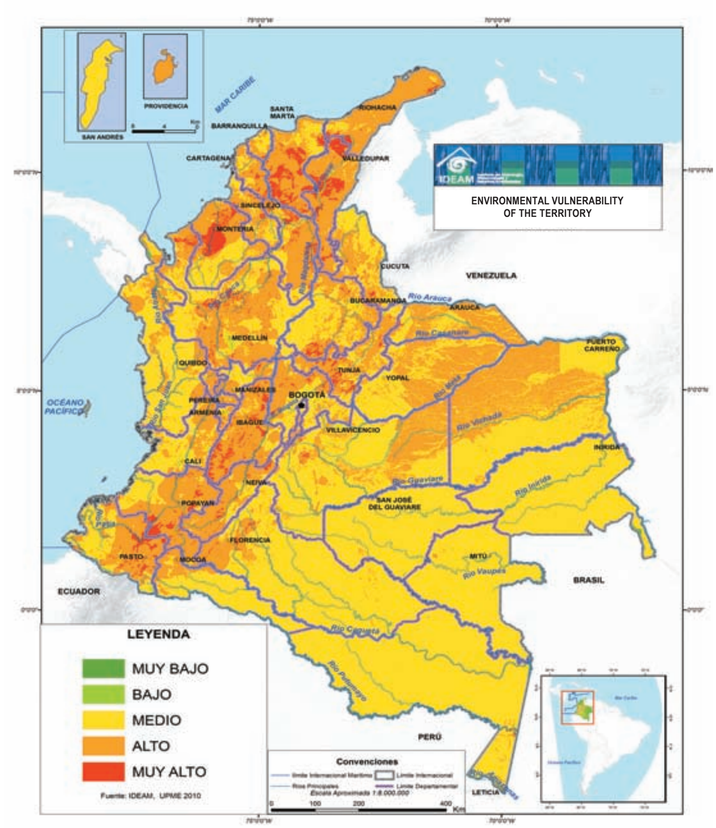
The criteria or basic aspects identified to establish the technical condition: a) Knowledge of impact and loss in the face of climate change/Analysis and prospects of impacts and losses in the face of climate change; b) The management of the effects of the extreme events; c) Organisation of institutions and civic participation; d) Risk transfer and the search for financial and economic strategies; and e) Opportunities and benefits of climate change.

The ecosystems, coverage, productive sectors, infrastructure and other variables analysed were: a) The high Andean orobiome, b) Natural and planted woodland, c) Secondary vegetation, pasture and scrub, d) Natural protected areas, e) Coastal herbaceous and scrub cover, coastal lagoons and mangroves, f) heterogeneous agricultural areas, g) Semi permanent and permanent crops (coffee), h) Annual and transitory crops, i) Analysis of some commercial crops (irrigated rice, oil palm, sugar cane), j) Pasture, k) Indigenous reservations, l) peasant smallholdings, m) natural continental bodies of water, n) Artificial continental water, o) Infrastructure areas for hydro-generation, p) Water resources, q) Coastal marine and island areas, and r) health.

4.4 POTENTIAL IMPACT AND VULNERABILITY

Taking account of the methodology proposed, Figure 4.10 gives a cartographic presentation of territorial vulnerability, based on potential impact for the period 2011- 2040, and the capacity for adaptation as preliminarily established.

Figure 4.10, Map of environmental vulnerability of the territory, 2011-2040



Source: Ideam-authors.

Based on the evaluation of global climate models which best represent the regional climate, and with the help of high-spatial-resolution regional climate models, simulations were made of a range of climatic scenarios which might occur in Colombia over the next few decades and to the end of the 21st century. The most probable scenario of climate change is the following:

