Ministry of Labor, Technological Development and Environment

Republic of Suriname

FIRST NATIONAL COMMUNICATION UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

NIMOS

National Institute for Environment and Development in Suriname

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Suriname
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Any comments on this report and inquiries for further copies may be addressed to:

National Institute for Environment and Development in Suriname (NIMOS)

Onafhankelijkheidsplein 2
Paramaribo
Suriname
Tel.: (597) 520043 or (597) 520045
Fax: (597)520042
Email: info@nimos.org **or** nimos@sr.net

Ministry of Labor, Technological Development and Environment

Wagenwegstraat 22
Paramaribo
Suriname
Tel.: (597) 477045
Fax: (597) 410465
Email: arbeid@sr.net

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The National Climate Change Steering Committee consisting of representatives from the Ministry of Labor, Technological Development and Environment (chair), the NGO-community (secretariat), the Ministry of Trade and Industry, the Ministry of Agriculture, the Ministry of Natural Resources, the University of Suriname, the UNDP (observer) and the Embassy of the Netherlands (observer) did the final review of the draft.

This report is the first report in a series of reports to be prepared to the UNFCCC on Climate Change issues concerning Suriname. Recommendations included in this report will be followed-up in the National Action Plan. The second report will inform the Convention on the impact of these actions on adaptation and mitigation to reduce the emission of greenhouse gases by Suriname.

FOREWORD

The Republic of Suriname is well-known for its strong tradition of nature conservation, protection of biodiversity and preservation of primary tropical forest. This is evidenced by a nature conservation system comprising 16 protected areas, which cover more than 14% of the country's surface. These protected areas encompass a wide range of ecosystems, from tropical forests to coastal formations. Over 80% of the land surface of approximately 164,000 square kilometers is covered by tropical rainforests.

Considering this richness in natural resources and its vulnerability and thereby acknowledging the problem of global climate change and its impacts, Suriname became a party to the United Nations Framework Convention to Climate Change on 14 October 1997.

The assessment reports of the Intergovernmental Panel on Climate Change showed clear evidence that serious climate change is taking place in the atmosphere, which may in the long term adversely affect mankind, living organisms as well as many other natural resources in the world. The rising trend of temperature, the consequently changes in the rainfall pattern and sea level rise are some of the parameters indicating the change of the world's climate, which if not kept within certain limits may have serious consequences for many nations including Suriname.

Suriname is particularly vulnerable to the negative impacts of climate change due to her characteristic of low lying coastal zone. This area is Suriname's most fertile land, where most economic activities are practiced and where the population is mostly concentrated.
Although Suriname barely emits greenhouse gases, because of the low development of industries, sea level rise may inundate large parts of the coastal zone.
The impact of sea level rise is therefore significant, and can be catastrophic for the country. Hence, Suriname's most concern is the vulnerability rate of the coastal zone.

Being aware of these negative impacts the Government policy has been directed towards as less as possible interference with the existing natural systems, while making use of the natural resources for the benefit of the nation. This policy has led to the establishment of several protected areas in the coastal zone and in the hinterland of the country. Efforts are being made to effectively manage these protected areas and to promote its conservation.
Suriname will continue to promote conservation of large forest areas in an effort to maintain biodiversity and consequently the various ecological systems, creating hereby large pools of sinks.

The development of this First National Communication has contributed to the availability of more concrete data and information on climate change impacts for Suriname and has produced recommendations, which will be worked out in a National Action Plan. Implementation of this plan will enable the Government of Suriname to contribute in achieving the noble goals of the UNFCCC and fulfill its commitments.

Drs. Clifford Marica

Minister of Labor, Technological Development and Environment

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LIST OF ACRONYMS

ADRON	Anne van Dijk Rice institute Nickerie
ALCOA	Aluminum Company of America
AOSIS	Association of Small Islands States
ATM	Ministry of Labor, Technological Development and Environment
BOG	Bureau of Public Health Service
C	Carbon
CARICOM	Caribbean Common Market
CCAC	Climate Change Advisory Committee
CCD	Convention to Combat Desertification
CDM	Clean Development Mechanism
CELOS	Center for Agricultural Research in Suriname
CFC	Chlorofluorocarbons
CH_4	Methane
CHM	Clearing House Mechanism
CIS	Coastal Information System
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COP	Conference of Parties
CPACC	Caribbean Planning for Adaptation to Climate Change
CSNR	Central Suriname Nature Reserve
DC	District Commissioner
ENSO	El Nino and Southern Oscillation
GDP	Gross Domestic Product
GEF	Global Environmental Facility
Gg	Giga gram
GHG	Greenhouse Gas
GIS	Geographical Information System
GPS	Global Position System
GWh	Gigawatt-hour
Ha	Hectare
HVGO	Heavy Vacuum Gas Oil
IMAC	Inter-Ministerial Advise Commission
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter Tropical Convergence Zone
LBA	Large-Scale Biosphere Atmosphere
$L/s/km^2$	Specific discharge
LULUCF	Land Use, Land-Use Change, and Forestry
LVV	Ministry of Agriculture, Livestock and Fisheries
MSL	Mean Sea Level
MUMA	Multi Use Management Area
MW	Mega Watt
NIMOS	National Institute for Environment and Development in Suriname
NGO	Non-Governmental Organization
CIS	Conservation International Suriname (NGO)
N_2O	Nitrous Oxide
NMR	National Council for Environment

NMVOC	Non Methane Volatile Organic Compounds
NO_x	Nitrogen Oxides
OAS	Organization of American States
ODS	Ozone Depleting Substances
OW	Ministry of Public Works
PFCs	Perfluorocarbons
PLOS	The Ministry of Planning and Development Cooperation
RADCHIS	Research of Atmospheric Dynamics and chemistry in Suriname
SAB	Suriname Alcohol Company
SAP	Structural Adjustment Plan
SB	Staatsblad
SER	State of the Environment Report
Sf	Surinamese guilders
SF_6	Sulphur hexafluoride
SLR	Sea Level Rise
SO_4	Sulfate
Sq. km	Square kilometers
SURALCO	Suriname Aluminum Company
SWD	Solid waste disposal
toe	Ton Oil Equivalent
UNCBD	United Nations Convention on Biodiversity
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UV	Ultra violets radiation

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EXECUTIVE SUMMARY

BASIC DATA AND NATIONAL CIRCUMSTANCES

Suriname is located on the Northeastern coast of South America, between 2°-6° Northern latitude and 54°-58° Western longitude, borders in the East with French Guiana, in the South with Brazil, in the West with Guyana and in the North with the Atlantic Ocean. In 2003 Suriname had about 481,000 inhabitants. Population growth is approximately 1% per year.

The total area of Suriname is about 164,000 km^2. Compared to many other countries in the world, the population density is low and equals to about 3 inhabitants per sq. km. However, the largest part of the total population, approximately 97%, lives in and around the Capital Paramaribo. The remaining 3% is spread over small towns in the coastal districts and in tribal communities along rivers in the interior.

The climate in Suriname is one of a semi-humid type, influenced by the up and down movement of the Inter Tropical Convergence Zone (ITCZ). Hence, two rainy and two dry seasons are observed annually over the largest part of the country, with a mean annual air temperature of about 27 ^oC, ranging from 26 ^oC in January up 31^oC in October. Average annual rainfall in the coastal area measures about 1,500mm and increases in the southern direction to about 2,500mm.

The coastline is about 386 km long and is dominated in the east by sand and the remaining part by mud flats and mud banks. Mud banks and mud flats are formed through suspension of the Amazonian sediments transported in the northwestern direction by the Guyana current, whilst the sand beaches are mainly a product of the local rivers. The dominant features of the coastal zone are its fertility, the low topography, concentration of about 90% human activities, including agriculture (rice and banana) and small industries, and highly important ecosystems, as breeding, feeding and nursery grounds for fisheries, shrimps, turtles and birds.

The abundant rainfall in Suriname has resulted in many rivers, swamps and creeks flowing generally in the south-north direction to the Atlantic Ocean. In the coastal zone, surface freshwater resources are used for agricultural purposes, whilst groundwater, derived from various aquifers is used for potable purposes. In the interior upland of the Suriname River a single man made lake has been build for generating hydroelectricity.

Suriname is home to many unique ecosystems. In the coastal plain complex mangrove ecosystem is found, which is an important breeding, feeding and nursery ground for fish, marine invertebrates, sea turtles and enormous numbers of migratory birds. More than 118 species of coastal birds, of which more than 70 species are defined as waterfowl according to the criteria of the 1971 RAMSAR or WETLANDS CONVENTION and are found on the coastal grounds of Suriname. This coastal region is considered as the principal South American wintering ground for shore birds from boreal and Arctic regions. A high biological diversity is inventoried in the tropical rainforest of Suriname.

Forest covers about 91% or 15 million ha of the total land area of which about 2 million ha or 13%, has the status of Protected Areas (4 Multiple-use Management Area, 1 nature park and 11 Nature Reserves). Forest is one of the important natural resources in Suriname. Other important natural resources are bauxite, kaolin and hydrocarbons.
Suriname started with petroleum production in the 1980's in the coastal area of district

Saramacca. The crude oil production at the end of 2003 is about 12,000 barrels a day. Further increase of oil production depends mainly on new oil reserves. Recent research indicates preliminary large reserves of oil off shore. Of the produced crude oil 7,000 barrels per day are refined into diesel, HVGO (heavy vacuum gas oil), fuel oil and asphalt bitumen for the local and the Caribbean market. The remaining crude oil is being exported.

The industrial base of Suriname is dominated by bauxite and petroleum industries, following by agricultural processing industries. The mining industry, which includes the sub sectors as bauxite, gold, petroleum and nonmetallic minerals as granites, has large potentials to grow. In particular, bauxite and petroleum industries form the sources for foreign exchange earnings. Agricultural and tourism sectors are also contributing to certain extend to the country's foreign exchange earnings. Large parts of these economic activities are concentrated in the coastal zone.

The Agricultural sector, including livestock, fisheries and forestry has an essential contribution in the GDP of the country. It provides the domestic industry with raw material, contributes to the overall food needs of the country, and export to foreign countries. A large part of the Surinamese population relies on the income from this sector. This is especially the case in the districts Coronie, Commewijne, Nickerie, Saramacca and a large part of Wanica. The sector provides therefore over 20% of nation's employment.

Economic conditions in Suriname have declined over years since the independence in 1975 from The Netherlands. Worse economic conditions have been reached during the implementation of Structural Adjustment Program (SAP), which was designed to halt the negative trend of the economy and create conditions for it's grow. However, the implementation of SAP has finally resulted in a real growth in the economy. Over the last decade further improvements in the Gross Domestic Product (GDP) have been observed.

In Suriname the energy production is mainly based on two sources: hydrocarbons (about 69%) and hydropower (about 26%). The remaining 5% is contributed by Biomass. Hydropower in the past has been used in the bauxite industry, for the Aluminum Smelter, but since its closure in 1999, large part of the hydropower is used in small and private industries. Despite of the enormous potential, approximately 2,590 MW, Suriname has in hydropower the production of hydropower has been constant at about 120 MW during the past decennia. In addition, Suriname possesses over an enormous potential of other types of renewable energy resources such as solar, with an average radiation of 1,635kWh/m^2 per year, and energy from biomass and wind. However, the present demand of energy is being covered by hydrocarbons.

The main source of CO_2 production is the combustion of fossil fuel (49%), followed by Land-Use Change and Forestry (31%) and Agriculture (19%). The growth of the GHG emissions is sharply decreased in 1999 due to the closure of the Aluminum Smelter, though showing a growth during the last years.

Greenhouse gas inventory

The first greenhouse gas inventory in Suriname was carried out for the year 1994 during The Netherlands Climate Change Study Assistance Programme (NCCSAP). The second greenhouse gas inventory has been carried out in 1998 and the third in 2003, both under the project "Enabling Suriname to prepare its National Communication in response to its

commitment to the UNFCCC". The method used for the inventory of greenhouse gas emissions of 2003 is the revised 1996 IPCC guidelines. The inventory includes greenhouses gasses of direct effect (CO_2, CH_4, and N_2O) and indirect effect (NO_x, NMVOC, CO, SO_4). The inventory is further compiled for the following sectors: Energy, Industry, Solvents, Agriculture, Land Use Land Use Change and Forestry, and Waste. Emission data from international bunkers and marine bunkers are also included. Table 1 indicates the general characteristics of the main greenhouse gas emissions during the period 1994-2003.

Carbon dioxide accounts for most of the greenhouse gas emissions in Suriname. The total green house gas (GHG) emission for the inventory year 2003 equals to 8,902Gg of CO_2 Equivalent. The total CO_2 Removals (GHG sinks) in Land-Use change and Forestry equal 3,862 Gg of CO_2 equivalents, making the net GHG emission equal to 5,040 Gg of CO_2 equivalents.

The energy sector is the largest GHG source, contributing about 71% to the total GHG emission and comprises primarily the combustion of fossil fuels, then follows Land-Use Change and Forestry and, Agriculture.

The main source of methane emissions is agriculture (40 Gg), then followed by Land-Use Change and Forestry (3 Gg), and waste (1Gg). Main share in methane emissions from the agriculture sector is attributed to rice cultivation and enteric fermentation.

Nitrous oxide emission equals in 2003 to about 12 Gg. Manufacturing industries and construction is the primary source of nitrous oxide emissions followed by the agriculture sector.

The Surinamese forest constitutes a sink of a significant amount for the carbon dioxide, about 3,862 Gg annually.
The sources of other minor gases are discussed in chapter 2 of this report.

Emission abatement
Suriname is not an industrialized country. Except for the bauxite sector and the petroleum industry, there are no industries, which can be regarded as serious energy use industry. The agricultural sector is too small and too limited to be regarded as players of significance in the emissions game. Hence, there are currently no policies, laws or measures in place on the mitigation of Greenhouse Gas Emissions. However, ongoing and planned developments in sectors as mining, forestry, agriculture and waste resulting in enhanced emission of greenhouse gases, bear significant pressure on the government to change its policies towards the mitigation of the these gases.

Suriname with her relative small population, greenhouse gas emissions and large forest tracts, lacks the necessary incentives and support to reduce these greenhouse gasses emissions in sectors as agriculture and energy. In the industry sector, as for instance bauxite sector, unfavorable conditions led to the closure of the aluminum smelter in 1999, resulting in large drop in greenhouse gas emissions.

On the other hand, balanced measures in the forestry sector, including the selective wood logging, reduced or stabilized the levels of CO_2 in the atmosphere.

A clear policy on this matter has not yet been formulated.

Sources	CO2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total National Emissions	3984	45	0	12	65	15	0
1 All Energy (Reference Approach)	2442			11	31	8	
(Sectoral Approach)	2442	0	0	11	31	6	0
A Fuel Combustion	1,693	0	0	0	1	0	
Energy industries	530			1			
Manufacturing industries and construction	1,384			4			
Transport	351			0	0	0	
Other sectors	100			2	1		
Commercial	0						
Residential	37						
Agriculture/Forestry/Fishing	2			2	2		
B Fugitive Emissions from Fuels	0	0		0	0	2	0
Solid fuels							
Oil and natural gas						2	
2 Industrial Processes	65	0	0	0	0	7	0
Mineral production	65					7	
Metal production	0				0		
3 Solvent and Other Product Use	0		0			0	
4 Agriculture		40	0	0	4		
Rice cultivation		37					
Enteric Fermentation		3					
5 Land-Use Change & Forestry	1,477	3	0	1	30		
Changes in forest and other woody biomass stocks	588						
Forest and grassland conversation	4,752						
Abandonment of managed soils	-3,858						
CO2 emissions and removals from soils	-4						
6 Waste		1	0				
Memo Items:							
International Bunkers	303	0	0	0	0	0	0
Aviation	101	0	0	0	0	0	0
Marine	202	0	0	0	0	0	0
CO_2 Emissions from Biomass	0						

Table 1.1: Short summary of the National Green house Gases Emissions and Removals in Gigagrams for the year 2003

Energy sector
The energy sector is not highly diverse. It is mainly based on thermal and hydropower energy. An increase in diversification and energy efficiency in all sectors of economic activity is needed. The use of clean technologies sectors can result in large savings of greenhouse gas emissions. At the moment the emphasis is largely placed on future development of the exploitation of the hydro potential in the country both on full and small scale, while also the use of other renewable energy resources for energy generation is strongly promoted.

Transport sector
A considerable expansion in the number of vehicles during the last years has been observed. Demand for the road transport will grow further owing to the location of the population concentrations and the transport infrastructure in Suriname.

There is a large potential for reducing emissions of CO_2 and other greenhouse gases in the following sectors in Suriname:
- the traffic and transport sector,
- private households
- the industry
- the energy industry
- water management sector and
- the agriculture and forestry

However, government policies and programs for achieving reductions on greenhouse gas emissions have yet to be formulated.

Vulnerability and adaptation
Global climate change and inter-annual changes on the territory of Suriname will have the following consequences:
- change in the temperature and rainfall pattern
- change in the sea level and therefore in the coastal issues
- change in the water sources
- change in the ecosystems
- change in the health sector
- change in the agriculture potential, and
- change in the socio-economic systems in the country

Average temperature in Suriname is increased with over the 1^{o}C in the past 30 years, whilst precipitation in large part of the country shows a decreasing trend. Both changes will have tremendous effect on the climate-dependent economy of the country as well as on the natural ecosystems here, in particular for the coastal zone. The annual floods and droughts superimposed by the El Niño and La Niña events, and change in the climate, may occur very frequently.

Coastal issues. Analyses of sea level rises, as given in de Country Study Climate Change Suriname (CSCCS), have shown that 1m rise in the sea level will have tremendous, if not catastrophic consequences for Suriname. The flat and low-lying coastal plain might suffer badly due to the frequent and intense attack of waves on the shorelines as the sea level will rise. Large-scale inundation, salination and loss of biodiversity will occur in the northern part of the country.

Erosion and sedimentation along the shoreline of the Suriname coast, including mudflats, mud banks and sand beaches, are also determined by sediment supply from the Amazonian region. Changes in the Amazonian basin may affect the sedimentary budget of the Suriname coast, which on its own turn will have impact on the mangrove forests as they occur at the land-sea interface. Occurrence of mangrove forest at the shoreline is seen as a natural defense of the coastline. Considering the regional and global changes it is expected that with the rise of the sea level a shift of the coastal line might occur. The vulnerability assessment has shown that due to these changes considerable land losses will occur and another part will be under risk.