- Considering that an average increase in temperature which has occurred (0.13°C/decade, nationwide), in the reference period 1971-2000, principally reflected in the Departments of Cordoba, Valle, Sucre, Antioquia, La Guajira, Bolivar, Choco, Santander, Norte de Santander, Cauca, San Andres, Tolima and Caqueta; and the most significant reductions in total annual rainfall (millilitres/decade) were recorded in the departments of Putumayo (-6.14), Atlantico (-5.88), Arauca (-3.86), Guaviare (-3.85), Boyaca (-3.6) and Cundinamarca (-3.00), the evidence shows significant change with adverse effects differentiated across the country, which would probably become manifest at the end of the 21st century. The departments with the highest increase in total rainfall by decade are Quindio (0.58); San Andres (0-.67), Cesar (1.47), Cauca and Vaupes (1.64), Guainia (2.14), Antioquia (2.31), Choco (3.34) and Caldas (3.88).
- The median values for minimum temperature project increases of the order of 1.1°C for 2011-2040, 1.8°C for 2041 -2070, at 1.9°C for 2071-2100.
- The projections show increases for median maximum temperature values of the order of 1.5°C for 2011-2040, 2.3°C for 2041-2070 and 3.6°C for 2071-2100, indicating that the days will be warmer with respect to the reference period 1971-2000. The most significant median temperature increases will be expected over much of the Caribbean region and Andean region, especially in the Departments of Sucre, Norte de Santander, Risaralda, Huila, and Tolima.
- As a result of assembling high-resolution regional models, it was found that the average temperature in Colombia will increase 1.4°C for 2011-2040, 2.4°C for 2041-2070 and 3.2°C for 2071-2100. The most significant increases will be found in the Departments of Norte de Santander, Risaralda, Huila, Sucre and Tolima
- Based on the scenarios which involve the highest GHG emissions, it is estimated that the most significant reductions in rainfall will occur particularly for the period 2071-2100 in large parts of the departments of the Caribbean region, that is, Sucre (-36.3%), Cordoba (- 35.5%), Bolivar (-34%), Magdalena (-24.6%) and Atlantico (- 22.3%). In the Andean region, the Departments of Caldas (-21.9%) and Cauca (-20.4%) will also have important reductions in their average annual rainfall.
- Increases in rainfall during the 21st century are projected for scenarios of climate change, particularly in large parts of the Departments of Vaupes, Choco, Guainia,, Amazonas, San Andres and Vichada. For the savannah of Bogotá, the scenarios of climate change with the highest volume of GHG emissions analysed show reductions in rainfall of the order of -11.6% for the period 2011- 2040, -16.1% for 2041 - 2070, and 3.4% for 2071-2100, in relation to the reference period climate of 1971-2000.
- The greatest reductions in rainfall for the rest of the 21st century can be expected in various regions of the Departments of Huila, Putumayo,, Nariño, Cauca, Tolima, Cordoba, Bolivar and Risaralda; and in some of those Departments evidence of this will clearly begin to show in the period 2011-2041, in particular in Huila, Cauca, Nariño, Risaralda and Tolima.
- The results of projections of climate change indicate that relative humidity will be reduced in Colombia throughout the 21st century, with in relation to 1971-2000, at levels of almost 1.8% for 2011-2040, 2.5% for 2041-2070 and 5% for 2071-2100. The most significant reductions in this variable over the 21st century will take place in the period 2011-2040 over much of Tolima, Huila and Quindio; and more slowly, through the middle and towards the end of the century, this will extend to other Departments such as Sucre, Bolivar, Cesar, La Guajira, Norte de Santander, Cauca, Cundinamarca, Santander, Nariño and Risaralda.
- Based on the results of the assembly of the high-resolution models, and according to the Lang climate classification, the Guajira peninsula will maintain its desert characteristics; the El Choco will continue to have a predominantly super-humid climate, Amazonia will continue to be humid, and a great part of the eastern plains (llanos) will continue to have a semi-humid, climate. The most significant changes can be expected in the Caribbean region, which will change from a semi-humid climate (i.e. current conditions), to semi-arid, and finally classified as arid by the end of the 21st century. In the Andean region, the most notorious changes can be expected with transition from a semi-humid climate to a semi-arid one, and this will particularly affect different areas of Cundinamarca, Boyaca, Tolima, Huila and eastern Valle del Cauca.
- Based on the rainfall and temperature scenario (2071-2100), and indirect estimates (hydric balance), starting from the results of the Precis models, with regard to the average reference condition, there will be reductions of some 30% in average run- off in the basins of the upper Guajira, lower Magdalena, Cauca and part of the Caribbean coast, Saldaña, Cesar and Bogotá, covering part of Magdalena, Cesar, Atlantico, Bolivar, Cordoba, Sucre and Cundinamarca.

The following conclusions are reached with regard to the most sensitive and vulnerable ecosystems:

Andean Orobiome

- The potentially very high and high impacts which affect ecosystems of the High Andean Orobiome in the period 2011-2040 cover more than 70% of the orobiome (44.3 million ha). This potential impact, if analysed as a function of environmental goods and services for greater concentration of the population and production systems which depend on it, means that there will be important consequences, particularly if account is taken of pressure caused by the advance of the agricultural frontier due to over-utilisation and conversion of natural ecosystems into crop and pasture areas.
- This orobiome also contains large tracts of natural woodland and scrubland (more than 40%), which play an important part in the regulation of run-off, which would be significantly (20%) compromised by high and very high impact of the total identified for the high Andean orobiome.
- Results obtained indicate that the natural or mildly-intervened ecosystems are less sensitive (intrinsic vulnerability), than transformed spaces in the rural areas. Nonetheless, the affectation due to climate change may bring significant consequences: the changes may be small but will affect large areas, as would happen in Amazonia or biogeographical Choco.

Protected natural areas

- The projected natural areas which record high and very high potential impact for the period 2011-2040 in the nature parks of Sierra Nevada de Santa Marta, Cocuy, Las Hermosas, Nevado del Huila Los Nevados y Puracé. In addition, the high Andean orobiome, the nature parks of Pisba, Los Nevados, Purecé, Las Hermosas, El Cocuy and Chngaza are particularly likely to suffer high impacts in the longer term.

Farming, and peasant smallholding areas.

- The most important areas for the Caturra coffee crop which would suffer high and very high potential impact related to a deficit in rainfall in the period 2011-2040 would be located in several parts of the Departments of Antioquia, Valle del Cauca, Quindio and Caldas. In addition, Huila, Tolima, Cauca and Risaralda, in particular, are forecast to suffer high potential impact. The percentage of the accumulated impact for the two categories - high and very high- would be of the order of 71% of the total area (approx. 869,000 ha), as surveyed by Coffee Federation census of varieties: Caturra 75%, Típica 63% and Colombia 71%. The greatest surface area which might be compromised by very high potential impact would be that of the Colombia variety (10%).
- Annual or transient crops located in different parts of the Departments of Antioquia, Tolima, Boyaca, Cordoba, Cundinamarca and Santander might suffer a very high potential impact in the period 2011-2040.
- In the period 2011-2040, the entire country may be compromised by high and very high potential impact affecting more than 50% of its pasturelands.
- The largest peasant smallholding areas which might suffer very high in potential impact due to reductions in rainfall would be partly in the Departments of Boyaca, Cundinamarca, Antioquia, Bolivar, Nariño and Santander. If all the surfaces which might receive high or very high impact from rainfall reduction in 2011-2040 are added together, they would account for 47% of the total peasant economy of Colombia.