The adaptation measures regarding the coastal issues are proposed according to the accepted climate change scenarios and are as follows: (1) the protection option, which includes building dykes and dams to prevent further erosion, land loss and flooding, and (2) the retreat option, which is least feasible as large land losses will be encountered.

Water resources. Water resources in Suriname, which are grouped in saline, brackish and freshwater resources, are depended on the rainfall. Reduction in the amount of rainfall and its pattern (duration and intensity) will have tremendous effect on brackish and freshwater resources of Suriname. Certain areas in the north, as the Coronie area, might experience a shift from the semi-humid climate to a more drier of even to semi-arid climate. The Prof. Dr. Ir. Blommenstein man-made lake (Brokopondo lake) established for generation of hydroelectricity will suffer due to a decrease in rainfall and an increase in evaporation. In the coastal area salt water intrusion due to less rainfall and sea level rise will affect the surface as well as the groundwater resources seriously. These impacts are enhanced by the El Nino events. Rising of the sea level will hamper the functioning of the drainage systems in the coastal plain. Analyses and assessments conducted, indicated that water resources in Suriname are very vulnerable to climate change, including the sea level rise.

The following proposed adaptation measures include (1) efficient utilization of water resources, (2) improvements in production and distribution of potable water, (3) optimization of cultivation practices, (4) recycling freshwater use, (5) expanding the capacity of the existing Brokopondo Lake and establishing new lakes, (6) adapting freshwater swamps in the coastal area to the new future situations.

Ecosystems. In Suriname the coastal zone ecosystems are divided into estuarine and freshwater ecosystems. These ecosystems have undergone serious changes at locations where human settlements have been established. These changes regard, except the biodiversity, also the geomorphology of the coast. The rise of the sea level and changes in the rainfall and sedimentary budget of the ocean water, force transformations in the ecological systems of estuarine as well as of the freshwater zone. The estuarine zone, where the mangrove ecosystems are found, is an important breeding, feeding and nursery ground for the marine fauna. In this zone large numbers of species of coastal birds are found. The zone offers also good conditions for over wintering of birds from the boreal areas. The sandy parts of the coastal zone are important nesting sites for the endangered sea turtle species. It is expected that these sandy beaches will suffer from erosion and hence the nestling ground of these species. Furthermore, the sea level rise with all its impacts on the coastal zone of Suriname will certainly affect also the nutrient rich ground adversely.

The freshwater swamp is home for a great variety of vegetation. Here, huge amount of peat is found. Climate change impacts on this swamp vegetation include peat and forest fires.

Considerable amounts of fixed carbon are then released. These developments encourage large transformations in flora and fauna in this part of the country. Transformations will also take place if a dramatic increase in water level within these swamps is observed. In this way the ecosystems are very vulnerable to climate change

For the mitigation of adverse consequences of climate change of the natural ecosystems of Suriname a strategy is proposed comprising the following measures:
- protection of all mangrove forests by giving them a special status
- implementation of the proposed Multi Use Management Area's (MUMA)
- stopping all activities affecting the natural ecosystems adversely
- encouraging individuals and organizations to protect these ecosystems

Agriculture sector. In Suriname rice is the most important agriculture crop, accounting for 55% of all agricultural production on about 48,000 ha land of the 1.5 million ha available land for this purpose. Other important sub sectors are banana, horticulture, fisheries and livestock production. Climate change impact on agriculture comprise first of all change in the hydrological cycle and hence shrinkage of the water resources that ultimately adversely affect the rice sector. Increased temperature and UV-B radiation result in production decrease, as many rice varieties in Suriname appear not to withstand the adverse impacts of the UV radiation. Moreover, change in the climate will affect the distribution and the degree of infestation of insects. A small temperature increase of 1-2 ^{o}C is detrimental to cattle production since the ambient temperature in Suriname is higher than the comfortable.
With regard to the production of aquaculture and fishery a decline in this sub sector is to be expected if climate change develops according to the IPCC scenario.

For the mitigation of the adverse consequences of climate change within the agriculture sector in Suriname, a wide range of adaptation measures should be implemented. Among those measures are first of all development or introduction of new rice varieties for fresh as well as for brackish water and dry land rice varieties in the hinterland of Suriname. For the banana sector, which is vulnerable to increased wind velocities, windbreaks need to be constructed in a way that could also lead to carbon sinks. For the livestock a farming system based on agro forestry principles need to be introduced. Within the fishery and aquaculture sector establishments of large, semi intensive aquaculture ponds are proposed.

Socio-economic sector. Suriname is rich in natural resources. The country is characterized by extensive occurrences in bauxite, gold, granite and other minerals, forests, petroleum, agriculture and fishery. Many of these resources are found in the coastal zone, which is the backbone of Suriname's economy. Hence, the majority of the nation population is concentrated in the coastal zone, with capital Paramaribo as the most populated area within this zone. Hence, major infrastructure is found in the coastal zone. Previous assessments have shown that one meter rise in the sea level will result in inundation of about 595 km^2 or 2.2% lands of the coastal zone, including the capital Paramaribo, which means a loss of about US$400 million representing 36.6% GDP, the movement of over 80% of the population, and at risk about 1% of total population of the country in the future. In this way the coastal zone is very vulnerable and the measures proposed are referred as "mixed feasible protection strategy". This strategy involves the implementation of all feasible protection measures designed to minimize risks and losses of land in the coastal zone.

In this regard it is suggested that more research has to be done on the following:
- protective measures as dams and dykes for populated and developed areas
- protection of coastal lines from increased erosion
- protection from flooding through better tide gates and pumping
- retreat and migration measures
- management of the coastal zone

Human health. In light of the expected climate change an increase in heat related mortality and morbidity, respiratory illness, physiological disorders, eye cataracts, eye irritation, respiratory illness, cardiovascular illness, skin cancer, is projected. Increased air temperature is expected to cause heat waves and thus increased heat-related mortality. Other effects of the climate change are the changes in distribution and seasonal transmission of vector borne diseases and increase in toxic algal blooms.
Changes in the seasonal rainfall might affect the vector mosquito populations, resulting in the increase of malaria, dengue and others. On the other hand, the expected sea level rise, corresponding with large inundation, will affect the growth of Bilharzias negatively.
The adaptation includes a complex of social, sanitary, preventive and administrative measures.

Education, training and public awareness
A growing interest to climate change has been observed since the start of the Netherlands Climate Change Studies Assistance Program (NCCSAP) in 1997. A lot of information have been processed and disseminated to the public by the Meteorological Service in Suriname via radio, television, workshops and meetings with individuals and groups of people and organizations. The fact that global climate change is a long-term process and its tremendous negative effects on Suriname's natural and socio-economic systems, has emphasized the importance of the continuation of training, and the promotion of awareness. For the National Institute for Environment and Development in Suriname (NIMOS) promotion and public awareness became a serious matter. In 2001 a first step was made to formulate the Initial Communication to the UNFCCC. In 2000 the Ministry of Labor, Technological Development and Environment was established by State decree with the overall responsibility to coordinate and formulate environmental policy. This Ministry is the focal point for the UNFCCC and therefore has the responsibility for the implementation of the convention of which awareness raising is a very important part. Training is required as to have a good understanding of climate change and related issues and to develop the necessary skills to identify the appropriate measures. Climate change programs and related subjects are not yet incorporated in the curricula of the University of Suriname, however efforts are made to so. Awareness campaigns and training activities are also being developed now and will be directed towards special cases in the country and to the public in general. With the initiation of new studies and establishments of new instruments at the Paramaribo Meteorological Station in Suriname a new dimension is given towards the promotion and rising awareness in the climate change issues, especially among the students at the University of Suriname.

Scientific research and systematic observations
The meteorological observation network in mid 1980 consisted of about 175 stations in total, out of which 40 were for climatic observation and the remaining for daily rainfall observations. Due to the civil war in 1986-1989 this was reduced up to 21 stations in total. All of them are concentrated in the coastal area. The same is valid for the hydrological network in the country. From 87 hydrological stations in 1986 only 7 are at present in operation.

A huge amount of high quality data is lost due to this war. Only from some stations data from the last 30 years is yet available. This gab in the observed data seriously affects the quality of the present investigations. These investigations are further hampered due to lack of topographical data, erosion and sedimentation rates, biodiversity, and other data regarding the socio-economy of the country. Except the hydro-meteorological observation networks maintained by the department of the Hydraulic Research Division and the Meteorological Service Suriname (both departments of the Ministry of Public Works) respectively, research is also being done by the Ministry of Natural Resources, Department of Suriname Forest Service (LBB), and recently by the University of Suriname. The University of Suriname is presently involved in the implementation of applied technology in the energy sector. Energy in the remote areas of Suriname is based on small diesel generators (5-60 kW). The intention is to replace this, where possible, with renewable resources, such as solar, wind and hydropower.
A number of projects related to global climate change and its impacts are under way. However, an integrated observation network is needed.

Linkages between conventions
The natural systems of Suriname are vulnerable to many dramatic climate changes, in particular the humid tropical forests. Large-scale deforestation may enhance surface runoff and erosion of the area resulting in degradation of the soil and consequently poor growth of vegetation in the area. Repetition of these events might further degrade this area into savanna or even in desert. These situations are then very difficult to rehabilitate. Suriname is aware of this problem and has ratified in the year 2000 the United Nation Convention to Combat Desertification (UNCCD). The United Nation Convention on Biological Diversity (UNCBD) has been ratified in 1996 and the United Nation Framework Convention on Climate Change (UNFCCC) in 1997. These conventions have much in common and are supplemental to each other. Prolonged and severe dry season might promote forest fire, surface runoff and finally into loss of biodiversity. Bridging these conventions will give new opportunities to attack these problems and mitigate the possible negative impacts.

INTRODUCTION

The Republic of Suriname has ratified the UNFCCC convention in 1997, thereby recognizing the importance of climate change and related problems for human beings worldwide. Moreover, by ratifying this convention Suriname took the obligations to interalia submit an initial national communication in order to contribute to its utmost to the world society in mitigating the effects of climate change. Up till now these contributions have been the establishment of the world largest forest nature reserve, the Central Suriname Nature Reserve (CSNR), covering an area of about one million ha. Also in relation to the coastal zone, the Government of Suriname recognized the multiple values and functions of coastal ecosystems, such as coastal protection, the high natural productivity, the high degree of biodiversity and the production of goods and services. This has resulted in the protection of almost the whole coastline where MUMA's and some nature reserves have been established.

But more steps are required to mitigate the adverse impacts of climate change. In this regard the studies and activities leading to the assessment of the vulnerability of the coast, in particular, have shown that if necessary steps are not taken in time, losses will be unforeseeable, on the national level as well as on the regional level. By submitting this report Suriname will draw the attention to conserve the natural systems as much as possible.

The first steps in pertaining the mitigation are raising of the awareness and wide dissemination of this information to the public, scientific world and in particular the policy makers. The latter segment is of great importance considering the development of policies and mitigating measures on the national and regional level and the use of appropriate technologies in realizing these policies and measures.

Following the above this communication will serve as basis for the future decisions dealing with mitigation of the climate change and so fulfilling the commitment to the UNFCCC.

1 NATIONAL CIRCUMSTANCES

1.1 Geographical setting

The Republic of Suriname is located on the Northeastern coast of the South American continent between 2°-6° North latitude and 54°-58° West longitude. It borders in the north with the Atlantic Ocean, in the south with Brazil, in the east with French Guyana and in the west with Guyana. These borders are historically established in the east and the west by the rivers Marowijne and Corantijn respectively, and in the south by the watershed between the Amazonian basin and the basins of the Suriname rivers. The land area of Suriname is about 164,000 sq. km. with a total population of about 481,146, the largest concentration being in Paramaribo, the capital of the Republic Suriname.

Figure 1.1: Geographical setting

1.2 Physical – geographical conditions

According to the physical geography Suriname belongs to the Guiana plateau, which, except for the lower coastal area in the north, represents a huge Guiana shield. This shield is composed of Precambrian rocks, which is for its largest part deeply eroded and weathered. The most significant height of the Guiana plateau in Suriname is situated approximately in the center of the country reaching a height of about 1200 meters. The remaining part is of monotonous landscape type of about 200 - 600 meters above the mean sea level (MSL). The coastal area in the north predominantly consists of young clay sediments of Amazon origin and sand contributed by the local rivers, which flow generally in the south – north direction.

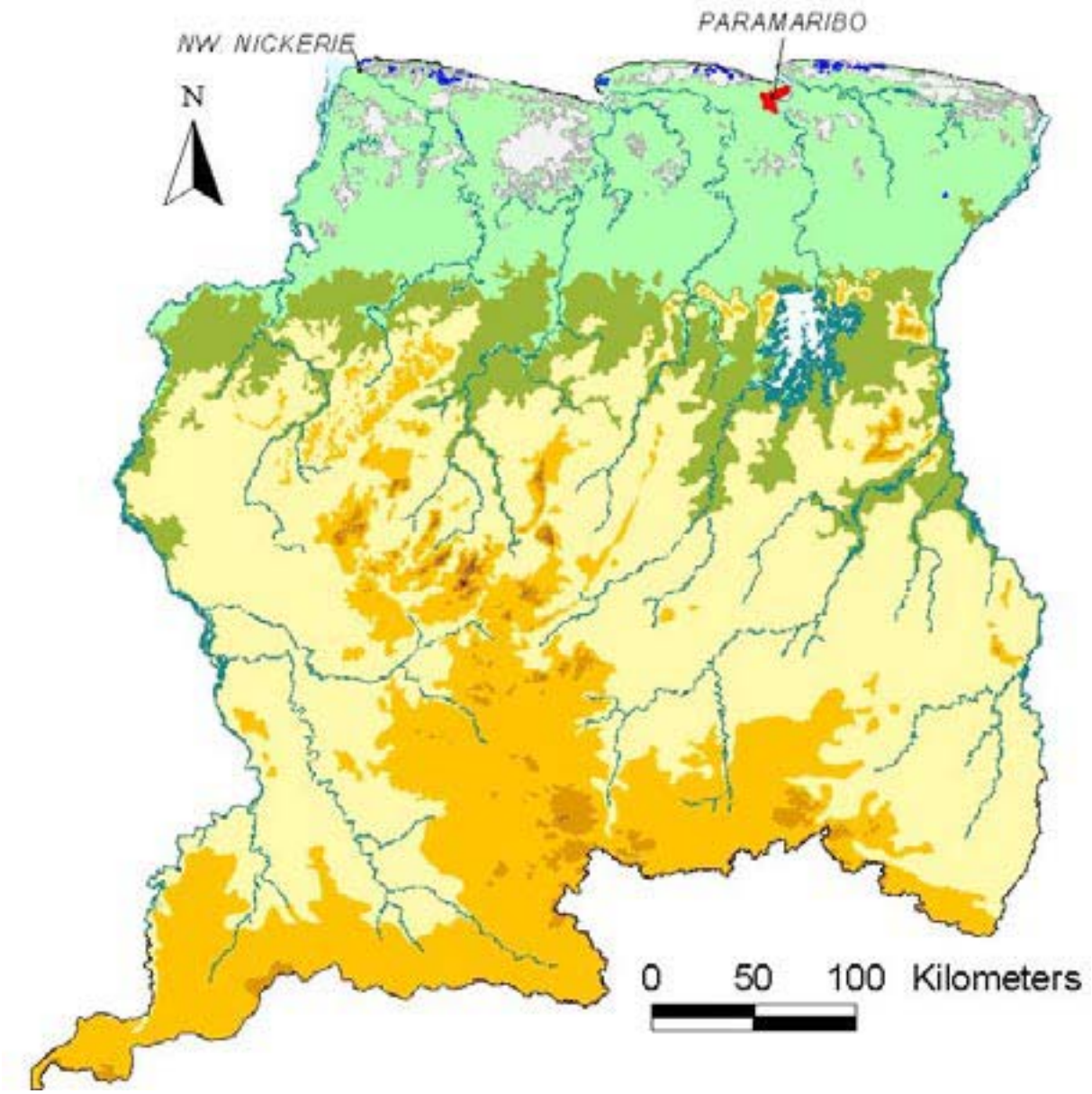


Figure 1.2: Physical-geographical conditions

The land area of Suriname is generally divided in five main geographic regions identified from north to south as follows: 1) the Coastline, formed by extensive mud flats and sandy shell beaches; 2) the Young Coastal Plain, ranging in width from about 20 km in the east to about 100 km in the west with height variations of 0–4 m above MSL; 3) the Old Coastal Plain, remnants of ridges, gullies and mud flats, with height variations of 4-10 m above MSL; 4) the Savannah belt, consisting of coarse bleached white sand and yellowish brown sands to clay loams, ranging from 10-100 m above MSL; and, 5) the Guyana highland region of the Interior, covering about 85% of the country with highly weathered Precambrian formations and heights of above the 100 m MSL.

1.3 Climate

The climate of Suriname is tropical with abundant rainfall, uniform temperature, and high humidity. The average rainfall at Paramaribo is generally taken as representative of the country. Two wet and two dry seasons are to be observed, with about 50% of the annual rainfall occurring in the four month long wet season and about 20% in the two –month short wet season. The remaining of the annual rainfall occurs in the dry periods.