Woodlands

- Measures for the management, protection and conservation of coverage in ecosystems with special environmental conditions need to be developed and implemented, taking account of the potentially high and very high impact that threatens the beginning of the period (2011-2040), due to reductions in rainfall in the woodlands of Boyaca, Valle del Cauca, Bolivar, Magdalena and Antioquia, , along with secondary vegetation, scrub and grassland in the Departments of Tolima, Cauca, Nariño, Valle del Cauca, La Guajira, Antioquia, Huila and Cesar. These ecosystems, in addition to demanding conditions of climate and pressure from human activity to which they are currently subjected (agriculture, cattle-raising, mining and infrastructure projects) are essential elements for the population of those Departments.
- The conditions proper to semiarid, arid and desert climates might (according to the models) expand and become more rigorous and extreme. These areas will also urgently require regular monitoring and evaluation, in order to produce an effective valuation of restoration plans now moving forward in those areas of coverage, given the evolution prospects of the period 2011-2040.

Bodies of water

- The natural continental bodies of water (rivers, lakes, lagoons and flood areas) would have a high potential effect, mainly in the Departments of Bolivar, Magdalena, Cesar, Santander, Tolima and Amazonas, and some 63% of Colombian territory would suffer high to very high potential impact in the period 2011-2040. There is also the important matter of the condition, interdependence and collateral impacts on other ecosystems which receive environmental goods and services from continental bodies of water.
- Further, if account is taken of the limited capacity of wetlands to adapt, it is considered that these bodies of water will be among the ecosystems most vulnerable to climate change. A small increase in the variability of rainfall regimes may have an important effect on flora and fauna in the wetlands (Keddy, 2000; Burkett and Kusler, 2000; cited by IPCC, 2008c)
- These reference points are corroborated by the very high impact (reductions of more than 30% in water yield), which is expected at the end of the century in some parts of the Departments of Nariño, Cauca, Valle del Cauca, Huila, Tolima, Cundinamarca, Caldas, Antioquia, Bolivar, Magdalena, Cesar, including the seashores in the Departments of Cordoba, Sucre, Bolivar and Atlantico.
- Further, there is very high vulnerability in more than 45% of Colombia´s areas of coastal mangroves, grasslands, scrub and lagoons during the period 2011-2040, particu7larly in the Departments of Magdalena, Nariño and La Guajira; and with the high vulnerability in Choco and Antioquia; this will cause cumulative impact on the sea-shore areas, if we also take account of the increase in sea level which will take place in those areas.

Dry ecosystems

- It is considered that about 16% of Colombia's territory will tend to be warmer and drier at the end of the century, and a part of the super-humid (13%) and humid (5%) territory will be reduced by 5% and 4% respectively, to make way for semi-humid, semi-arid and arid climates (6%, 2% and 1%, respectively). It is therefore most important to make progress in the management of such conditions, particularly in sustainable management areas associated with loss of soil, optimisation of water regulation and distribution, and its close relationship with the processes of deterioration of the natural environment and poverty.
- Towards the end of the century (2071-2100), there will be an increase in semi- humid areas (11%) in Colombia, and an increase in semi-arid (2%) and arid (3%) areas, at the expense of areas classified today as humid (10%) and super-humid (6%).
- The evaluation of processes of desertification, and the effects expected from it from them, beyond the release into the atmosphere of an important fraction of carbon in the soil, is essential, in order to improve knowledge of vulnerability and risks related to the loss of environmental services which dry ecosystems provide to society, including the various sectors with regard to the imbalance which would arise due to the application of management or measures of adaptation which are not particularly effective or bad, generated by certain productive sectors.
- A review of major changes in surface using the Lang climate classification by Departments, with a tendency towards drier climates, is identified for the departments of Magdalena and Cesar, which would cease to have principally semi-arid and a semi-humid climates, and come to have semi-arid and arid conditions.
- In the Departments of Bolivar, Tolima, Cundinamarca, Huila and Valle del Cauca can expect more drastic changes, since mainly humid and super-humid climates would be exchanged for semi-humid, semi-arid and arid climates. The range of variation is much wider than that expected for the period 2011-2040.

Coastal and island areas

- For the island areas of San Andres and Providencia, scenarios often called “pessimistic” show reductions of close to -6.7%, -7% and -10% for the three periods of reference for future climate (2011-2040, 2040-2071, and 2071-2100, respectively).
- If the sea level rises 1m by 2100, the population affected would be of the order of some 1.4-1.7 million, equivalent to 2-3% of the population of Colombia in that year; and 80% of them live in the Caribbean region and 20% in the Pacific region.
- Approximately 55% of the population of the Caribbean coast will be exposed to the direct effects of flooding from the sea. About 90% of this population affected is located in the larger towns and cities there, while the rest are scattered in rural areas. The cities would be under greatest threat, namely Cartagena, San Juan de Uraba, Turbo, Ponedera and Puerto Colombia, and rural areas of Cartagena.
- On the Pacific shores, some 41% of the population would be affected by flooding due to the rise in sea level. Some 36% of the population is to be found in the towns, while the rest are scattered in rural areas. The towns

of Tumaco, EL Charco, Nuqui, Jurado, Santa Barbara and Olaya Herrera have the largest of concentrations of population with some possibility of flooding.