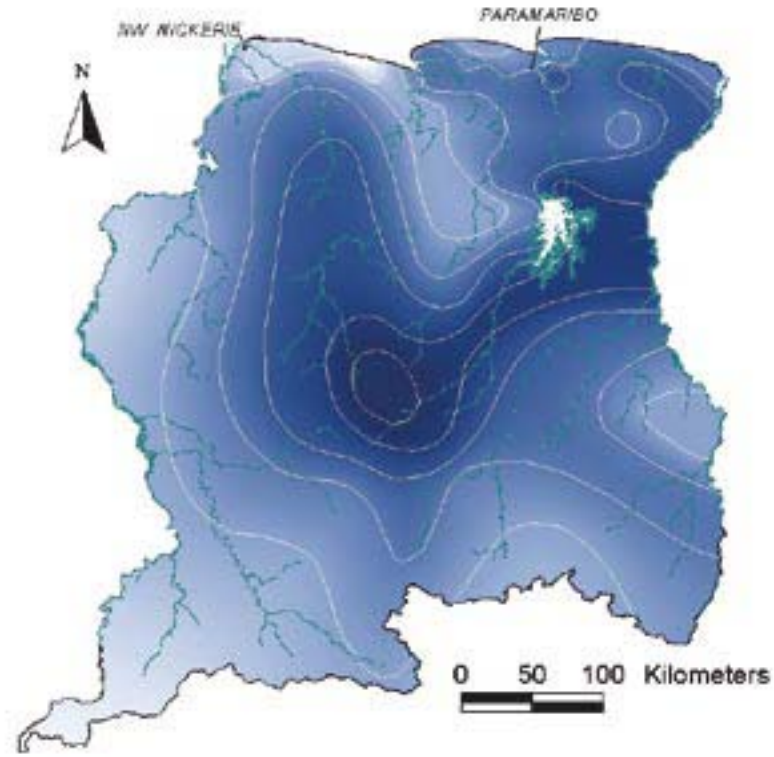


Figure 1.3: climate

El Nino / ENSO phenomenon The El Nino/ENSO phenomenon has also impact on the climate in Suriname, which occurs once every 2-7 years. Generally during El Nino years, when there is excess rainfall on the west coast of South America, it is dryer in Suriname. Case studies in Suriname show that El Niño periods coincide with very dry years in the coastal area of the country. The 1997-1998 El Niño year had a negative impact in most of the productive areas, resulting in high levels of dislocation in many socio-economic sectors.

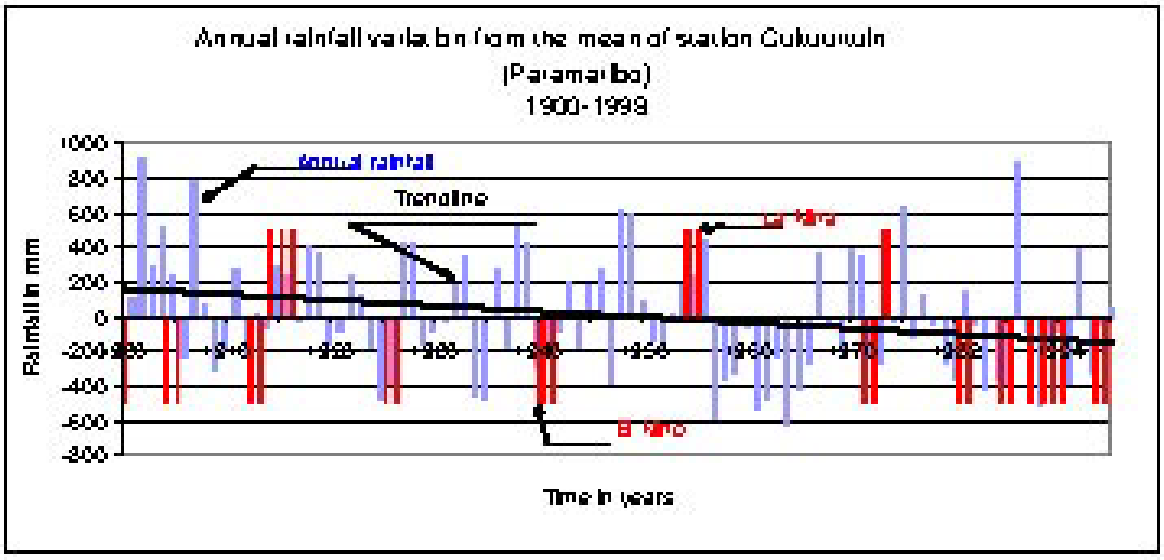
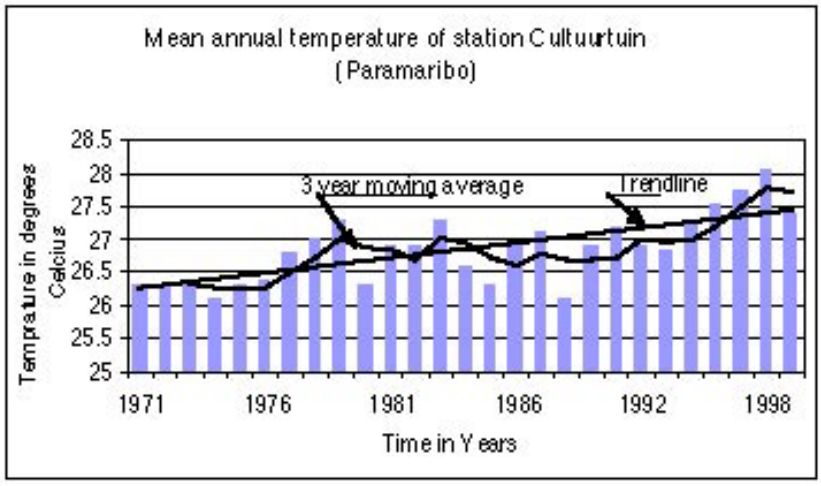


Figure 1.4: Annual rainfall variation from the mean of station Cultuurtuin (Paramaribo)

Air Temperature. The average daily temperature in the coastal region is 27º Celsius (ºC). January is the coldest month (average 26 ºC) and October is the warmest (average 31ºC). Annual variation of the average temperature lies within a range of 2-3°C, in relation to variation of daily temperature, which is 7-8°C.



On a long-term basis a slight change in the air temperature is observed. For the capital Paramaribo, the mean annual temperature over the last 30 years has risen with about 1.0ºC.

Figure 1.5 Mean annual temperature for station Cultuurtuin (Paramaribo)

Wind. The mean wind speed is 1.3 Beaufort. Maximum mean wind speeds occur during the dry seasons attaining 1.6 Beaufort in February with a second peak in September and October. Minimum mean wind speeds of 1.0 Beaufort occur in January. At the coast the wind speed is 3-4 Beaufort during the day, becoming gradually weak to calm during the nocturnal hours in the interior. These values are expected to change in accordance with the temperature change.

Air Humidity. For the coastal regions daily air humidity in average is as high as 80-90 percent. In central and southern regions of the country, daily air humidity decreases and averages about 75 percent. In the forest tracts air humidity depends, among others, on the penetration of sun radiation. Variation of relative air humidity in forest tracts lies within the limits of 70-100 percent and between 50-100 percent in open areas.

1.4 Natural resources

Suriname is endowed with many natural resources such as soil, water, forests and mineral ores. The fertile soil of the young coastal plain, and the large freshwater swamps and rivers in the north have together created initial conditions for developing large scale agriculture. Apart from this, exploration and exploitation of crude oil has begun recently in the north-central part of the young coastal zone. Other natural resources as forest and mineral ores, i.e. bauxite, gold, iron ore, platinum, diamond, are found in the interior of the country.

1.4.1 The Soil

Soils of the Suriname territory are categorized according to four types of geological formations: the Demerara, Carolina, Zanderij and various Precambrian formations. The Demerara Formation, including soils of the young coastal plain (legend 1-7), is basically formed by sediments derived from the Amazonian basin, and in particular from the more mountainous hinterlands.

This part of the country is the most fertile zone of the territory, where large-scale agricultural activities are observed. Soil of the Carolina Formation, following immediately after the Demerara Formation is generally composed of clay, sandy-clay or clayey-sand (legend 8-9) and the lighter soils offer good opportunities for agricultural development, in particular horticulture. South of the Coropina, the Zanderij Formation is found, consisting of non-bleached sands to clay loams and bleached coarse sand, having a high infiltration and percolation rates. The latter are important for drinking water because the largest part of abundant rainfall percolates here into the ground recharging the freshwater aquifers, which in the coastal plane are used as a groundwater resource for potable purposes. Due to the low fertility agricultural activities in the Zanderij formation are limited to some small-scale dry crops (legends 10-11). The remaining part of the territory is covered with hilly and mountainous land, mainly composed of weathered and eroded Precambrian rocks with a generally moderately thick regolith layer (legend 12-19)

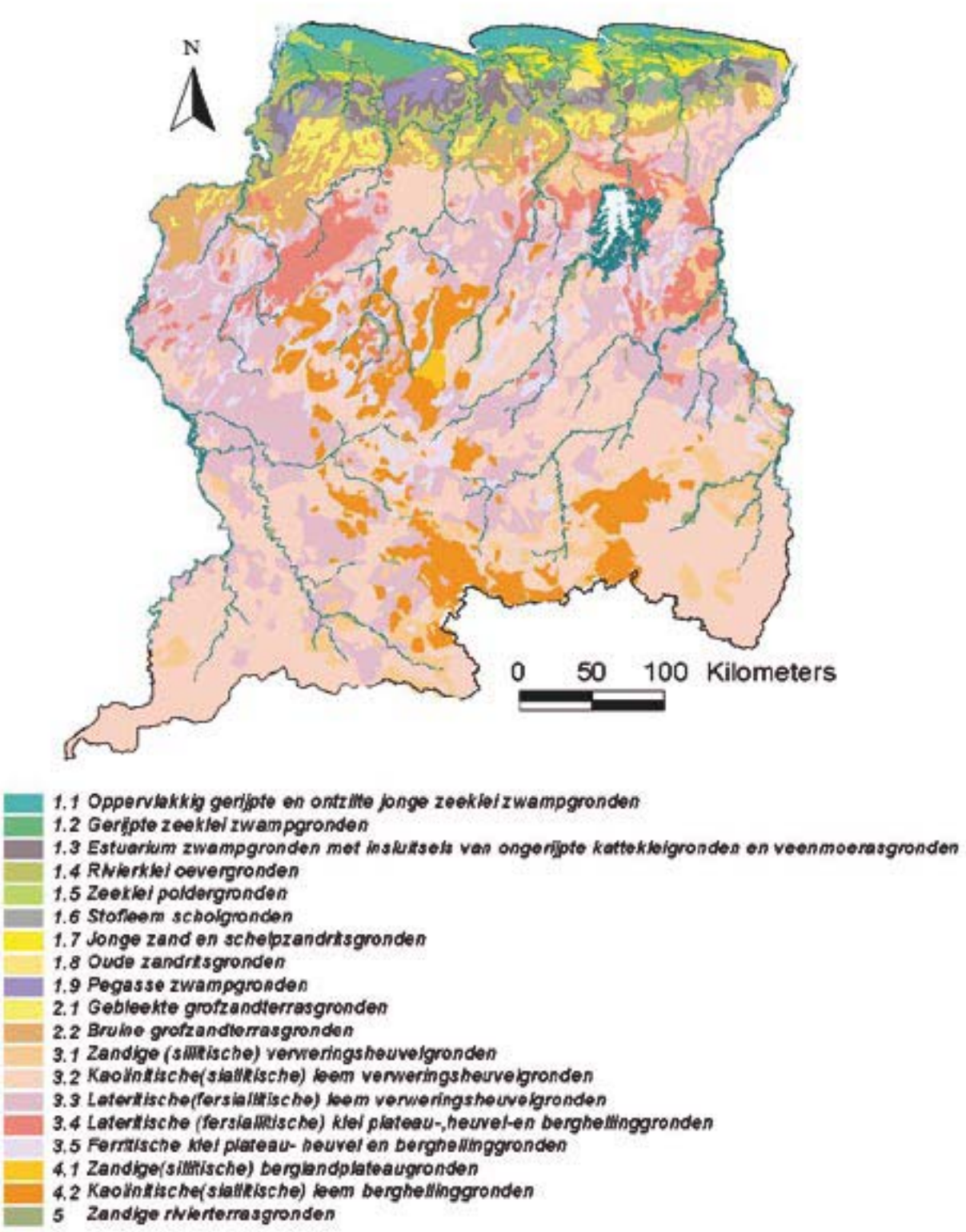


Figure 1.6: The soil

Human activities such as selective logging, shifting cultivation, exploitation of other natural resources, may enhance these impacts and the degradation of these poor soils. These degradations have not been observed yet on large scale in Suriname; however, some serious spots are to be seen in the hinterland.

1.4.2 Water Resources

The main source for the existing water resources of Suriname is the re-occurrence of abundant annual rainfall, which together with the topography, soil and land cover has resulted in many streams and large wetlands. Seven main rivers, originating in the hilly to mountainous interior of the country convey about 4,800 m^3/s fresh water annually into the Atlantic Ocean, which is about 30% of the annual rainfall. The Marowijne and the Corantijn, being the Trans-boundary Rivers in the east and west respectively, contribute 70% to the total discharge. Of the remaining rainfall, the largest part evaporates and only a small part percolates into the ground forming ground water reserves.

The hilly to mountainous interior is covered with forests, and has a dense network of streams in contrast with the low-lying coastal areas, where fewer streams and extensive swamps are found. Depending on the water quality the latter is divided into salt, brackish and freshwater swamps. Rivers and freshwater swamps constitute the surface water resources; whilst freshwater of various aquifers constitute groundwater. The first mentioned resources are mainly used for irrigation, i.e. rice, banana and generation of hydroelectricity, whilst the latter is used for potable purposes. Extracting freshwater from these resources enhances the saltwater intrusion. Rises in the sea level further promotes this intrusion.

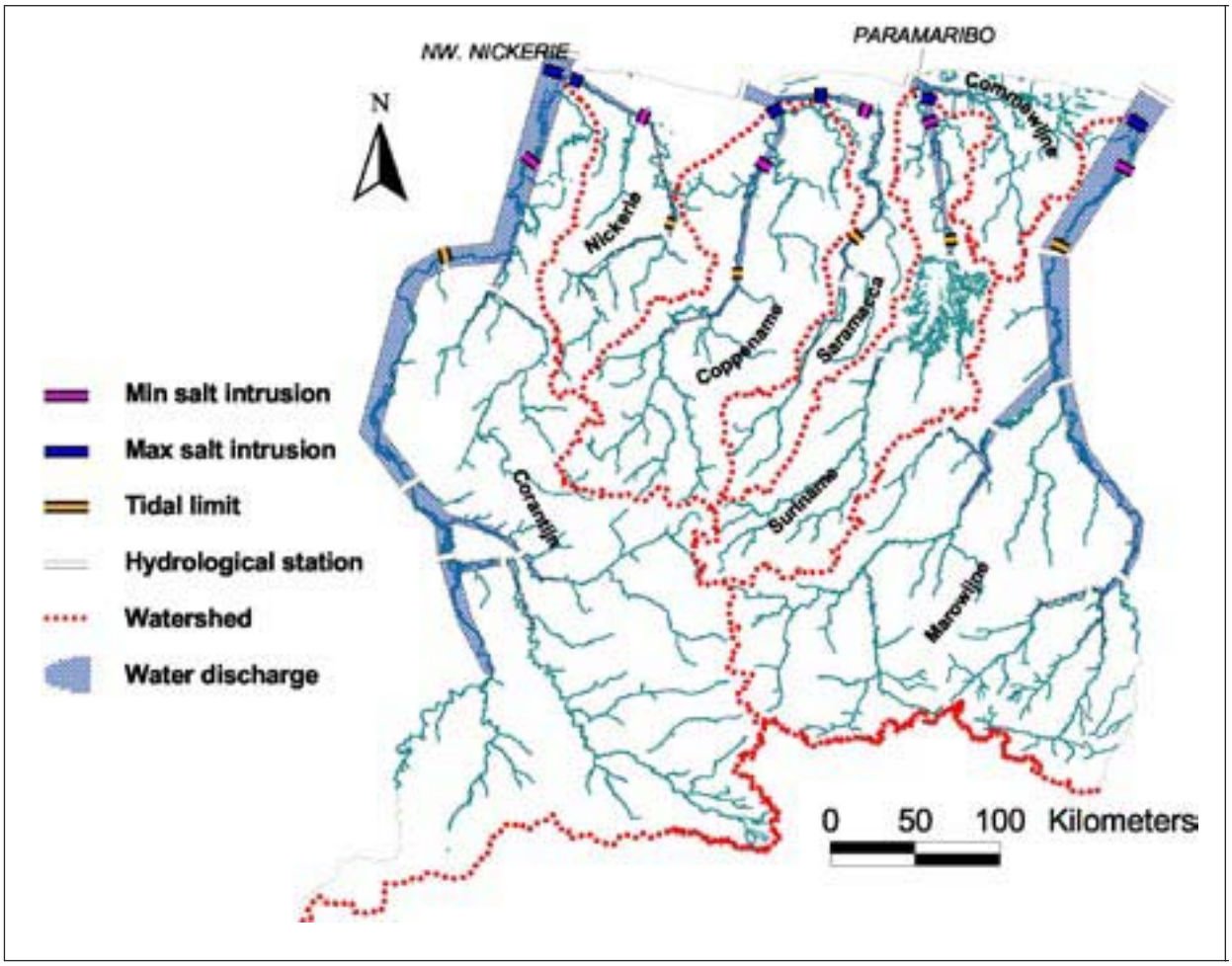


Figure 1.7: Water resources

1.4.3 Ecosystems

Suriname is home to many unique ecosystems, both in the Coastal Plain and in the Interior Uplands. The estuarine zone of Suriname is an important breeding, feeding and nursery for fish, marine invertebrates, sea turtles and enormous numbers of migratory birds. More than 118 species of coastal birds, of which more than 70 species are defined as waterfowl according to the criteria of the 1971 RAMSAR or WETLANDS CONVENTION, are found on the coastal grounds of Suriname, total number of which may reach to as many as 5 million individuals. The most numerous are the shorebirds, large parts of which are migratory. Between the Orinoco and the Amazon River mouths, the coast of Suriname shows the highest density of nestling colonies of cucumiform birds. For the South American endemic scarlet ibis, the coast of Suriname is of critical importance with up to 35,000 breeding pairs during top years. Besides this, the Surinamese coast may be considered as the principal South American wintering ground for shore birds from boreal and Arctic regions. No less than 52% of the 2.9 million shoe birds wintering in South America were observed along the coast of Suriname.

The interior uplands, covered by the tropical rainforest of Suriname, have a richly abundant variety of biological species. A high biological diversity with e.g. 185 mammal species, 668 bird species, 152 reptile species, 95 amphibian species, 338 fresh water fish species, 452 marine fish and shell fish species, 1,750 higher invertebrates, hundred of thousands of lower invertebrates, 5,075 Spermatophytes and hundred of thousands ferns, mosses, fungi, and algae are found here. Many species identified as being at risk, or those living in the more sensitive habitats are to be found in the protected areas.

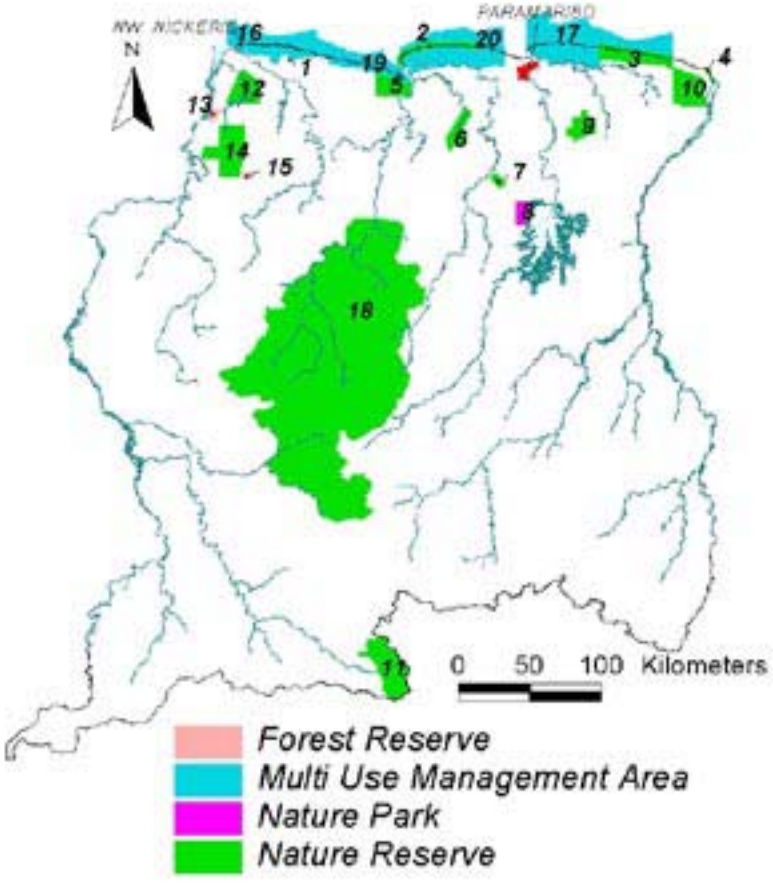


Figure 1.8: Ecosystems

Approximately 11 million ha of the total forest area of 15 million ha is not yet commercially exploited and about 2 million ha has the status of Protected Areas (4 Multiple-use Management Area, 1 nature park and 13 Nature Reserves). The protected areas cover approximately 13% of the land surface of Suriname. In 1998 one of the protected areas has been established as the Central Suriname Nature Reserve (18), enclosing three pre-existing protected areas, namely the nature reserves of (a) Raleigh vallen, (b) Tafelberg and (c) Eilerts de Haan Gebergte, to form a conservation corridor of more than 1.6 million hectares (about 10% of the land surface of Suriname).

The other nature reserves are: Herten Rits (1) – 100 ha; Coppename monding (2) – 12,000 ha; Wia Wia (3) –36,000 ha; Galibi (4) – 4,000 ha; Peruvia Nature Reserve (5) – 31,000 ha; Boven Coesewijne (6) – 27,000 ha; Brinckheuvel (7) - 6,000 ha; Brownsberg (8) – 8,000 ha; Copi Nature Reserve (9) – 28,000 ha; Wane kreek reserve (10) – 45,000 ha; Sipaliwini (11)- 100,000 ha; Nani Nature Reserve; (12); Kabouri Nature Reserve (14); Bigi Pan Multiple-Use Management Area (16) - 68,300 ha; North Commewijne-Marowijne MUMA (17) – 61,500 ha; Central Suriname Nature Reserve (18) - 1,592,000 ha, North Coronie MUMA (19)- 27,200 ha and the North Saramacca MUMA (20) – 88,400ha;

1.4.4 Vegetation

The land is almost completely covered by vegetation. On the coastal shoreline mangrove forests are found, whilst in the middle and southern part the tropical rainforests. In the marshes of the younger part of the young coastal plain a large variety of herbaceous freshwater swamp plants grow on the top of the sometimes thick peat (pegasse) layer. In extreme dry periods these peat layers may catch fire and open pans may form. These pans may gradually be overgrown by weeds and grasses and, in a later stage, by canopy and forest trees. A next forest fire might convert the area again into an open pan and the process repeats. Conversely, in the absence of forest fires these areas may gradually go over into marsh forests and finally into high dry land forest. Periodically inundation due to abundant rainfall and poor drainage often results into seasonal swamps and marshes, where mostly two-storied forests are found. The upper story is a less dense forest and reaches a height of about 15-30 meters, whilst the lower story is dense with an average height of 5-15 meters. Higher upland, these forests become monotonous. In the higher elevated regions, the trees may reach heights of about 30-40 meters, beneath which trees of shorter length occur, including palm, shrubs, etc. Forests encountered within the savanna areas are often one storied, varying from 20 –25 meters in height. In poorly drained soils the heights of these trees might be shorter. However, the best trees, for harvesting purposes, are found within elevated terraces, colluvial and high hills. Here 3-4 storied forests occur reaching a height of about 40-45 meters.

1.4.5 Mineral Occurrences

Suriname is a mineral-rich country containing a number of important deposits as bauxite, beryl, copper, diamond, gold, platinum, iron, manganese, pegmatite and stannum. Furthermore, building materials, hydrocarbons, sand and shells are also found. However, except for bauxite, gold and hydrocarbons, which form at present the most important sources of the country's economy, are becoming substantial industries and have the potential to be economically exploitable.

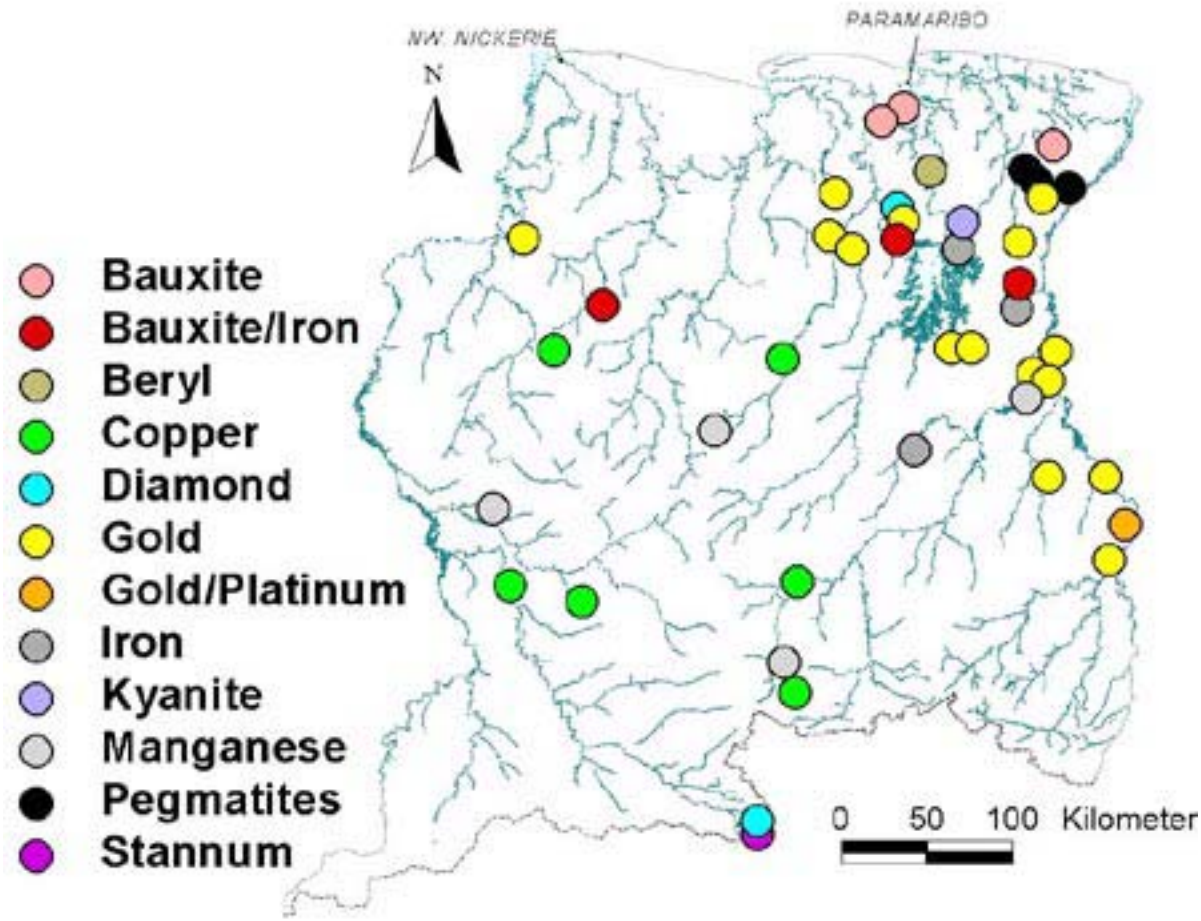


Figure 1.9: Mineral occurrences

1.5 Population

The population of Suriname is multi-ethnical and multi-religious. This diversity stem from several waves of importation of slave labor for the plantations importation up to 1863 (year of abolition of slavery in Suriname) and hereafter indentured labor from China, India and Indonesia. They were brought in to run the plantation-based production system in the country during the colonial periods. In 2003, Suriname's total population of 481,146 comprised of the following ethnic groups: 36% Hindustani (from the Indian sub-continent, 31% Creoles (of African or mixed descent), 15% Indonesians, and 10% Maroons (descendants of run-away slaves). Smaller groups comprise the Amerindians, the original inhabitants, Chinese, Lebanese, and descendants of European settlers. This mosaic of races and cultures co-exists peacefully and makes Suriname an exceptional example of social harmony. The country is also multilingual with Dutch as the official language. Sranang Tongo, the lingua franca and English are widely spoken. Furthermore, the oriental languages originating from China, India and Indonesia are also spoken and/or written by part of the population. All the major religions such as Christianity, Hinduism and Islam are practiced.

As of 2003, about 97% of Suriname‘s total population was concentrated in the coastal zone, especially in and around the capital Paramaribo. The remaining 3% were spread over small towns in the coastal districts and in tribal communities along rivers in the interior. In the interior Maroons and Amerindians are predominant. The overall population density is about 2.9 people per km² and indicates that Suriname is very sparsely populated. In this respect the most important coastal districts are Paramaribo and Wanica, having population densities of 1,338.2/km2 and 193.1/km2 respectively. In relation to 1980, population growth in 2003 has been registered at the rate of 35.4%. However, the rate of population growth for the Suriname has declined over time, but stabilized since 1995 at around 1% per year. Of the total population in 2003 about 39% was younger than 19 years, whilst 60 years or older, only 8.5%.

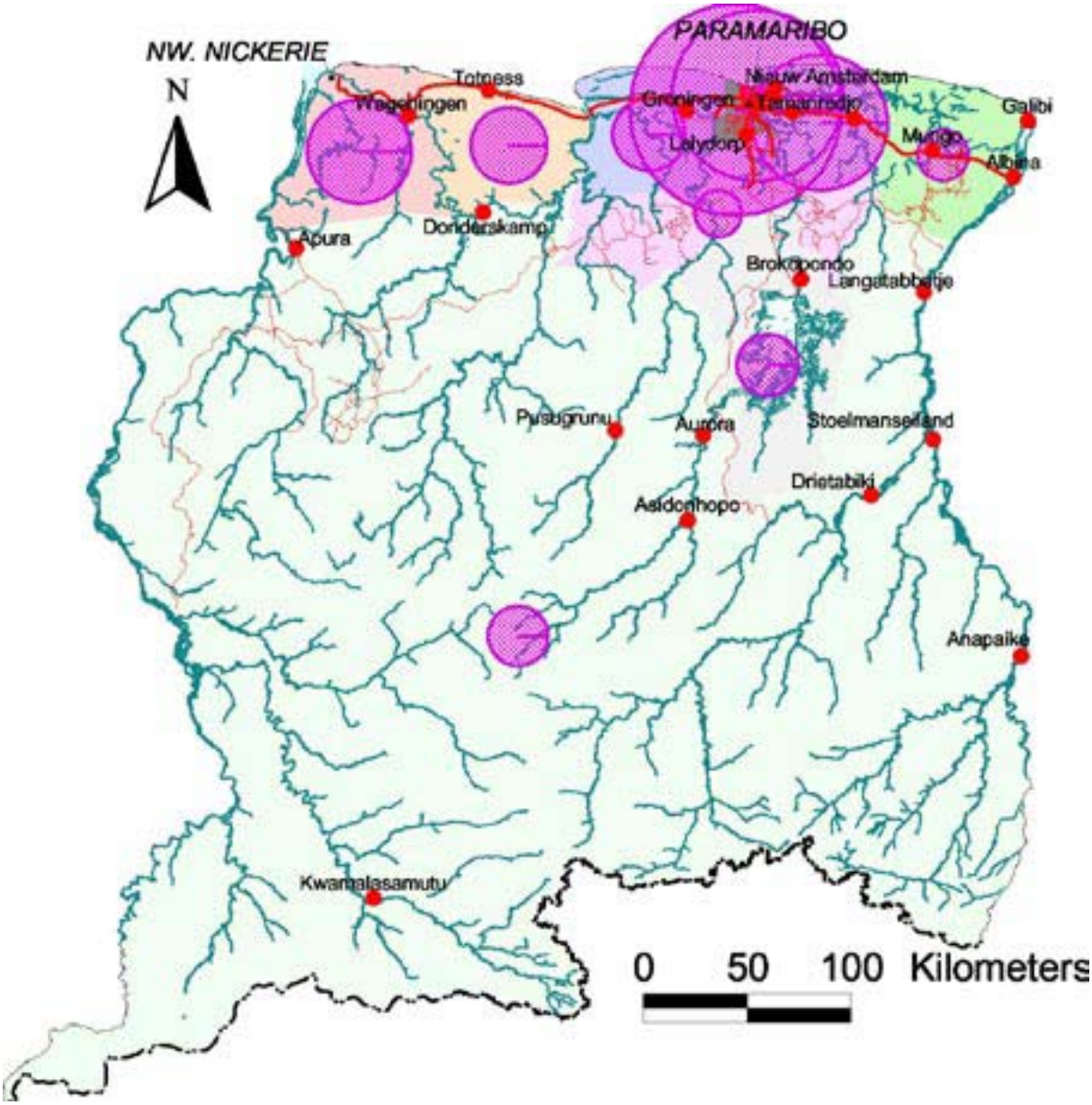


Figure 1.10: Population distribution

Life expectancy, for males is about 64.7 and for females 70.1 years. The infant mortality rate continues to fall due to improvements in the health care system. In 2002 it was around 1.0 per two thousand.

1.6 Economy and development

The creation of Suriname in 1667 as a Dutch colony and its subsequent evolution under Dutch hegemony until independence in 1975, exhibit all the characteristics of a common colonial experience. The history of Suriname's economy is therefore a plantation economy. The buoyancy of the economy has historically been derived from the several hundreds of plantations established along the rivers of the coastal area. All but handful old plantations remained along with some new established ones.

Since World War II, the economy has become largely based on bauxite mining and processing activities, which are carried out by a joint venture of ALCOA and BHP Billiton. From the 1960's onwards exports of bauxite, alumina, and aluminum have accounted for 70 – 80% of total export revenues, forming thereby the basis for the bulk of government revenue. Before the independence from the Netherlands in November 1975, the Surinamese economy was highly centralized and inward oriented, with a dominant and expanding public sector, while deriving much of its buoyancy from the foreign-owned bauxite mining industry. After independence, the bauxite sector continued to dominate in terms of its contribution to the economy as a whole. As of 2003, the bauxite sector still holds as the single most important sector of the economy in terms of foreign exchange earnings, government income, contribution to GDP and employment. On the other hand, the government received an enormous grant aid from the Netherlands, to marshal the development of the small and undiversified economy.

On account of these two pillars, the economy grew at average rates exceeding 3% p.a. in the seven years after Independence. During the mid-eighties, the economic situation worsened on account of declining commodity prices on the world market, and suspension of aid in 1983 by the Netherlands, following political developments in Suriname. An internal war in the interior of the country during the 1983-1987 period destroyed much of the economic infrastructure of eastern part of Suriname, as roads, bridges and some economic activities, such as the oil palm production.

The early and mid-nineties (1992-1995) were characterized by the implementation of a Structural Adjustment Programme (SAP), designed to revitalize the economy and arrest negative growth rates of GDP and avert pauperization of the population. As a result, GDP at factor cost (at constant prices), totaling Sf.1,812 million in 1998, showed annual growth up from –12.67% in 1993 in the SAP period to 32.77% and 5.28% in the post-SAP period in 1996 and 1998 respectively. During the period that the Structural Adjustment Programme was being implemented, inflation reached a height of 370% at the end of 1994, thereby contracting the economy in real terms by 0.61% in that year. Exchange rate volatility also fed the inflation-spiral during the SAP period.

The sectoral origin of GDP at current prices shows that in 2003, the main contributing sectors were sectors operating in the tertiary sector: trade, restaurants, hotels, transport and communication, financial intermediation, renting and business activities, other community, social and personnel service activities (46.7%), Government sector and defense (18.7%),

Mining, agriculture and fishery (15.3%). The Manufacturing sector has remained stable in the preceding years reaching a share of GDP of 13% in 2003.

	2000	2001	2002	2003
Primary	607	717	692	641
Secondary	620	656	664	664
Tertiary	1,919	1,634	1,725	1,893
Government	466	476	481	482

Table 1.1: Sector origin GDP

Source: Financial note of the Ministry of Finance
Primary = agriculture, fishery, mining; Secondary = industry, electricity, gas, water, construction
Tertiary = trade, hotels, restaurants, transport, communications, financial institution, commercial activities, other community, social en personal activities.