- The rise in sea level by 1m, could cause flooding to affect more than 10% of the island of San Andres, in represented by swamps, the coastal strip, artificial infills, and some low coral terraces covered by mangrove. Residential and commercial urban areas would be affected in these places, as well as the island's port. On the islands of Providencia and Santa Catalina, the area exposed to flooding would represent 2.8% of the area of the islands, affecting places currently occupied by residential, commercial and public property, including the port of Providencia. There will also be adverse effects on the tourist areas of the bays of Manzanillo, Suroeste and Aguadulce where there could be a retreat of the beaches, and the swamplands could become flooded.
- Colombia's coastal and island zones classified as critical are the following: Cartagena, Barranquilla and Santa Marta for the Caribbean, Tumaco and Buenaventura on the Pacific. Cartagena and Tumaco will have the highest of vulnerability indicators for the Caribbean and Pacific, respectively

Areas and infrastructure for hydro generation

- Further important high (37%) and very high (6%) impacts might be caused to the capacity for hydro generation (effective and net for the period 2011-2040) in the departments of Antioquia, Caldas, Cauca, Cundinamarca, Huila and Nariño, which in relative terms would affect some 43% of the existing total capacity.
- Projected capacity (average energy), which in part reflects the greater capacity for generation that there might be in the future (2011-2040), would suffer high and very high impact, with a particular emphasis on the Departments of Antioquia (10%), Santander (9%), Tolima (6%), Huila (5%) and Cundinamarca (5%),. This identification should be taken with relative reference to projects located in other Departments.
- If high and very high impact is accumulated in generating capacity, in the context of total future projects, the figure is something similar (43%), to that found for projects currently in operation for the period 2011-2040.

5 ADAPTATION

Adaptation is the adjustment which is made by natural human systems in response to real or expected climatic stimuli or effects, which attenuates the damage caused, or potentiates beneficial opportunities (IPCC, 2007).

Adaptation to climate change is an important and complex series of activities, which presents challenges in particular to developing countries (UNDP[14], 2008). The impact of climate change is already affecting those countries, in particular the poorest and most vulnerable, because they have fewer social, technological and financial resources to adapt with. Further, climate change affect the sustainable development of countries, and their capacity to achieve their MDOs for 2015.

As can be seen in the vulnerability analysis, Colombia is highly vulnerable to the effects of climate change. Therefore, in addition to national effort, there must be an availability of economic resources and international support.

It is to be expected that the implementation of measures for adaptation proposed the impact and vulnerability of Colombia will be reduced, and that potential environmental, economic and social effects will be attenuated, and for the this reason, an efficient monitoring system is being promoted for the evaluation of the relevance and effectiveness of measures for adaptation, along with re-orientation of actions to be taken, as appropriate.

5.1 Guidelines for adaptation

Given the progress that Colombia has made in its environmental and sector policies and regulation, the actions for adaptation proposed are largely addressed to the strengthening of actions already taken, but which require consideration of climatic variables in planning and execution. One of the most important efforts has been a much-needed articulation of policies, plans and programmes for sectors, with environmental actions, considering climate change in order to seek synergies and to avoid "bad" adaptations which will damage the efforts of other productive sectors in that respect.

The following strategic lines are proposed for development, structuring and subsequent preparation in detail through a National Adaptation Plan, in the context of the content of our Second National Communication (SNC), and on the CONPES policy document on Climate Change, currently being executed by DNP.

14 United Nations Development Programme: Pnud siglas en español.

5.1.1 Strengthening activities in research and transfer of knowledge

It is a priority to have a store of studies as a base which matches the needs of decision-makers in the most vulnerable sectors and ecosystems. Therefore, reliable forms of support must be obtained in order to interrelate the climate variables with the base of resilience of ecosystems and productive sectors, amongst which are the most sensitive and vulnerable, a) farming, b) health, c) coastal, marine and island ecosystems, d) high mountain and paramo ecosystems, e) hydric systems, f) infrastructure, g) energy systems and h) dry ecosystems

The focus proposed in this guideline is oriented towards an improved information flow, and towards in-depth research in productive sectors, ecosystems, biodiversity and population, and research into socioeconomic indicators.

5.1.2 Strengthening risk management

There has been important progress in research, and in the availability of resources and increased capacity for integral risk management, although such efforts must now be re-focused to achieve the most cost-effective results, in addition to acting as a support in the protection of communities, natural capital, and infrastructure, to combat the effects of climate change. So, we propose a need to need for medium and long-term applied research, for integral risk management, considering climatic variables and the need to strengthen and deepen mechanisms of risk transfer, particularly towards the agricultural sector, considering changes in climate.

5.1.3 Improved use of territory as a strategy to do reduce vulnerability

Greater equilibrium must be achieved between the processes of urban development and improvement in the conditions of life of rural areas, in order to reduce the concentration of the population in the major cities, which may be strengthened by giving guarantees of conditions of lasting peace, access to social services to be made available in an alternative and innovative manner to those who live in rural areas, reinforcing the generation of jobs in rural areas designed to take account of generation and gender, strengthening the local context in its capacity for governance and management, and securing levels of use of, and access to, natural resources by the local population.

One of the means of materialising the management of natural resources is land-use regulation, which is an attempt to provide an organisation of human settlements and activities in accordance with an economic policy which matches objectives of environmental sustainability and quality of life.

In this context, a range of plans for land-use and regulation must be prepared, including climate change and its effects. The specific issues which are developed in the strategy with the inclusion of risk management and climate change planning are to be found in territory planning instruments, and a greater penetration of land-use regulatory instruments such as the River Basin Regulation and Management Plans (POMCA).

5.1.4 Reduction of environmental, economic and social impact.

In the context of the integration of measures to adaptation and mitigation, values must be assigned to the vulnerability of water resources at regional and local levels, in terms of availability, demand, and water shortage in various scenarios of climate change, giving priority to sectors which depend on offer, such as farming, electricity generation, public services (rural and municipal water supplies).

Colombia's energy matrix is predominantly water-powered (more than 64%), and therefore there is a dependence on the availability of water resources; research must therefore be done on the vulnerability and availability of that resource in different scenarios of climate change. This research should include an analysis of the function of regulation which is provided by forestry ecosystems in the hydrological cycle for the various supply basins which feed reservoirs, thus allowing the measures for conservation and restoration of forest cover to be validated and incorporated as a response to climate change, in order to secure energy offer.