Macro-economic indicators	2000	2001	2002	2003
GDP at basic prices 1	911,570	1,250,913	1,677,751	2,160,114
GDP at basic prices 2	1,054,770	1,466,509	1,950,002	2,573,398
GDP at market-prices 1	1,017,240	1,474,947	1,946,415	2,570,010
GDP at market-prices 2	1,160,440	1,690,543	2,218,666	2,983,294
GNI at basic prices 1	848,231	1,017,710	1,575,891	2,032,640
GNI at basic prices 2	991,431	1,234,306	1,848,142	2,445,924
GNI at market-prices 1	953,901	1,242,744	1,844,555	2,442,536
GNI at market-prices 2	1,097,101	1,458,340	2,116,806	2,855,820
Mid-year population	463,837	470,064	476,374	482,769
National income per capita 1	2,057	2,644	3,872	5,059
National income per capita 2	2,365	3,102	4,444	5,915

Table 1.2: Gross Domestic Product (GDP), Gross National Income (GNI), Mid-year population, National Income per capita during the period 2000 – 2003

Source: Financial note of the Ministry of Finance
1 = formal sector; 2 = formal + informal sector

	2000	2001	2002	2003
Gross Domestic Product (Market prices; 1990=100 1)	3,381	3,568	3,659	3,792
Gross Domestic product (Market prices; 10= 100 1)		4,420		4,756

Table 1.3: GDP in real terms

Source: Financial note of the Ministry of Finance

1.7 Legal Framework

The legislation regulating the protection of the environment in the Republic of Suriname is as follows: the forestry act (GB 1947, no. 42), the nature protection law (GB 1954, no. 20), and the fish protection law (GB 1961 no. 44). These laws contain provisions which directly address the ecological security of the population, the rational use natural resources, as well as nature conservation and environmental protection.

1.8 Environmental Management Structure

The establishment of the National Environmental Council (NMR), and the institutionalization of the National Institute for Environment and Development in Suriname (NIMOS), has marked a significant step towards the planning and development of environmental policy in the country. The NMR was established by Presidential order on June 9, 1997 to support the Government of the Republic of Suriname by advising on national environmental policy. NIMOS was established on March 1998 as the Executing Agency of the National Council for Environment and is responsible for research (Environmental Impact Assessments), training, awareness rising and the execution of projects.

In 2002 the environmental structure was strengthened with the establishment by State Decree of the Ministry of Labor, Technological Development, and Environment (ATM), which is the overall responsible agency for coordination of activities related to global environmental management and the governmental and non-governmental bodies and institutions. The other Ministries have responsibilities over specific areas of global environmental management according to the Government Decrees on tasks of Ministries, 1991. The two environmental bodies, namely NMR and NIMOS are now supporting the work of the Ministry of ATM.

Up to and until 2004, the management of coastal districts of Suriname has been under combined management of both levels the sectoral as well as the district levels. On the sectoral level, different ministries are charged with implementing policies nation-wide and promoting the interests of the sectors that they represent. Specifically the ministries of Agriculture, Livestock and Fisheries (LVV), Natural Resources (NH), Labor, Technological Development and Environment (ATM) and Public Works (OW) are closely involved with activities related to coastal management and the effects of climate change. The Ministry of Planning and Development Cooperation (PLOS) coordinates the planning activities of the government.

On the district level, the District Commissioner (DC), functioning under the Ministry of Regional Development is the main representative. As the focal point of activities within the district, the DC acts in close cooperation with the elected District Council to marshal general management, the economic promotion and development of the district.

Environment management

Suriname with its clean living environment has, since the establishment of the NIMOS, adopted approaches that reflect its geography, the unique structure of its social, cultural and environmental priorities. Accordingly, Suriname shapes its strategic interests on the precautionary principle that environmental protection and environmental improvement are complementary to successful economical development. Today the success of its environmental protection measures receives worldwide recognition. Suriname's belief is that environmental protection requirements must be integrated into the definition and implementation of national and international policies to ensure maximum benefit. Over the next decade Suriname will make sure that its population has an environment worth living in by fulfilling five basic prerequisites:

- Management of climate change risks while preserving economic growth and international competitiveness;
- Implementation of "Environmental Friendliness". This implies, inter alia, prevention of environmental degradation by careful land-use planning;
- Adoption of economic instruments based on the **polluter-pays principle**;
- Practice of Environmental pollution control. This includes treatment and recycling of waste water, safe management of hazardous waste and toxic chemicals.

2 NATIONAL GREENHOUSE GASES EMISSIONS 2003

Introduction

As mentioned in chapter 1, about 97% of the population is concentrated in the northern coastal plain of Suriname. Consequently, most of the economic activities, with the exception of bauxite and gold mining, are concentrated in this area, particularly in and around Paramaribo. Here the economical activities are driven by services, mainly based on imports of goods, banking, insurance, transport and communication and other sectors such as the wholesale and retail sectors. The Agriculture sector, which is predominantly developed in the northwestern part of the country, produces mainly rice and bananas. In the north central part of Suriname other agricultural products, like vegetables and fish are dominant. Land-use changes are more frequent practiced in the coastal area than in the interior of the country. Forestry and gold mining are the major economical activities in the hinterland of Suriname. The activities that use energy from combustion of fossil fuels appear to be the largest source for CO_2 followed by the emissions from land use and land use changes.

Methodology

The revised 1996 IPCC guidelines were used to compile Suriname's emission estimates for carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). For the energy sector two approaches were used to establish the GHG inventory: the reference and sectoral approaches. The Reference Approach is based on the revised IPCC guidelines to compile the green house gases of all sectors, whilst the Sectoral Approach is based on gathered data of the sectors individually. Data for the inventory were obtained from governmental sources and private companies. For the whole inventory default IPCC values have been used. It should be noted, however, that estimations were unavoidable for those sectors or part of sectors, where data were incomplete or missing. The inventory is compiled for the following sectors: Energy, Industry, Solvents, Agriculture, Land Use Land Use Change and Forestry, and Waste. Emission data from international bunkers and marine bunkers, reported separately, is given in accordance with the IPCC guidelines.

2.1 Emission Inventory overview

The total green house gas (GHG) emission for the inventory year 2003 equals to 8,902Gg of CO_2 Equivalent, using the 2001 Global Warming Potential guidelines of the Intergovernmental Panel on Climate Change (IPCC). Total CO_2 Removals (GHG sinks) in Land-Use change and Forestry equal 3,862 Gg of CO_2 equivalents, making the net GHG emission equal to 5,040 Gg of CO_2 equivalents. Table 2.1 below illustrates the share percentage of corresponding Green House Gas emissions. Except carbon dioxide and methane other gasses are also produced in Suriname, but in very small amounts or have short atmospheric lifetime. These gases will be mentioned more detailed later in this chapter.

Gas	Emissions (Gg)	GWP's	CO2 - equivalent	% of total emissions
CO2 (Carbon Dioxide)	39,874	1	3,984	79.38
CH4 (Methane)	45	23	1,035	20.62
TOTAL			5,019	100.00

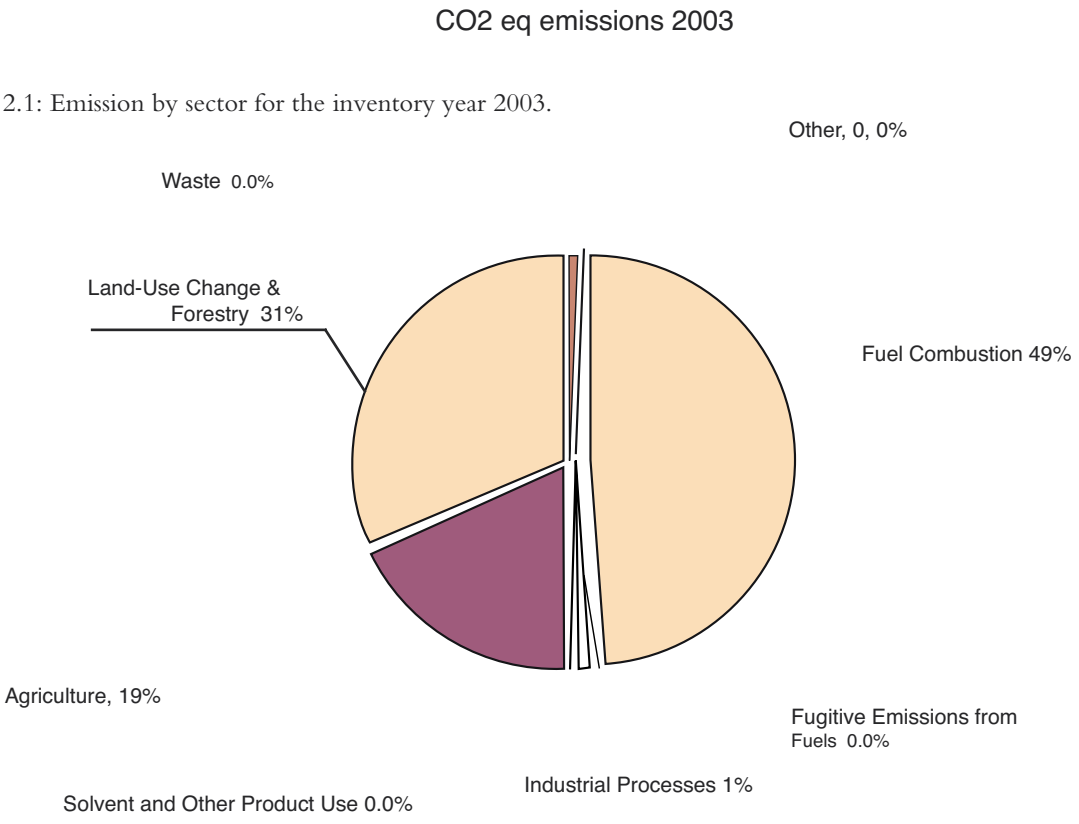
Table 2.1: An overview of major GHG Emissions for 2003

The sector contributions of GHG within the total emissions are presented in table 2.2 and figure 2.1. According to this table the sector Land-Use Change and Forestry is the second largest source of GHG emissions, taking about 26% of the total GHG emissions to its account. This is due to the conversion of Tropical Forests for wood logging purposes, including the export, and forest clearing for shifting agriculture. The energy sector is the largest GHG source, contributing about 71% to the total GHG emission and comprises primarily the combustion of fossil fuels. Other sectors contribute less than 2% each.

Sector	Emission in CO2 equivalent	Percent of total
All Energy	2453	48.66
Industry	65	1.29
Agriculture	936	18.57
Wastes	24	0.48
LULUCF	1563	31.01
TOTAL	5041	100.00

Table 2.2: Contribution of GHG from different sectors 2003

Figure 2.1: Emission by sector for the inventory year 2003.



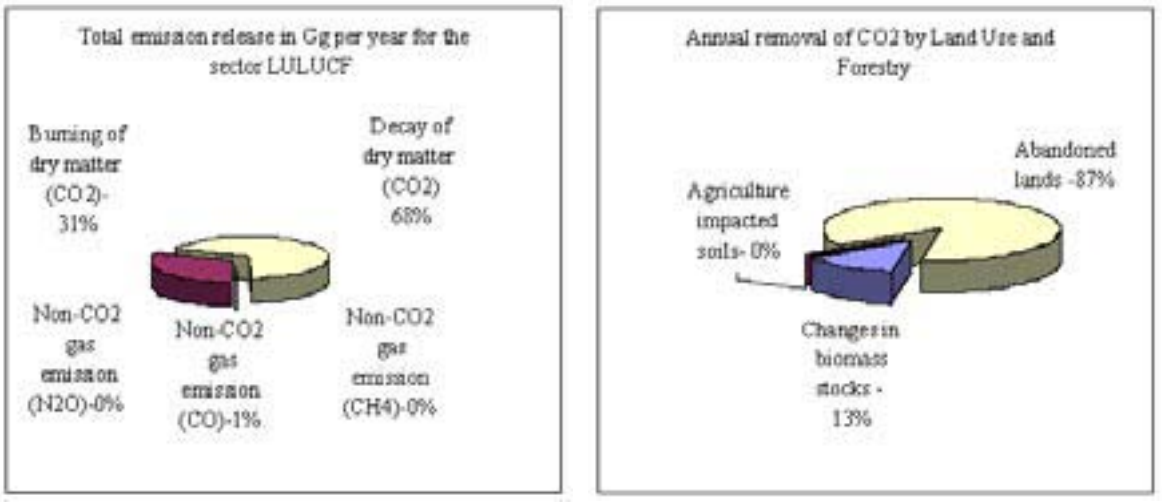
2.2 GHG inventory by sector

2.2.1 Emissions and sinks of greenhouse gases from Land Use and Land Use Change and Forestry

The forest area of Suriname covers about 14.5 million hectares or about 82% of the total land's surface, comprising the entire interior of the country. In this rather inaccessible area the most widespread land-use activity is the selective light timber harvesting, a method of wood logging, which is not considered to be a basis for large-scale degradation of land and biodiversity. Presently 4 million ha of this area are accessible and about 1.3 million ha timber exploration and/or exploitation licenses exits.

Changes in forest and other woody biomass stocks

Annual loss of biomass due to land conversion is calculated to be 5,290.49 kt dry matters of which 1,788.80 kt is left on site for decay. The total annual released emission from the biomass conversion equals then 4,751.98 Gg CO_2. It should be noted that large part of the harvest wood is meant for export and as building material and therefore must be seen as fixed and not released CO_2.



a b

Figure 2.2 (a) Carbon release, and (b) Carbon uptake by Land Use and Forestry.

Carbon uptake by land use and forestry is calculated for biomass increase with about 1,052.25 kt per year, which is equal to about 3,858.25 Gg CO_2 annually.

Within the Forestry Sector another very significant event recently took place: the establishment of the Central Suriname Nature Reserve (CSNR). This single, most important nature reserve in the Region has a surface area of about 1.6 million ha and boasts the highest diversity of biological life forms in the region. In November 2000 the CSNR was placed on the UNESCO World Heritage List. The forest of this Nature Reserve is legally protected guaranteeing that trees within this vast forestland will not commercially be cut. In this regard the CSNR will contribute as a sink pool.

2.2.2 Emissions from the all energy sector

The Energy Sector is the largest contributor to Green House Gas emissions followed by Land Use Land Use Change and Forestry. As primary energy sources, hydropower, hydrocarbons and biomass are utilized. Hydropower comes from the country's only hydropower plant in the district of Brokopondo, whilst hydrocarbons are produced locally and are partly imported as derivative products, and biomass, consisting mostly of firewood and agricultural residues.

The energy demands of the coastal zone are covered by hydropower and thermal power stations. The inland has no professional continuous energy providing system. Electricity is provided through the use of diesel generators. A relative large part of the fossil fuels are being used for transportation, comprising basically lorries, motorcycles, and busses. There is relative small marine and air transport for domestic and international operations. The locally produced hydrocarbons are used for electricity generation and, as input in the bauxite industry and the remaining are exported.

Normally the bauxite sector consumes roughly 70% of all energy. In the last years however, this number has decreased to 62% in 1998 and 55.4% in 1999, due to the closure of the aluminum production in 1999.

The combustion of hydrocarbons is the major source for GHG emissions in this sector, excluding emissions from biomass burned for energy. Emissions from international bunkers are reported under separate subchapter. The total CO_2 emissions from the Energy sector amount to 1,154 Gg. However, for estimating the total national emissions estimations, the Reference Approach is used, since the Sectoral Approach could not provide all activity data, in particular the gold industry sector. Table 2.3 exhibits the sources of the various green house gas emissions.

Sources	CO2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total National Emissions	3,984	45	0	12	65	15	0
1 All Energy(Reference Approach)	2,442			11	31	8	
(Sectoral Approach)	2,442	0	0	11	31	6	0
A Fuel Combustion	1,693	0	0	0	1	0	
Energy industries	530			1			
Manufacturing industries and construction	1,384			4			
Transport	351			0	0	0	
Other sectors	100			2	1		
Commercial	0						
Residential	37						
Agriculture/Forestry/Fishing	2			2	2		
B Fugitive Emissions from Fuels	0	0		0	0	2	0
Solid fuels							
Oil and natural gas						2	
2 Industrial Processes	65	0	0	0	0	7	0
Mineral production	65					7	
Metal production	0				0		
3 Solvent and Other Product Use	0		0			0	
4 Agriculture		40	0	0	4		
Rice cultivation		37					
Enteric Fermentation		3					
5 Land-Use Change & Forestry	1,477	3	0	1	30		
Changes in forest and other woody biomass stocks	588						
Forest and grassland conversation	4,752						
Abandonment of managed soils	-3,858						
CO2 emissions and removals from soils	-4						
6 Waste		1	0				
Memo Items:							
International Bunkers	303	0	0	0	0	0	0
Aviation	101	0	0	0	0	0	0
Marine	202	0	0	0	0	0	0
CO_2 Emissions from Biomass	0						

Table 2.3: Short summary of the National Green house Gases Emissions and Removals in Gigagrams per year.

2.2.3 Emissions from industrial processes

Emission form industrial processes include only those, that are generated during the industrial process it self and do not include emissions resulting from energy use in this sub sector. The production processes that emit CO_2 include limestone consumption and the beer production from the PARBO Beer Brewery. Total CO_2 emissions from these sources are approximately 65Gg. Different halocarbons (and SF_6) are also consumed in industrial processes or used as alternatives to ozone depleting substances (ODS) in various applications. Other potential industrial emission sources of GHGs and ozone and aerosol precursors are the emissions of nitrogen oxides (NOx), Nonmethane Volatile Organic Compounds (NMVOCs), Carbon monoxide (CO) and sulfur dioxide ($SO_{2)}$.

2.2.4 GHG Emissions from the agricultural sector

Suriname produces most of its agricultural demands and is thus self-sufficient in most of its food products. The majority of the agricultural activity takes place in the young coastal zone, with a total cultivation area of about 478.000 ha. Shifting cultivation in the interior has only little effect on the total GHG emissions in this sector. Hence, the main sources of emissions in the agricultural come from rice and banana cultivation in the coastal zone, including incineration of organic residues in agricultural fields, and the livestock sector with processes of enteric fermentation and manure management. These emissions do not include emissions resulting from energy use in the sector.

Emissions from rice cultivation

Emissions from rice cultivation are: methane (CH_4), Carbon dioxide (CO_2), Carbon monoxide (CO), and nitrogen (NO). Methane released due to anaerobic decomposition of organic material in flooded rice fields equals about 842.72 Gg. Carbon dioxide, carbon and nitrogen are released during the processing of wet harvested paddy to cargo rice. The large amount of husk produced during these activities, totaling biomass of 76.01 Gg of dry matter (dm) are burned. During this process the total carbon release equals 31.5 Gg and the nitrogen 0.44 Gg.

Methane Emission from Animals

The total emission for domestic livestock is 78.89Gg, CO_2 equivalent with cattle, both dairy and non-dairy compromising 47%% and 49% of the total, respectively.

2.2.5 Emissions from Waste

At the moment there is no controlled waste Management in Suriname. The collection of household waste is restricted to the Capital Paramaribo and some other parts of the rural areas in the coastal zone where the concentration of population is high. Methane is the main emission product from this sector and is produced from solid household waste and waste from

small industries though anaerobic bacterial decomposition of the organic matter in open landfills and dumps. By using default values for populated areas methane (CH_4) emission is estimated at 1 Gg. In the remaining area, including the hinterland, where the population concentration is extremely low, methane emission from solid waste is negligible. Wastewater management and / or treatment are until now not practiced in Suriname.

2.3 GHG emissions by gas

Emissions of carbon dioxide (CO_2):
The total carbon dioxide emissions in 2003 were about 8,902Gg. This amount is based on emissions emitted by the energy sector through combustion of fossil fuels (about 2,442 Gg, using the reference approach), Land Use Change and Forestry (about 4,752 Gg) and emissions emitted through industrial process (about 61 Gg).

Emissions of Methane (CH_4)
Methane emission originates mainly from the agricultural sector and the waste management sector. The CH_4 emission for 2003 has been calculated to 45Gg, of which 1Gg comes from the waste management sector, 40Gg from agriculture sector and 3Gg from Land Use Change and Forestry.

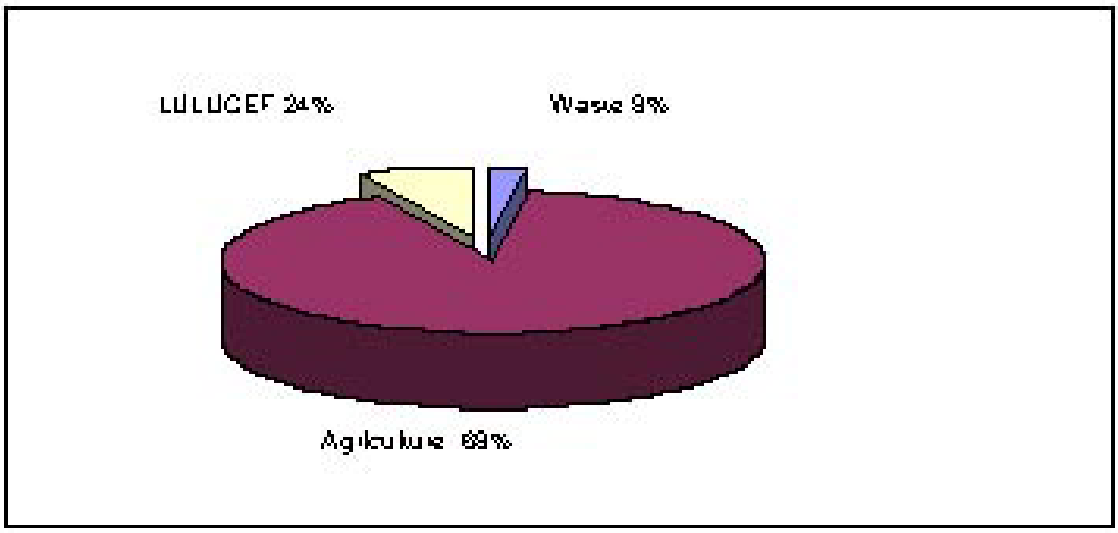


Figure 2.3: CH_4 Emissions by Sectors

Emissions from other gases
The other emissions figures, although some having a large global warming potential, are relatively small. The **CO_2** emissions, mostly from the LULUCF and fuel combustion sector, have been calculated to 65Gg. For NO_x and NMVOC - mostly from fuel combustion- the figures are 12 and 15Gg respectively.

CO_2-Emissions (reference approach)
For the estimation the emissions, the IPCC default values of the carbon emission factor and combustion efficiency were used, as provided by the IPCC-manuals. In the figure below an overview of the fuel types normally utilized in Suriname are presented, as well as their respective apparent consumption and the estimated CO_2 emissions for 2003. Detailed calculations for all years between 1990 and 2003 can be found in the technical paper.

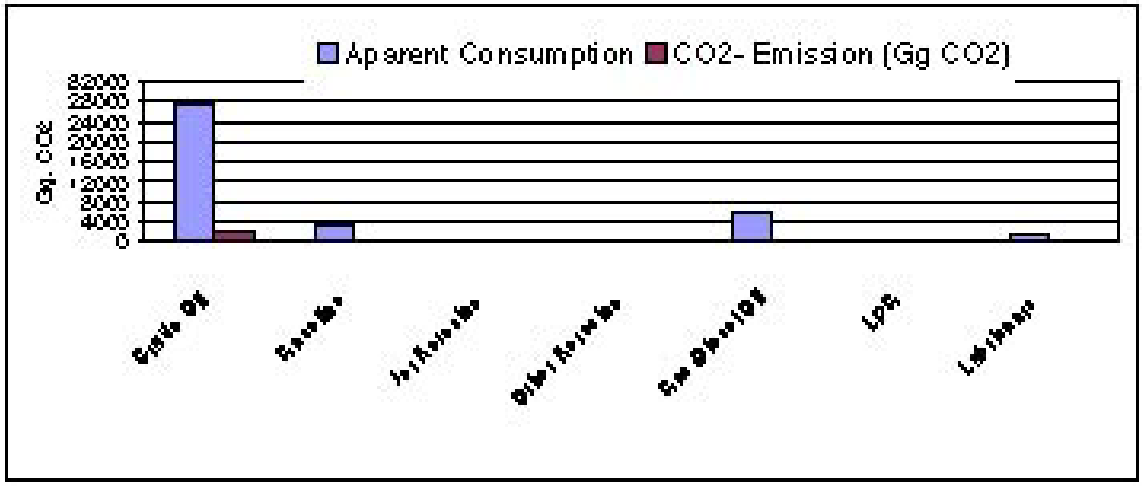


Figure 2.4: Apparent fuel consumption and their CO_2 Emissions in 2003

The actual domestic emissions from energy sources in 2003 were 2360.28 Gg CO_2. The emissions due to international bunkers were 303.10 Gg CO_2. Between 1990 and 2003 there was an annual increase for CO_2-emissions and International bunkers. Basically this is due to the growth in population and the developmental thrust exerted by each country to improve their gross national product.

2.4 International bunkers

According to IPCC guidelines emissions from international bunkers are excluded as mentioned earlier from the total emissions. The total CO_2 emissions from international bunkers equals to 303.10 Gg and is composed of emissions from Aviation and Marine with 101 Gg and 202 Gg of CO_2 respectively.

2.5 Emissions forecasts 2000 - 2015

Forecast of CO_2-emissions

In order to forecast the CO_2-emissions the trends for CO_2 will be used for extrapolation to the year 2010. These trends are based on the average growth method and will be used to make forecasts, through extrapolation, resulting in a business-as-usual approach. This method is accurate for large communities, however since Suriname is a small community some prudence has to be made and forecasts have to be corrected when information becomes available that justifies so.

The figure here below illustrates the forecast trends for both of the methods for the period of 2000 to 2010. There seems to be a slight difference between these two estimations.

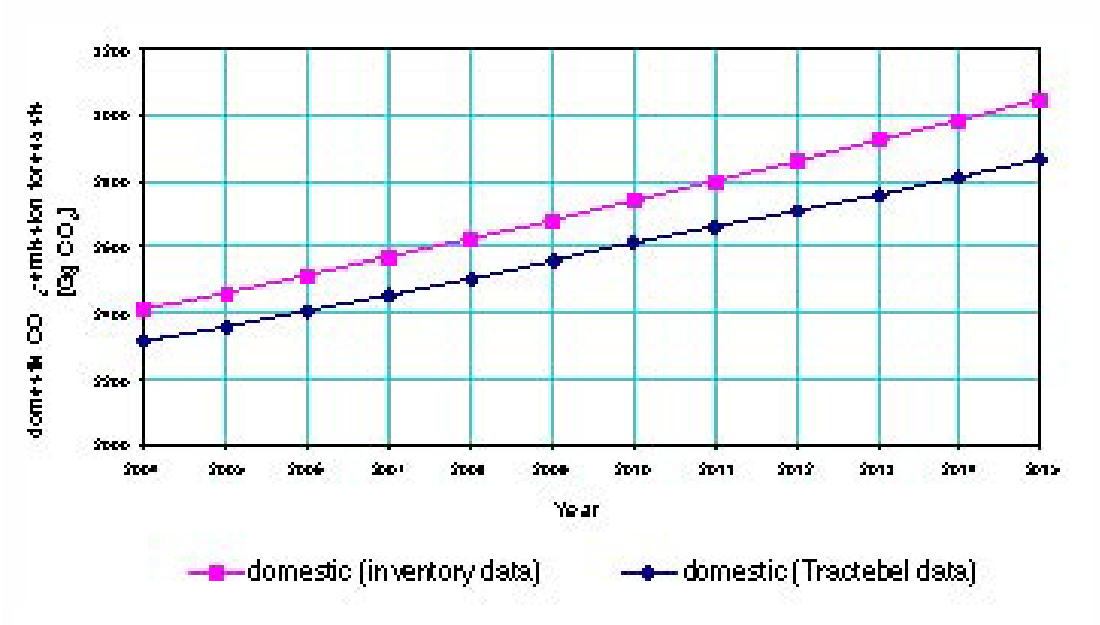


Figure 2.5: Graphical display of forecasts for CO_2-emissions (2000-2015)

Forecast of non-CO_2-emission

The forecast of non-CO_2 emissions was made in accordance with those done before and guidelines of IPCC, resulting in emission figures for CH_4, N_2O, NO_x, CO and NMVOC given here below.

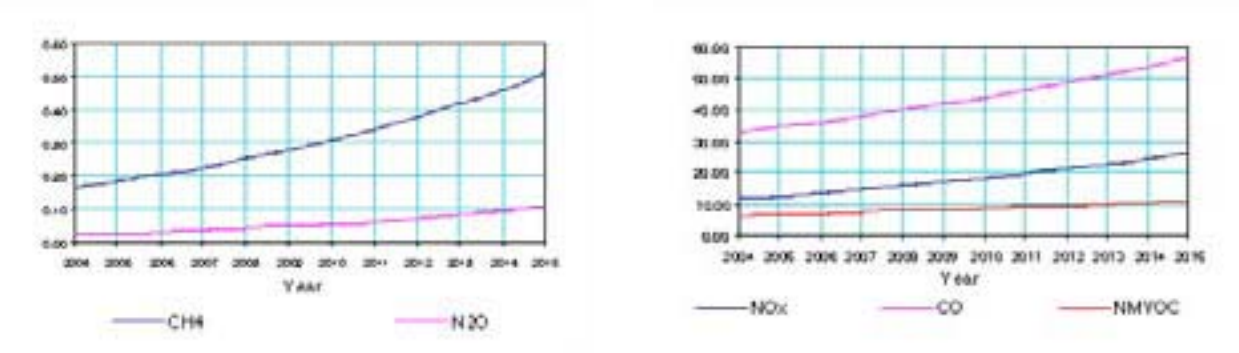


Figure 2.6: Emission forecasts of CH_4, NO_2, and of NO_x, CO and NMVOC over the period (2000 –2015)

2.6 New developments

New developments in the agriculture and mining sector, where large acres of forests will be cleared, are predicting a likely increase in the level of GHG emissions.

2.7 Future energy potential

The total hydroelectric potential in Suriname amounts to approximately 2,590 MW of which roughly 189 MW has already been developed. At the end of 1996 the total original oil reserves in Suriname was estimated at 900 million barrels, of which at least 157 million barrels were economically recoverable.

Up to the end of 1999 a total of 30.1 million barrels were produced. The expectations are that these activities will lead to an important increase of the proven reserves and ultimately to a boom in the crude oil production.

Each year approximately 30 tons of wood is used for cooking purposes in the hinterland. Because of the fragile economic situation of the country and the scarce investment capital, it is not realistic to expect any change in this situation on a short term.
Suriname has an enormous potential of solar energy with an average radiation of 1,635kWh/m^2 per year. The utilization of this resource will depend on future developments in the costs of solar energy.

The wind energy potential is determined by the trade wind regimes with an average velocity of about 5 m/s at a height of 10 m above sea level throughout the whole year. In recent years a number of feasibility studies regarding wind energy have been initiated. Hence, it can be expected that wind energy will give great possibilities in the near future.
Suriname has an estimated peat potential of about 18,650,000 toe, with an economically recoverable reserve of about 1.5 million m^3 (350,000 toe), which could deliver about 1,000 to 1,200 GWh of electricity

In 1998, Suralco still operated its Aluminum smelter, which was important for the volume of the GHG emissions. In April 1999 Suralco closed the smelter, which accounts for the important reduction of CO_2 emission of 50%. It is not expected that in the near future the smelter will be restarted and thus there will be no increase of GHGs from this part of emissions.
Currently CO_2 emissions are being recovered (from the Bayer process in the production of alumina) and being utilized in the refining wastewater treatment.
The maintenance of the deplorable roads will increase the demand of asphalt in the coming years.

After the closure of the sugar plantation Mariënburg, former national alcohol & sugar Company, SAB has extended its alcohol and other alcoholic diversification production. Information about the volume of produced alcohol is important to estimate the GHGs emission. Availability of data from this sector is important to be able to calculate the total GHGs emissions.

It is expected that the production of flour will not substantially increase in the future.
New industries, with an important GHGs emissions contribution, are not expected to emerge in the near future. The nation's awareness of environmental issues is growing. The governmental institutions dealing with environmental legislation and other environmental requirements are in a process for the set up of national regulations on environmental aspects. More manageable emissions can be expected rather than a reduction of the total volume of GHGs.

2.8 Uncertainty

The inventory of Green House Gases and Sinks in Suriname is the third in Suriname. The first attempt was taken in 1997 (base year 1995). The second inventory was made in 2001 with 1998 as base year, but has not been published. All inventories have been made according to the IPCC guidelines and are based largely on incomplete data.

This is especially the case in the Forestry Sector, where due to incomplete data expert judgments have been made and therefore many uncertainties should be handled with care.
An explanation for this doubt is given here below.

- First, as has been mentioned earlier, only 4 million ha of the 13.5 million ha are accessible out of which 2.7 million ha is licensed for wood harvesting purposes.
- The techniques and methods used for wood logging purposes restrict large-scale clear-cutting of the forests.
- An unknown part of the harvested wood is meant for export purposes, the other part for the local market.
- Wood and wood products are widely used as building and construction materials in Suriname, especially in house-building industry.
- The re-growth of the harvested forest, which takes place naturally.

Moreover, research data shows that the Amazonian forest, of which the Suriname forest is part of, increases in biomass and thus may be interpreted as net CO_2 uptake. Within this perspective the contribution of the Forestry Sector needs to be adjusted by implementing a detailed research study using satellite images of various years up to present.
Waste is another sector of which very less data are gathered and known, as is also the case with the transport sector. Data collection is desired to be continuous. Missing or incompleteness of basic data consequently hampers high confidence levels of the GHG emissions inventory also in the future. In this regard serious attempts have to be made in order to gain higher results during the next emissions inventory.

3 EMISSIONS ABATEMENT

In Suriname there are no serious industries of a certain magnitude, except for the bauxite sector, which can be regarded with respect to energy use and emissions related concerns. One industry with potential impact is the growing petroleum "State Oil" industry, which started with the production of crude oil in 1982. In 1997 a refinery was set up and came into production. Other industries, such as those in the agricultural sector are too small and too limited to be regarded as players of significance in the emissions game. Consequently, these and other factors have indicated that there are currently no policies, laws or measures in place on the mitigation of Greenhouse Gas Emissions. However, ongoing developments in sectors as mining, forestry, agriculture and waste resulting in enhanced emission of greenhouse gases, bear significant pressure on the government to change its policies towards the mitigation of these gases. The government has responded to this development with a number of legislative actions to pave the road for further action.

This Communication report is the first fundamental document dedicated to the assessment of Greenhouse Gas Emissions, estimation of Climate Change impacts, development of measures for emissions abatement and measures for the adaptation to climate change. The measures most useful for serving Suriname's future needs are:
- Improvement of national legal legislation/framework;
- Restructurization and modernization of the economic sectors;
- Promotion of the increase in energy efficiency and energy conservation;

However, sector related abatement measures are lacking, since there are no or a few investigations and studies done in corresponding sectors. In the following communication and action plan additional information on these sectors will be provided.

3.1 Actions for Greenhouse Gas Emissions Abatement

3.1.1 Energy Supply Sector

The objectives for a national energy policy must take note of the following actions:
- Improving the efficiency with which energy is transformed and distributed;
- Improving the efficiency of combustion in the "standard" fossil fuel power plant;
- Reducing transmission and distribution losses
- Increase use of renewable (biomass power generation, solar based rural electrification, methane emission reduction, wind energy, rice husk power generating and hydropower generation.

The energy efficiency can be improved throughout the entire process of the energy generation to energy supply. By using cleaner energy and new technologies, especially in the hinterland, where diesel generators are used for electricity generation, decrease of CO_2 emissions will certainly be gained. Among these technologies are the Micro – and Pico hydropower, photovoltaic system and wind propelled electric generators. In villages along the rivers in the hinterland, diesel generators could be (partly) replaced by establishing micro hydropower stations and/or in combination with photovoltaic, whilst in the north, at the shoreline, wind propelled electric generators could be used. The high initial costs, however, oppose the implementation of these technologies in these sparsely populated rural areas.