The farming sector, in terms of the vulnerability analysis, would be one of the worst affected by conditions of climate change. It is therefore essential to strengthen and deepen the mechanisms of risk transfer for farmers, and in particular, for small producers in the poorest communities, since this is where the worst affectations will arise.

An analysis will also have to be made of the various sector development policies, in order to avoid conflicts arising between sectors in relation to environmental goods such as water; and the mining development plan should be articulated to agricultural expansion agricultural, forestry and cattle breeding expansion plans, thus avoiding a predominance of actions known as “bad” adaptation, that is, actions which instead of improving the country's resilience to climate change, tend to worsen the situation.

5.1.5 Improving the capacity to adapt of vulnerable communities

Policies need to be integrated into the sustainable performance of the major productive sectors in Colombia, and they in turn will be affected by climate change in respect of productive capacity. The generation of employment and the integration of marginalised groups of the population into strategies for climate change will undoubtedly be an opportunity for development in Colombia. In the context of the results of the pilot project for adaptation to climate change, there has been an emphasis on the importance of civic participation in a range of different spaces and mechanisms during the process of formulation of measures for adaptation, in order to facilitate the assimilation of targets and results. Therefore, actions are proposed in relation to a) Design of policies for production of policy considering climate change, b) Reduction of the economic effects of climate change impact, and c) Strengthening of social organisations.

5.1.6 Design and implementation of appropriate institutional arrangements for adaptation

Guidance will have to be provided for the development of the capacity to adapt and resilience based on better coordination of the State to face adverse situations and uncertainties arising global processes of climatic change. This activity may be pursued by strengthening social protection networks and the process of decentralisation of public administration, the development of a culture of prevention as part of the cycle of risk management, a reassessment of the values and effective dialogue in relation to the local knowledge scientific knowledge.

Actions related to the following programmes are described here for further development: a) Institutional actions and agreements for the design of instrumentation of the National Adaptation Plan, b) Design of instrumentation for national, regional and local integration mechanisms, c) Potentiation of inter- institutional synergy, d) Long-term planning, and e) inter-institutional coordination in the design and development of policies, plans, programmes and actions of productive sectors, and of the productive sectors with the environmental sector.

5.1.7 Placing a value on the productive base and protecting it, based on biodiversity goods and services

In addition to the need to improve technological capacity and infrastructure in areas related to the climate, and the design of an infrastructure with resilience to climate change, it is recognized that ecosystems provide vital services such as potable water, protection, habitat, food, fresh matter, genetic material, and also able to act as a barrier to disasters, a source of natural resources, and many other ecosystem services on which people depend for their survival.

To that extent, the proposal is that adaptation to climate change should consider ecosystems in the design of measures, given that the ecosystems act as a support and generate essential goods in inputs and services for productive sectors.

5.1.8 Strengthening of cooperation activities and resources for adaptation

Colombia´s institutions, particularly environmental ones, are engaged in important efforts to finance projects related to climate change, without ignoring the significant support obtained from international co-operation. Nonetheless, due to the magnitude and complexity of the subject and its potential effects, Colombia will have to make more resources available, from local and foreign sources, in efforts to understand the phenomenon, and in particular, to design and implement measures for adaptation, particularly in non-environmental sectors.

Despite this, in order to avoid the dispersion of effort and obtain greater effectiveness in the implementation of future projects for adaptation, it must be a priority to design the National Adaptation Plan, as a guidance for external sources, and thus maintain a unity of criterion in the development and obtaining of results that will be more coherently applicable in the context of the framework for action.

5.2 PRINCIPAL ACTORS AND ACTIONS IN ADAPTATION

The following are the most important institutions which took part in the pilot product project for adaptation, or which lead other actions related to the issue of adaptation to climate change, in synergy with national, local or regional entities: MAVDT, MADR, DNP, Ideam, Invemar, IAvH, Parques Nacionales, Corpoica, Universidad Nacional de Colombia, Colciencias[15], Cruz Roja Colombiana, CI-Colombia, WWF-Colombia, Universidad del Cauca, and others.

15 Now “Departamento Administrativo de Ciencia Tecnología e Innovación”

5.3 SUCCESSES OF THE PILOT PROJECTS FOR ADAPTATION IN COLOMBIA

5.3.1 Definition of vulnerability in the bio-geophysical and socio-economic systems due to a change in sea levels in the coastal areas of Colombia

One project which forms part of the Dutch Assistance Program for Studies on Climate Change, through MAVDT, allowed Invemar to study a project to define the vulnerability and measures of adaptation to be taken in by geophysical, socioeconomic and governance systems on the Colombian Caribbean and Pacific coasts, in the event of a possible rise in sea level.

This project was completed in July 2003: it enabled three critical areas to be identified, and an action plan drawn up taking account of the result of "high" vulnerability of Colombian coastal areas in the event of possible increases in sea level (SLR), together with the definition of priority actions to be taken in coastal zones for the period 2002-2012, 2012-2030 and 2030-2100.

The formation of a Research Centre Network is one of the most important developments in into institutional co-operation and information exchange in the area of marine sciences, and of extension on issues of climate change[16]. In the information system laboratory (LabSIS) of Invemar, there are some important materials for geomorphology, coverage, ecosystems, productive systems, and uses of coastal areas. A national programme of "Research foe the Prevention, Mitigation and Control of Coastal Erosion in Colombia-Action Plan 2009-2019)" was generated.

In particular, also, there were items relating to development plans and to risks in coastal zones in relation to natural threats to which they are exposed, in addition to adaptation measures which have been or are being included in the land-use regulations (such as the POT of Tumaco, Cartagena and EOT of Turbo, Necocli, San Juan de Uraba and Arboletes).

5.4 NATIONAL PILOT PROJECT FOR ADAPTATION TO CLIMATE CHANGE (INAP)

The Inap project, with general technical coordination supplied by Ideam and administrative coordination by Conservation International-Colombia, has been developing actions in four specific components, which have been the result of conclusions related to environmental and health variables which are most affected in the First National Communication (FNC).

This project, founded by GEF-World Bank, focuses its action on the generation of reliable information on climate change (Component A). It is executed by Ideam, which in turn coordinates the last component and the design and implementation of a programme for adaptation in high mountain ecosystems (Component B). The development of a programme for continental island adaptation is the responsibility of Invemar, and the development of the adaptation programme for the ocean island environments is being developed by Coralina (Component C). The health service INS seeks to diminish morbidity from malaria and dengue through the design and implementation of an integrated surveillance and control system (SIVCMD), which is a response to possible changes in the dynamics of transmission and exposure, including those induced by climate change (Component D).

The Inap project has enabled progress to be made in Colombia's capacity to produce and publicise climate information, and to prepare scenarios of climate change as a means of strengthening technical and scientific capacity. In addition, it has promoted the development of key adaptation measures required to reduce the vulnerability in the Chingaza massif, and monitoring of the glacier area in the snow-capped mountainous related to the water cycle; the reduction of negative impact in regulation of the Rio Blanco basin through the economic, ecological and participatory restoration of the landscape; the adoption of planning models for land use, incorporating the impacts of climate change on the municipalities of La Calera and Choachi, through Adaptive Living Plans, and the adaptation of productive systems to climate change through training and in local communities in agro- ecology and organic agriculture.

With regard to the progress in the programme for adaptation in the island areas of the Colombian Caribbean, certain measures have been defined, such as the establishment of the global ocean observation system (GOOS) in the western Caribbean, with the installation of monitoring stations, and the setting up of a data management centre (DMC). In addition, integral water management systems have been constructed, with a system for monitoring coastal erosion, and a preliminary document on the population policy for the Archipelago of San Andres and Providencia, with the participation of local communities.

16 Members of the network will include Universidad del Valle, Universidad Jorge Tadeo Lozano. Universidad Nacional de Colombia, DIMAR and INVEMAR.

With regard to the Component D, an analysis of dengue and malaria is being made in certain municipalities, using statistical models, to make a proposal for adaptation measures which will avoid the reproduction of the dengue vector, both in terms of its biology, and of its impact on certain human activities.

5.5 JOINT PROGRAMME: INTEGRATION OF ECOSYSTEMS AND ADAPTATION TO CLIMATE CHANGE IN THE COLOMBIAN MASSIF

The joint programme starts with a joint analysis of the country made by the United Nations System, and the priorities defined by the Colombian government in its 2006-2010 National Development Plan. The partners in the programme are DNP, MAVDT, Ideam, CRC (Cauca Development Corporation), the municipalities of Puracé and Popayán, the indigenous assemblies of Kokonuko and local peasant farmers association, Asocampo.

The pilot area for the programme is the basin of the Upper Cauca, in the municipalities of Puracé and Popayán, with a population of some 11, 219, between the indigenous reservations of Puracé, Kokonuko, Paletará, and Quintana and the peasant community association Asocampo and Asproquintana, and peasant sectors of Poblazón and Paletará.

As a result of the analysis of vulnerability of the pilot area of the programme, and the MDO baseline for the municipalities of Puracé and Popayán, three major work fronts were defined as a guide for the application plan, and these have been developed to produce the measures of adaptation proposed in conjunction with the community 1) Water security 2) Food security and 3) Capacity building.

On the issue of water security, the proposal is made for a participatory construction of pilot models (in houses and schools), with appropriate technology for storage, handling and treatment of water, with priority attention to women. The capacity- building work is to be done by government with respect to water, provided by local authorities and District Boards. Priority is to be given to areas with a capacity for water regulation; stands of trees, and dense natural woodland. Design and implementation of actions to store resources for collective and family use, and the regulation of watercourses, based on the impact of drought and surplus water. Generate appropriation by the community of new health practices to manage climate change risks in health. Enhance local capacity of for meteorological monitoring. Implementation of early warning systems and local plans for community emergencies.- Definition of unsafe areas affected by recurrent natural threats

In the area of food security, the proposal is intended to identify and develop alternatives for production and generation of sustainable income. Actions to improve the food production and plans to improve nutrition levels with priorities for women heads of household. Handling of agricultural chemicals in the home and at school (storage). The location of priorities for the incidence of the municipal food security plan, and the incorporation of risk management into the land-use regulations. Generation of added value with productive links (barter). Improved structure of revolving funds with training for best practices (capitalisation). Initiation of reconversion processes in land use, with the regulation and planning of agricultural production to enable areas to be released for conservation and water, the establishment of seed banks and temporary nurseries for the climatic adaptation of propagation material for plants. Productive arrangements of agricultural systems based on “best practices”, and the enrichment of biodiversity in terms of more flexible or adaptable germplasm between one bioclimatic level and another. Materialisation of a process of regulation based on the consolidation of sustainable production, the definition areas for ecological restoration focused on water regulation.

The strategy for capacity-building is transverse to all the foregoing, and comprises educational proposals for generation change and preparation for climate change, the empowerment of the young as agents of positive action and change. Incorporation of differentiated strategies with a focus on gender and ethno-cultural aspects in the implementation of adaptation to climate change, in order to facilitate the achievement of MDO. Analysis of the participation of women in decision-making, and design and promotion of actions. Capacity building in regional and municipal environmental and traditional influences, with an emphasis on risk prevention and territorial planning (includes promotion of awareness of climatic change, organisation-building, technical training for adaptation, community education with an emphasis on formal education instruments, and regulatory development).