Other possible options for energy generation are energy generation through waste incineration, combustion of waste in the agriculture sector and in the wood industry. A large source in the abatement process is the conservation of the energy, which in particular is valid for the industries, residential and commercial sector of the society.
Emission abatement should include the following measures:

- upgrading of the general thermal efficiency in fossil fuel consuming stations from about 33% to at least 45%
- establishment of new power stations with large and more efficient state of the art power units
- improvement of management and maintenance concepts
- separation of the energy production from the energy distribution
- reduction of transmission losses during power transmission on the public grid.

3.1.2 Energy demand sector

In the *industry sector*, energy conservation will tend to reduce the CO_2 emissions. In this regard the following measures and policies are recommended:

- improvement of energy management systems through the use of high efficiency motors, fans, compressors and drive controls,
- monitoring of energy demand through data collecting on industrial energy consumption and energy indicators,
- promotion of energy efficiency and environment protection

Conservation measures in the *residential and commercial sector* can also contribute significant amounts of energy savings and therefore reduction of CO_2 if summarized over a long period of time. This could be reached through implementation of the following measures:

- Improvement of energy management in the this sector, which could be reached through regular maintenance, turning off of unnecessary lightning in the offices, departments, houses, and other buildings, and maintenance of equipments including air conditioning, etc. A main step in realizing this is the promotion of awareness among the inhabitants.
- The use of solar heat systems instead of electrical boilers for heating water. All these require studies to define ways and means of developing programs to encourage the use of the above-mentioned improvements.

3.1.3 Energy Use Industry Sector

The voluntary options available in the industrial companies to improve their energy efficiency can be classified into four types. The first involves *new management measures,* which can be implemented at little or no expense. Examples include switching off equipment when not in use, use of lagging and insulation to reduce heat losses, monitoring and target setting schemes with aim of improving energy efficiency. Second, *Additional Equipment measures*, which involve capital, with the aim of saving energy, such as waste heat recovery systems. Third, *Equipment Replacement Measures,* which involve replacement of worn-out and obsolete equipment. Fourth, *New Process technologies*. These involve the introduction of low new consumption processes to carry out particular tasks.

3.1.4 Transport sector

Mitigations in the transport sector include measures towards increasing the efficient use of energy and its demand. In this regard the following are mentioned:

- mitigation through improvement of vehicle control and maintenance
- rehabilitation and maintenance of transport ways
- Introduction of electrified railways for mass transportation within the city, taken against the background of increasing cars and automobiles, while transport problem worsen.

3.1.5 Agriculture Sector

Mitigation in this sector includes the reduction of methane in the first case and in particular from rice cultivation. Presently an area of approximately 50,000 ha can be flooded annually for rice cultivation purposes. Methane emissions, in general, are proportional to the number of days the fields are flooded. By switching from long to short duration varieties significant methane reduction can be achieved. Presently the farmers are switching from a variety lasting 120 days to a variety lasting 100 days. Mitigation of methane here can be achieved though appropriate management and proper planning, water distribution, water management and cultivation techniques.

Application of fertilizers within the rice field's for increasing the crop values promotes also the methane emission. The main type of fertilizer being used is the urea, which by its substitution will result in emission reduction. However, for proper results studies are required.
Carbon dioxide emission in the agricultural sector deals in particular with the burning of the rice waste in the field and the paddy waste at the rice mills, mitigation of which can be achieved by making use of these raw materials instead of burning. However, financial and know-how limitations restrict implementation of this option.

Livestock, especially dairy and non dairy cattle, produces significant amount of methane, due to anaerobic conditions. Through processing by altering fermentation patterns, methane reduction can be achieved. However this approach has to be accepted by the breeders and farmers first. To this end no attempts have been made.

On the other hand, forests and high biomass producing crops are important sinks for Carbon dioxide. In this regard worthwhile mentioning is the attempt to re-establish the "palm-oil" plantation in the district Para, after its destruction during the civil war.

3.1.6 The waste sector

The impact on human health is not yet fully considered within solid waste disposal activities (SWD) that are currently being undertaken. The SWD practices in Suriname have not kept pace with the demands posted by increases in population and waste generation. The landfills in Suriname are also very small. Research has shown that small, shallow landfills do not produce methane as large, deep landfills, where the density and moisture content is likely to be greater. Controlled waste disposal activities should not only prevent health threat, but also control the GHG emissions for this sector.

3.1.7 Emissions from liquid waste

The majority of households have relied on septic tanks for disposal of sewage effluent. With the exception of Santo Boma prison, there are no sewage treatment systems in Suriname. Both domestic and industrial liquid wastes are generally disposed of through ocean outfalls.

Suriname's waste management sector is a relatively insignificant source of greenhouse emissions. However, dumping of waste can lead to contamination of groundwater, rivers and lakes. The release of gases from landfill sites can also be detrimental to the health of local residents and the environment. Proceeding on the premise that less waste means less resource consumption and less environmental impact, the following objectives for a future waste management policy are evident:

- generation of waste must be avoided as far as possible;
- unavoidable waste must be recycled as far as possible, and
- waste which cannot be recycled must be disposed of in an environmentally sound manner.

To achieve these targets several policy initiatives could be pursued:

- Implementation of a waste management strategy: focus on selective waste collection, storage, transportation, protection and sound use of trans-boundary river systems, protection and sustainable fresh water resources
- Implementation of an urban landfill levy
- Industrial responsibility: manufacturers have a special responsibility for their products and need to think about end-of-life recycling options right from the design stage.
- Implementation of sewage treatment systems. The sewage treatment systems receive both domestic and industrial liquid wastes and reduce biological and physical treatment processes to remove solid materials and reduce the organic content of liquid waste. Treatment of secondary wastewater can be disposed of through ocean outfalls. While solids can either be directed to landfill for disposal or used as a feedstock for composting or to manufacture soil amendment products.
- Public participation: the conviction and active participation of each and every individual is needed. And for this, there must be a broad social consensus on objectives and an acceptance of the measures needed to achieve them. Environmental education is of great importance.

Emission reductions include therefore the treatment of the municipal solid and liquid waste disposal system. Presently measures are being elaborated for a better and efficient waste management system in cooperation with the Ministry of Public Works and the private sector. By implementing appropriate measures emissions can be kept within limits. The following measures are proposed:

- Establishment of a specialized administrative mechanism for solid waste management;
- Provision of financial and technical assistance to private sector entities which are interested in waste collection and waste recycling;
- Training management personnel in specialized skills for management of solid waste in this sector;
- Pretreatment of the liquid waste requires priorities, prior to discharging it into open water area;
- Maintenance of treatment systems;

3.2 Land Use Change and Forestry

Suriname with its large forest cover, ranking the 37th country in the world in terms of existing forest area and as one of the Amazonian countries containing the highest amount of biomass per hectare of forests undoubtedly will be a country where the forestry sector will play a major role in mitigation of the greenhouse gases.

According to the inventory of anthropogenic greenhouse gas emissions and removals, see chapter 2, Land use, Land use change and Forestry (LULUCF) rank as the second largest source of emission of greenhouse gases in Suriname. In this regard forestry can serve both as a source and as a sink of greenhouse gases.

The national forestry objectives for Suriname are to optimize and sustain the production of wood and non-wood products and services which the forests provide, including the regulation and purification of water supplies, the protection of the soil, and the conservation of biodiversity and that of the general environment. Sustainable forest management in Suriname has been improved with the establishment of the Foundation for Forest Management and Production Control in 1998. The Situation in the forest exploitation sector has since then changed from virtually no control to a situation where harvesting of logging is controlled, to avoid over-cutting and removals of undersized logs and protected species. The Foundation for Forest management and Production Control is maintaining a close cooperation with relevant institutions concerned with forestry development, mainly with the Jan Starke Training Center, which is responsible for the training of forest guards, lower and middle-level technical forest workers, among others. NIMOS is another partner involved in the development of national legislation and strategies for forestry development. Forest research is executed by the Center for Agricultural Research in Suriname (CELOS) and for specific subjects by the University of Suriname itself. In the past two years, the forest research program was focused on silviculture, wood technology and remote sensing for forest classification.
Initiatives to conserve and extend traditional knowledge are undertaken by the NGO,
Conservation International Suriname (CIS)_with regard to the use of medicinal plants and traditional healthcare. To conserve a major proportion of the nation's biodiversity the Government of Suriname has established in 1998 the CSNR. With this action about 1.6 million hectares of mostly forestland (±12% of the country) is protected. This is in addition to other existing protected forest areas.

Forest ecosystems store carbon in the vegetation, the forest debris and in the soil. A mature forest is more or less in equilibrium with regard to carbon release and carbon uptake. The loss or degradation of forest ecosystems will cause Carbon emissions to increase.

The forestry sector has the potential to contribute in the mitigation activities if the goals for sustainable management of existing forests and protection of biodiversity are reached, on the other hand, and on the other to improve the efficiency of the wood industry and decrease wood waste.

The strategy for abatement in forestry in Suriname will be threefold:
- to maintain and protect existing carbon reserves
- to establish sinks on selected areas
- to promote the substitute of wood fuel for non-renewable energy sources

3.3 Potential abatement activities in forestry

Improved management of the protected forested areas. Monitoring of the protected areas will benefit from the use of modern tools like GPS, GIS and remote sensing.

Sustainable forest management. Uncontrolled logging leads to severe damage to the forest ecosystem. In some parts of the hinterland degradation of the forest has been observed with the diminishing of commercial species as a consequence.

A controlled logging operation will decrease damage at the residual stand. In this regard the Forest Management System, elaborated in Suriname, will be introduced nation wide.

Improved efficiency in the wood industry. Poor planning and improper harvesting and skidding techniques have led to a high percentage of log waste. Equipments used in the wood processing are often inappropriate and seldom in proper condition, which contribute to recovery rates. A program for training and extension to loggers and sawmill workers has to be implemented. Basic courses on felling and wood processing with mobile equipment should also be offered.

Agro forestry techniques in the interior to maintain stability of the agricultural system. The shifting cultivation system in Suriname is already now giving signals of not being a stable system and cannot be relied upon to fulfill the growing demands of an increased population. Agro forestry can serve as a tool to improve soil fertility and thereby increase the production. Furthermore, through agro forestry additional income in the form of tree products can be generated. Initiatives by the NGO community working in the interior show promising results.

Efficient methods for the use of woods as fuel by people in the interior and other rural areas. To avoid a further intrusion of fossil fuel into areas where it was traditionally not the case, the renewable energy in the form of firewood must be made available in a convenient way. Conventional use of firewood entails open fire for preparation of meals. Cooking stoves designed to reduce the amount of firewood used will be an improvement over the traditional ways of using firewood, and is an alternative to the use of cooking gas stoves.

Use of sawmill waste to produce energy. Sawmill waste can be easily used to provide energy. Attempts are being made to achieve this goal. Wood waste can be used as substitute for fossil fuel in the processing of the timber. However, improved technologies to utilize waste are needed.

Cost Benefit Analysis will be done in the making of the National Action Plan

4 VULNERABILITY AND ADAPTATION

Introduction

Owing to the flat and low location of the Suriname coast any rise of the sea level will contribute to adverse impacts on the ecosystems and human settlements of the area. A sea level rise of 50 cm over the coming 100 years, as reported by IPCC, will have disastrous consequences for the entire nation, since the largest concentration of people is being found in the coastal region. Here, almost every sector will be severely impacted, as increased erosion, large-scale inundation, loss of fertile land, reduction of freshwater resources, decline of biodiversity, and worsening of human health would result. In addition, climate change is likely to result in changes in the hydrological cycle, including rainfall, its intensity and distribution, and draughts. The combined effect of these changes makes the country vulnerable to climate change. To date the few studies done in these areas show the high vulnerability of whole coastal zone.

4.1 Coastal erosion and land loss

The coast of Suriname has been classified as muddy because of the immense volumes of argillaceous muds, originating from the Amazon River is transported in suspension towards the coast where it gets deposited forming mud therefore flats/banks. The mud banks move at an average rate of about 1.5 km per year in the western direction and causes accretion where they attach themselves, while other areas may suffer erosion or ridge formation.

Picture 4-1: Continuous erosion at district Coronie (2004)

This erosion / accretion mechanism does not account for continuous erosion along the entire shoreline of Suriname. Continuous erosion seems to be stocked at those locations where agricultural areas were created after deforesting the coastal forests. Owing this erosion permanent loss of land and episodic flooding of the immediate area are observed annually. This has resulted in establishing of dykes and dams in some regions of the country as Nickerie, Coronie and Commewijne.

However, both dykes as well as dams pose problems due to its weak construction and the lack of maintenance. When these defenses are breached or overtopped, as happens occasionally, tidal flooding by saline water causes damage to agricultural areas as well as to infrastructure such as roads and housing.
Flooding also results from riverbank erosion by the strong tidal currents, and subsequent dyke failures. Especially for district Commewijne and Nickerie is this valid.

4.1.1 Impact of the sea level rise

Sea level rise will have large and multifaceted complications on the relatively flat and low-lying coast of Suriname. A 50 cm rise of the water depth in front of the coastline will, together with changes in wind pattern and wind intensity, result in intensified wave attacks on the shoreline, land loss, owing to this inundation and flooding, salination and loss of biodiversity of the immediate coast.

Inundation

Among these impacts, long lasting inundation will be the most common phenomenon. Large-scale inundation will be observed when heavy rains will coincide with high water tide, since the greater part of the drainage systems will be closed as this is based on gravity flow. The impact zone of the sea level rise will comprise a part of the Young Coastal Plain, including low-lying creeks, river valleys and inland swamps. The low-lying coastal foreland, which is virtually without protection, except for the natural defense by the mangrove zone, will be subjected to permanent flooding. This may reach as far as the first natural (sand and shell ridges) or artificial (roads, polder dams) obstacles in the south, thus covering an area of up to 15 km from the sea. Inundation will also be enhanced as part of the coastal plain is getting subsided due to the ongoing agricultural and land reclamation activities. Subsidence could also be expected by oil-extraction onshore.

Erosion

As the sea level will rise the frequency of occurrence of a storm surge at a given height will increase. However, absence of storm activities on the Suriname's coast should normally keep this coast free of storm surges at least in the near future. However the winds shall definitely be stronger than what they are now owing to the increase of CO_2 in the atmosphere and the rise in temperature, which is directly connected to the storm activity.

Picture 4-2: Strong erosion at the Coronie – Nickerie coast (2003)

These changes will contribute to higher wave intensity and consequently an intensive and stronger attack on the shoreline, resulting in a stronger degree of erosion. In the most eastern part of the country, where sandy beaches occur, a large part of these beaches may disappear, and only those with appreciable width will survive and may even be reworked and pushed back if more sands are available. In the western part of the country, especially the muddy coast of the districts Coronie and Nickerie intensive erosion is to be expected. In addition, changes will enter also in the estuaries of the rivers. This will involve a change in riverbed and bank sedimentation and erosion patterns. It is to be expected that part of the shores along the lower river courses will be subjected to increased erosion, while elsewhere more sedimentation will take place.

Erosion and sedimentation along the coastal shoreline is among others also depended on the supply of sediment. A decrease of sediment supply to the coast is likely to happen in case of less rainfall in the source area. According to IPCC the Amazon area is subjected to less amount of rainfall. In contrary, if increased erosion in Andes region and in Amazonia due to increased rainfall and ongoing and future deforestation, will take place, the sedimentary budget may revise upward and a possible addition of sediment to the sea may result in accretions.

Mangroves

Sea level rise and changes in the sedimentary budget will certainly have impact on the mangrove forests as they occur at the land-sea interface. The mangrove scenario in Suriname would be one of stability in areas of accretion. In areas suffering strong erosion, the mangrove will be destroyed. Whether the mangroves will encroach on the newly flooded areas will depend on relatively homogeneous geomorphology, meso or macro-tidal range, muddy sediments,

accreting coasts, gentle land gradient and humid climate are favorable factors in advance of the mangroves on the land in the wake of SLR.

Marshes within the coastal wetland are likely to maintain or even grow in their aerial extent in the face of SLR. They will be altered as a result of increased water logging, changes in salinity and even biota. Increased storminess will have effects on mangrove population as well as on coastal habitat.

4.1.2 Adaptation measures

There are a few policy options that can be undertaken as adaptation measures within the section coastal erosion and land loss. These measures given here below are prioritized as follows:

Picture 4-4: Sea defense at Nickerie (2004)

1. Integrated coastal zone management: this option will involve criteria and guidelines to redirect resources away from vulnerable to areas less vulnerable areas within the coast. This plan should further involve priorities for the use and management of coastal and marine resources.
2. Retreat. This option is least feasible since large losses will be encountered. However, for certain areas it might be the only solution as for instance Weg naar Zee and Coronie North.
3. Building dykes and dams to prevent further erosion of the coast, land loss and flooding consequently. It is quite unlikely to set up sea dykes and river dams over the whole coastline and the estuarine. At present, measures are proposed for only those locations where structures are already in place and where other adaptation options will be more expensive and less sustainable. However, new defense structures will have to be created, especially for the capital Paramaribo, in order to prevent human settlements from inundation and loss of their properties.
4. Breakwaters: to build groynes, which are hard structures, used to reduce the wave energy reaching the coast line. This option is very expensive, about 3-4 million Euro per kilometer length (€), but will however have fair environmental impact in contrast with building dykes and dams.

4.2 Vulnerability of Water resources

Suriname is endowed with freshwater resources. The yearly rainfall, concentrated mostly in the short and long rainy seasons, results in relatively large river basins and freshwater wetlands flowing generally in the north south direction, except for the small rivers, which under pressure of the Guyana current and the moving mud banks/flat bend in the northwestern direction. The various geological formations of the coastal zone and the topography also contribute to the formations of extensive swamps, seasonal swamps, and lagoons. Fresh to saline water wetlands are mainly found in the coastal zone, where developments of human settlements, associated with agricultural and industrial activities, are observed. Drinking water supply to these settlements is mainly based on the groundwater reserves whilst the agricultural and industries depend on the surface water resources. Freshwater systems are moreover sources of income from fisheries, aquaculture, and tourism. The interior rivers possess over relatively large potentials for hydropower generation. However only in the early 60's a man-made lake has been established in the Suriname River for generation of hydroelectricity. In this way, water availability, in particular freshwater, is an essential component of welfare and productivity.