6 PUBLIC EDUCATION, FORMATION AND SENSITISATION

In this chapter, we draw attention to the actions taken in Colombia with regard to Article 6, principally actions taken between 2007 and 2009. There are proposals for an action in strategic lines to extend knowledge regarding issues of climate change in Colombia. The focus approaches the action lines established in the New Delhi working programme, with regard to Article 6: 1) Promotion of public participation, 2) Access to information, 3) Creation of awareness, 4) Training, 5) education and 6) International co-operation (UNFCCC, 2002).

With regard to the promotion of participation, the situation is that in recent years there has been increased participation by the public in issues of climate change in Colombia, as a result of initiatives led by the Government, civil society, the academic sector, the industry associations, the media, and communities. NGOs have undertaken actions to promote activities and results regarding public awareness and participation. Similarly, there has been important participation by children and the young through formal, non-formal and informal educational activity.

The media - radio, press, TV and Internet portals - have also played an important part in providing access to information, as being the most important mass source of public information on matters of climate change. One of the Government's efforts in this area has been the webpage www.cambioclimatico.gov.co), which draws attention to general, legal, technical and scientific aspects of climate change. Also, on the webpages of MAVDT (www.minambiente.gov.co), the Ideam page (www.ideam.gov.co), and the national environmental information system (www.siac.gov.co), provide access to information on the subject.

Among the activities undertaken to enhance awareness of climate change there have been campaigns, events, awareness sessions, and the production of publicity materials, academic events at the academic, scientific and research events, and others. One proposal which should be implemented in centres of higher and intermediate education is related to the creation of extra-curricular courses of analysis of knowledge related to climate change.

Colombia, with the support of a number of local and international organisations, has promoted the holding of courses, seminars and encounters for the exchange of experiences. Among the international events held between 2008 and 2009, there has been a course on the generation of scenarios of regional climate change; the Ibero-American Seminar on Scenarios of Climate Change; the workshop for evaluation of adaptation measures for climate change in Ibero-America; the V Annual Encounter of the Ibero-American Network of Climate Change Offices and the International Encounter for Working Group Researchers on Andean and Caribbean Snow and Ice .

Colombia has made significant progress in the processes of environmental education, both in formal and in non-formal areas, through the nine strategies of the national environmental education policy (MMA and Ministry of Education, 2002). These advances are the result of inter-institutional and inter-sectorial work on this subject, but no detailed statistics are available at present.

Some of the actions undertaken include the national website on climatic change (www.cambioclimatico.gov.co) , the national campaign bank led by WWF with MAVDT support, the Bayer Youth Environmental Encounter competition, on the issue of climate change, the production of the first video of adaptation to climate change, launched in the context of the 13th conference of the UNFCCC members in Bali, Indonesia in 2007, and in the International Environmental Fair (IEF).

6.1 GENERAL ASPECTS OF THE EDUCATION STRATEGY

The principal objective of the strategy is to set guidelines which will contribute to the creation of capacities at local, regional and national level on issues of climate change through the implementation, follow-up, accompaniment and evaluation of measures to promote access to information, encourage public awareness, training, education, research and participation.

Further, the strategic lines to implement this strategy are 1) participation, 2) access to information, 3) public awareness, 4) training, 5) education, and 6) research. These will be the lines around which the actions of the various institutions at local, regional and national levels will be constructed.

Finally, the follow-up and evaluation of the strategy will be developed jointly among the entities responsible for promoting it, Ideam and MAVDT. Taking account of the fact that the New Delhi work programme will be reviewed at world level in 2010 and 2012, Colombia will make two preparatory views in those years, and will publish is results.

7 OBSTACLES, LACKS AND NEEDS

7.1 Challenges in coordination

There is no doubt that one of the major challenges in the face of climate change is the improvement of inter-institutional coordination. This coordination should allow the negative impact of climate change to be reduced through a) Increased resilience on the part of communities, which should start with work and agreement with communities, b) Strengthening of entities responsible for supporting and guiding measures for adaptation, c) Progress in regional and local models, enabling simulations to be set up, along with the determination of scenarios which will lead to an evaluation of individual and aggregate risk by sectors, depending on environmental and goods and services threatened, d) Individual capacity in the peasant farming economy, differentiating crops and associations which will give the greatest food security, e) Increased capacity to soften the effect of extreme events, and f) strengthening of the creation of regional applied research groups, to optimise synergy between countries with similar challenges, and to achieve greater efficiency in the integration of strengths and experiences of more advanced countries in terms of research processes, and the application and evaluation of results.

7.2 NATIONAL ADAPTATION PLAN FOR CLIMATE CHANGE

While Colombia has taken the initiative in the implementation of the projects explained in the chapter on adaptation, there is a priority to generate a national structure with participation of a range of entities and individuals in the other organisations involved, in which the priority lines of action will be:

management of surface water and groundwater, as a transverse element integrating various sectors - energy, farming, industry, etc.

Design and implementation of measures for adaptation, based on prior evaluations of vulnerability, in such a way as to involve the goods and services provided by ecosystems, the optimisation of land-use regulation, and socio-economic variables and technical conditions to establish the capacity of adaptation to climate change.

Evaluation of risks associated with extreme events, mainly related to hydrometeorological variables.

Allocation of a vulnerability value, based on the SCN methodology, to permit the mutual relations and discussions between sectors, ecosystems and interest groups.

7.2.1 Institutional arrangements and guidelines for national plans for adaptation/mitigation

One opportunity to achieve more cost-effective investments of resources must be based on the National Adaptation Plan, supported by open and expeditious participation acting for the interests of the most vulnerable groups or communities. Therefore, it will be important for Colombia to construct a national adaptation programme, not for the purpose of aggregating interests, but as an option for a real increase in timely and practical support of existing capacity between different institutions.

The Adaptation Plan should also concentrate on national, regional and local planning, in order to integrate them, and to use indicators for sustainable development, to integrate clear signals of evolution and organisational capacity, technology, and knowledge and skills in institutions. A structure will be required for the formulation and implementation of this national adaptation and mitigation plan, to enable coordination of all capacities wills and regulatory support required to deal with l the challenges mentioned.

It is important to include depreciation -i.e. the consumption of natural capital, in order to achieve sustainable economic welfare, in which there is no downward path from one generation to the next, and indeed, there may even be an improvement. In other words, strategic wealth must be maintained (biodiversity), as a basis of productive value for an economy composed of capital of human origin, natural capital, knowledge, institutions and capacities.

With these purposes in mind, adjustments must be worked out for development, such that the measures for increased resilience among communities and in their means of sustenance, with the construction of territorial security based on the most lasting assets and capital. The strategy, aside from being necessary, should also be seen as a starting point for facing climate change in Colombia, since it contributes to the struggle against poverty, and to the achievement of the MDOs.

The analysis of the effects of climate change should have a broader scope and coverage and a longer term for ecosystems such as the high Andean systems, and the arid and a semi-arid zones, wetlands, swamps, estuaries, inter-Andean valleys, and the effects on fisheries, subsistence crops, the Pacific and Amazon jungles, etc.

7.3 TECHNICAL AND FINANCIAL NEEDS

7.3.1 Technical needs

Information management

With regard to the generation of sufficient reliable information for future GHG inventories, actions must be taken such as the strengthening and adjustment of instruments for the capture of detailed sector information. This action should permit a more accurate and precise calculation of the GHG inventory.

The results obtained in the GHG emission inventory for Colombia make it clear that there is a need to generate more detailed and more specific sector information, in order to promote the construction of local emission factors. This entails interinstitutional commitments in the generation and supply of detailed information on the scales required>, because even if the participation of sector entities with functions and knowledge of the subject[17] were available, there must be support and linkage for the delivery of information.

With regard to the analysis of vulnerability, is a priority to have groundwork in studies which meet the needs of decision-makers in the most vulnerable sectors. Therefore, there must be reliable support to allow an inter-relationship between the climatic variables, worked out on the basis of sustainability of ecosystems and productive sectors, amongst which the most vulnerable and fragile are a) farming, b) health, c) marine and coastal areas, d) hydric systems, e) vital infrastructure, amongst others, as a result of extreme climatic events.

Further, it would be appropriate to take account of the direction of environmental effort in terms of instruments, supported by the management of uncertainty in decision making.

Participatory research and applied research in the most vulnerable sectors

Taking account of potential effects on productive processes of the measures for mitigation of GHG emissions, work will have to be done on projects which will allow calculation of potential economic impact on a range of sectors caused by possible scenarios or projects for mitigation.

The investigation related to future climate scenarios should continue to make progress and consolidate in Colombia. This is one of the most important and complex requirements today, since, due to the need to have a number of scenarios and timescales for different geographical contexts, so that analyses can made with less uncertainty about future threats which Colombia will face. Ideam needs to l be strengthened for this effort, since it is the national entity responsible for approving and structuring all information and models in research centres, universities, and projects to construct a reliable database to allow decision-makers in all sectors to make a correct analysis of the future situation of the climate.

Innovative mechanisms are needed to share risks and face new challenges proposed by the proposals for the adverse effects of climate change, including the loss of biodiversity and the degradation of land. All of this must be evaluated in order to create a subsidy due to the initial burdens imposed by the risks of climate change, to be paid by those responsible for new margins all bands derived from man-made stresses external to Colombia.

From the point of view of research into biodiversity, it is of great importance and urgency to introduce criteria of economic self sustainability into most research.

Technical cooperation

Efforts must be joined to strengthen the ties between diagnosis and orientation at national level, together with the regional capacity to act. In the same line, local cartographic information is required in relation to the impact of climate change, and national orientation is needed amongst other things for 1) Municipalities to be able to adjust their land-use regulations and to prepare the local and regional committees for disaster prevention and attention, 2) The regional development corporations to issue territorial regulations, in managing basins and in access to, and use of, environmental goods and services, 3) The nature parks must modify their regulations and take measures for adaptation which will be favourable to biodiversity and the functionality of ecosystems, in accordance with environmental goods and services provided; and 4) For productive sectors and communities to be able to prepare themselves, and to set a direction for them to adapt their activities..

7.3.2 Financial needs

Once agreement has been reached at senior levels of government, it will be appropriate for the generation, analysis and publicising of information, to be open and expeditions, as managed through Ideam. The various environmental organisations, productive sectors, research centres, and other ministries are oriented towards the same purposes, in order to progress in adaptation. All this will be possible if the necessary financial and technical resources are available to secure the objectives of the plan for adaptation to climatic change.

17 The formation of technical groups, the exchange of information with sector organisations and the holding of workshops to obtain consensus on some technical matters have led to improved quality and greater volumes of information in comparison to the situation at the time of the first national inventory, because the participation of industry associations and government agencies has been decisive in providing information and defining technical concepts.

7.4 Other needs

Given the complexity of the ecosystems, and economic and cultural considerations, in addition to the extent and risk of those involved, it will be necessary to design and implement a number of projects, in coordination with the those affected. The projects to be implemented will require knowledge of investment and social and technical processes which are beyond the capacity of most institutions and technical situations existing today in Colombia.

Account should be taken of the fact that project should be focused on long-term sustainable objectives in adaptation, starting from initial results, with adjustments during the process and will have room, determined as a functional model which reduced the margins of uncertainty.