Changes in the global climate will have serious impacts on water resources because of its sensibility to interannual fluctuations, such as those associated with the El Niño events, and changes in the hydrological cycle, such as distribution, intensity, commencement of various seasons, etc. Changes in the hydrological cycle might result in extreme precipitation with increased inundational effects of large areas in the coastal zone. In addition, surface runoff and groundwater resources will be aggravated in certain areas by human activities and unsustainable development of water consuming activities. On the other hand, reduced precipitation will have serious consequences for many sectors including hydropower generation, water withdrawal for irrigation and for potable water supply.

4.2.1 Occurrences of surface freshwater resources

Surface freshwater resources, which include rivers, swamps, lagoons and man-made lake, are subjected to climate change. Changes in the rainfall pattern will be directly observed in the hydrological regime of the rivers and swamps.

In Suriname there are seven main rivers, from the east to the west: Marowijne River, Commewijne River, Suriname River, Saramacca River, Coppename River, Nickerie River and Corantijn River.

The largest rivers are the Marowijne and Corantijn, bordering French Guiana in the east and Guyana in the west respectively. Hydrological characteristics of these rivers are presented in the table here below.

Main river	Catch-ment area (km^2)	Mean discharge at outfall (m^3/sec)	Specific discharge (l/sec/km^2)	Water level near outfall exceeded once in 25 years (m MSL)	Minimum salt intrusion in km from outfall	Maximum salt intrusion in km from outfall
Marowijne	68,700	1,780	25.9	2.14	57.0	59.0
Commewijne	6,600	120	18.2	1.93	60.0	---
Suriname	16,500	426	25.8	1.98	54.0	90.0
Saramacca	9,000	225	25.0	2.08	37.0	89.0
Coppename	21,700	500	23.0	2.22	31.0	95.0
Nickerie	10,100	178	17.6	2.50	28.2	105.0
Corantijn	67,600	1,570	23.2	2.80	40	82.0

Table 4.1: Hydrological characteristics main rivers of Suriname

At the upper reaches, beyond the tidal influence of the Ocean, the water levels and currents are under influence of the freshwater discharge. Here high water corresponds with peak flows in wet season and low water with low flows in dry season.

In the coastal plain, river water is subjected to tidal movement and salt intrusion. The tidal influence and salt intrusion depend upon the topography and the freshwater discharge from upstream. During periods of peak flows the salt intrusion is minimum and maximum during period of low flows.

During the dry periods serious problems occur in the interior, dealing with river transportation, lacking of fresh water for potable purposes as gold miners pollute river waters, and water withdrawal for irrigation purposes. This situation exacerbates during the El Niño years and may affect the food supplies seriously whilst at the same time enhance malaria and other water borne diseases in the area.

Water reservoirs found in swamps and wetlands can be divided into (1) the saline and (2) the freshwater wetlands, including the man-made lake. Saline and freshwater swamps are located within a relatively small strip along the coast at land-sea interface. At some locations the saline/brackish wetlands and the freshwater swamps are linked together permanently or temporary as well as by artificial structure as by natural water divide, creating ideal conditions for aquaculture and breeding and nursing place for shrimps, fisheries and (migrating) birds.

The Prof. Dr. Ir. Van Blommenstein Lake is the only existing man-made lake, and is located at Afobaka, at km 194 (measured along the river) upstream the Suriname River and is build for generation of hydroelectricity in 1964, primarily for the aluminum industry.

Due to the closure of the aluminum industry, recently, additional hydroelectric power is available for electrification and for other small industries. However, hydroelectric production during dry periods, especially during the El Niño years is at its lowest. Aiming an optimum use of the hydropower, a lake management is applied. In this regard studies are planned to investigate the possibilities to expand the capacity of the hydroelectric power plant, among others to divert water from neighboring river basins to the lake. Impacts of this lake on the local climate are unfortunately not studied. Currently efforts are made to apply micro and pico hydropower for generation of electricity for the villages located along the rivers in the interior of the country.

4.2.2 Occurrences of groundwater resources

From the several aquifers found in the coastal area of Suriname most important are the A-sand, the Coesewijne and the Zanderij freshwater aquifers, out of which only the Zanderij aquifer is subjected to modern recharge. The aquifers, mentioned above, are used for potable purposes, especially in the urban areas of the coastal plain. More than about 0.66 m^3/sec (2,400 m^3/hr) is withdrawn on average. The supply of potable water also faces scarcity problems during the dry periods and extremely dry years. Wells located near the coastal line are subjected to salinity. Here salt intrusion plays a major role. The increase of sea water level will further enhance this intrusion. Also mining of ground water from confined aquifers affects the salt intrusion positively.

4.2.3 Impacts on water resources

Future developments such as population growth, agriculture and urbanization, will enhance the impacts on the existing water resources of the country. However, the largest impact on the existing water resources remains the ongoing change in the rainfall patterns of the climate. Continuation of the negative rainfall trend for a large part of Suriname will affect seriously the availability freshwater for agricultural and potable water supply, hydroelectric power generation and navigation. In addition some humid areas may become semi-arid, especially the northern part of district Coronie.

Decrease in rainfall pattern will affect transportation as rivers are used as waterways to transport people and goods to the various locations in the interior. Decreased freshwater discharge will be compensated in the lower courses of the rivers with salt-water intrusion from the Atlantic Ocean.

This problem will be superimposed with the sea level rise, where among others irrigation and drainage facilities will be affected and disrupted, and large areas of fertile lands will be lost due to high salinity. Current infrastructures and water works such as ports and waterways, bridges, dams, dikes, sluices and pumping stations might not function properly due to the higher sea level and increased sedimentation and erosion.

Picture 4-5: Drainage outlet in the Nickerie river (2004)

4.2.4 Proposed adaptation measures

The existing water resources of Suriname satisfy quite sufficiently the demands of the nation today and in the very near future, notwithstanding the adverse affect of the climate change. However, this might not continue for long. As global warming intensifies and climate changes, water resources of Suriname will change accordingly resulting in depletion and exhaustion of the available fresh waters. Therefore measures have to be taken in advance. In this regard adaptation measures are proposed and prioritized as follows:

1. Efficient utilization of water resources. In this respect a total assessment of all the available water resources in Suriname is needed followed by a national water policy including regulations on water withdrawals from water bodies and the discharge of effluents within the different river basins.

1a. Regarding the potable water supply in urban areas, efficiency improvements in production and distribution of potable water is needed. It is reported that loss of potable water due to leakage in the piping system is about 30-40%. It is necessary to improve these water supply systems, their technical conditions, and maintenance and equip these with modern devices.

2. Optimization of the cultivation practices so that the use of available fresh water will be more efficient. Adapting in this regard the tillage practices and the preparation of the land for the crops, aiming less water use. Application of rotation in the irrigation practices, as well as

recycling of drainage water is recommended. The consideration of cultivation of crops with lower water demand and/or crops tolerable to higher salinity should also be made.

2a. Recycling of water. Water from the agricultural areas is drained into the rivers and ocean. If strong measures are taken towards the improvement of quality of water drained into the rivers, large amounts of this could be reused.
3. Expanding the capacity of the existing van Blommenstein storage lake (hydropower) and where necessary the creation of new reservoirs into the rivers for storage and other purposes of fresh water thereby regulating the rivers for hydropower and irrigation, and minimizing the salt intrusion.
3a. Transferring the freshwater swamps into freshwater reservoirs through dams. These dammed-up wetlands can be used to purify drainage water from agricultural and or/ aqua cultural areas naturally.
4. The estuarine zone should be left undisturbed as much as possible, which means that the management as protected areas or Multi Use Management Areas (MUMAs) should be very strict.
4a. Switching from freshwater to brackish water fish and shrimps cultivation.
5. Adapting the necessary infrastructure within the urban and production areas to the higher rainfall intensity and increasing sea level rise, through increasing of the drainage capacity of the canal systems and installing additional pumping stations.
5a. Continuing the maintenance of existing dikes, which consists of the maintenance of sea, and estuary dikes and swamp dams.

4.2.5 Vulnerability of Coastal Zone Ecosystems

The coastal zone ecosystems can generally be divided into an estuarine and a freshwater zone ecosystem. In case of Suriname, human settlements and infrastructure are found at quite a distance from the ocean shoreline leaving an essential strip along the coast untouched, except for some locations, as Nw. Nickerie, Coronie, Commewijne and Paramaribo. Anthropogenic impacts of the colonial period have resulted in some ecosystem diversification of these parts of the coastal zone and in increased erosion. The enhanced erosion and flooding in such locations will be exacerbated by the global climate change, resulting in ecological consequences. It is believed that with the rise of the sea level and changes in the rainfall and sedimentary budget of the ocean waters, transformations in ecological systems of both – estuarine and freshwater zone will take place.

4.2.6 The estuarine zone ecosystem

The estuarine zone, which is about 1200 sq km in extend, comprises brackish wetlands, covered with mangrove forest, lagoons and brackish herbaceous swamps, as well as a strip with freshwater swamps directly south of it. The fresh water swamps, while draining towards the ocean, mix with the salt ocean water penetrating landward during high tides, therefore creating and maintaining the brackish (estuarine) zone. Furthermore, the estuarine zone has soft, saline to brackish clay soils and waters ranging from (hyper) saline to (nearly) fresh.

On silted mudflats up to elevations above the mean high water level, a mono-specific Black Mangrove or “Parwa” (*Avicennia germinans*) forest develops and on slightly more settled black mangrove forest is found.

Picture 4-6: Estuarine zone (2004)

Within this zone a natural process of growth and decay of mangrove forests take place. Together with appropriate water quality, the tidal action of the ocean and inland waters, ideal conditions are created in providing the estuarine zone with nutrients, organisms, spawn, juvenile fish and shrimps. These mangrove ecosystems are particular important as spawning and nursery ground for the marine fauna. In this respect the ecosystems serve as breeding, feeding and nestling ground for numerous species of coastal birds. About 118 species of coastal birds are found along the coast of Suriname. Of this amount more than 70 species are defined as "waterfowl" according to criteria of the 1971 RAMSAR CONVENTION, out of which, 21 species are found at different parts of the Suriname coast, making the Suriname coast of "international importance".

Between the Orinoco and the Amazon river mouths, the coast of Suriname shows the highest density of nestling colonies of "ciconiiform" birds (herons, ibises, spoonbills and storks). For the South American endemic Scarlet Ibis, the coast of Suriname is of critical importance with up to 35,000 breeding pairs during top years. The total number of waterfowl species along the Surinamese coast at one time (total of estimated maximum numbers of each species) may reach to as many as 5 million.

The Surinamese coast may be considered as the principal South American wintering ground for shore birds migrating from boreal and Arctic regions: over half of the 2.9 million shore birds wintering in South America have been observed along the coast of Suriname. In addition, estuarine ecosystems provide food for a number of fish, crab and shrimp species living as immature in the brackish swamps, lagoons, tidal creeks and river estuaries, and as adults in the sea or even in fresh water ecosystems.

Accretion and erosion of the coast both affect the ecosystem of the coast in one way or another. In case of accretion swamp water may become fresher during wet seasons, and hyper saline during the dry season.

Erosion of the coast, in contrast, may increase the influence of seawater on the freshwater swamps, creating thereby conditions for development saline lagoons. In addition, the new accreted areas are new sources of carbon storage. Carbon storage also increases when brackish or saline swamps go over into freshwater swamps, where peat formation takes place on large scale. However, during the extreme dry periods part of this storage may be lost during fire outbreaks. Presently under these circumstances large amount of peat occurs in the freshwater swamps.

The global climate change and a sea level rise in the coming 100 years may affect the naturally mixing of fresh and saline waters at certain locations seriously, since relative large part of the entire coastal fringe will be permanently inundated. Under these circumstances marine fish and shrimp harvesting, small-scale fisheries in shallow sea, river estuaries, tidal creeks and lagoons,

might seriously hamper. Along the coast the projected sea level rise will lead to an increasingly higher deposition of the mudflats. This will lead to a higher coastal zone compared with the land south of it. Along the accretion parts of the coast the Black Mangrove forest zone will essentially remain the same, but the brackish zone south of it, if any, will experience sedimentation and will very gradually face deeper water conditions. It is also to be expected that the brackish zone will extend further to the south when the seawater inundates this lower zone at high (spring) tide. Hyper saline conditions may arise when the drainage of floodwater back to the sea is blocked by the higher mudflat in front of the brackish zone or otherwise (e.g. ridges).

In this way the estuarine ecosystems are not expected to change dramatically, although some serious shifts will occur. The ecosystems will essentially remain to be able to provide the functions mentioned above.

In the eastern part of Suriname (Marowijne (Galibi), Commewijne), sandy beaches occur, covering approximately 10% of the total shoreline. These sandy beaches are relatively high and wide. Along the remaining coast they are discontinuous and rather indistinct, locally forming narrow and low “over-wash” bars at the edge of the coastal clay flats.

Picture 4-8: Braamspunt, Suriname river (2003)

The sand beaches in the eastern part are important nesting sites for endangered sea turtle species. Diminishing areas of sand beaches will reduce the numbers of sea turtle nests and increase the pressure on the turtle species nesting in Suriname. The most common species are the Leatherback Turtle (*Dermochelys coriacea*) and the Green Turtle (*Chelonia mydas*). Less common and (also worldwide) very vulnerable is the Olive Ridley (*Lepidochelys olivacea*). For Olive Ridleys the Galibi beach along the Surinamese coast is the most important nesting beach along the Atlantic Ocean.

4.3 The freshwater zone ecosystem

Freshwater swamps (herbaceous swamps and swamp forests) comprise most of the remaining part of the non-cultivated part of the Coastal Plain south of the estuarine zone, covering approx. 11,000 sq km. Apart from the cultivated and abandoned agricultural land another 4,000 sq km in this part of the Coastal Plain is covered with high seasonally flooding marsh forest and high dry land forest. These freshwater swamps thin (<20 cm) to moderately thick (20-40 cm) peat layers are found. In poorly drained swamps thickness of peat layer may exceed 40 cm.

The herbaceous swamps show a great variety of grasses, sedges and forbs, usually with certain species dominating over large areas. The older herbaceous swamps in the south are poor in species and most of the time one single species dominates in these swamps. This is especially the case in swamps with frequent grass fires and in deep depressions with extremely thick or floating peat layers (such as the southern Nani Swamp, the central Coronie swamp and the swamp upstream of Buku Creek in the Cottica drainage basin (Buku Swamp or Great Swaying Swamp).

In swamps with a thin peat layer on clay, and in the absence of fires, tree lets invade herbaceous swamps, announcing the succession towards swamp wood. Depending on the local water quality, the hydrological conditions and/or the occurrence of fire, different species may dominate in these swamp woods. Prolonged absence of fire is expected to result in the development of a species-rich high swamp forest.

The possible impacts of climate change on this vegetation include peat and forest fires - resulting from prolonged and extreme dry periods, transformation of herbaceous swamps from great varieties of grass into poor species or even to single vegetation. Prolonged dry seasons in combination with rainfall decrease will promote invasion of arid vegetation at the ridges.

These transformations and invasions will certainly affect the wildlife of the region. At present a considerable list of mammals, birds, reptiles, amphibians, fishes, shrimps and crabs can be compiled. Of these the Manatee (*Trichechus manatus*) and the Brazilian Giant Otter (*Pteronura brasiliensis*) are considered as vulnerable species in Suriname. The Iguana (*Iguana iguana*) and the Spectacled Caiman (*Caiman crocodilus*) are still common, but are diminishing in populated areas.

The most common treat to this wildlife forms the global climate change and human activities. Due to polder development and the expected sea level rise, swamp waters in the northern part of the fresh water swamps are expected to rise gradually, resulting in gradual thickening of peat layer. Studies have shown that peat growth has kept in pace with the rising swamp water level. Owing to this considerable carbon will be fixed in the future, as 1 cm of peat contains approximately 5 tons of carbon per hectare. On the other hand increased temperature will affect the wildlife populations in the region.

At the same time a dramatic rise of swamp water levels will however have a severe impact on the vegetation species. A rise of 20 cm above the usual maximum levels reportedly killed or severely damaged swamp wood and swamp forest in western Suriname after damming up the Nani Swamp by the construction of a drainage diversion dam. Such a scenario may become possible in synergy with the expected sea level rise and rainfall. This will therefore result in

freshwater swamps or forests with less species diversity. In addition drainage of polluted water from the agricultural lands into swamps, establishment of new infrastructure, as roads, dams, canals, will further enhance the loss of species.
It is expected that on the long run, swamp forest will replace the seasonally flooding marsh forest where a peat layer will develop. Decreasing plant diversity will result in decreasing fauna diversity.

Proposed adaptation measures
One of the major impacts of climate change on the ecosystems includes the transformation of one vegetation type to another. Prevention of these changes is unfeasible and also illogical as another replaces one ecosystem, which may be considered a natural process.

However, a strategy towards the protection of the coast against further erosion and degradation should put in place as soon as possible. This strategy should include the following, given in the order of priority:

1. Protection of all mangrove forests by giving them the status of "Special Protected Forests" based on the Law of Forest Management (SB 1992, No 80).
2. Implementation of the currently proposed MUMA's and all legal, administrative and organizational facilities for their proper functioning.
3. Stopping of the issuance of land in the estuarine zone in order to halt further degeneration of the coastal protection by mangroves.
4. Withdrawing the not used and abandoned land in this zone that is already issued.
5. Provision of incentives to protect the existing mangroves and to discourage further agricultural (including aquaculture) activities on issued land in the estuarine zone, so that mangroves will be able to re-establish in those areas where the mangrove zone has been damaged or removed.
6. Implementation of a monitoring system to check on the above points; this can be done by taking frequent (e.g. bi-annual) satellite images, of the estuarine zone; these images will also be very useful to follow the dynamic coastal processes

4.4 Vulnerability of the Agriculture sector

The major crops in Suriname include rice and bananas, the most important agricultural sub sector being rice. It is responsible for 55% of the agricultural production on about 48,000 ha land of the 1.5 million ha that is considered suitable for agriculture. Other important sub sectors, except bananas, are horticulture, fisheries and livestock production.

The most substantial impact of global climate change will be its impacts on the hydrological cycle and reasonable utilization of the water resources in the agriculture. Salination of lands resulting from saltwater penetration and shrinkage of water resources in the coastal zone affect immediately among others the agriculture sector of the country, decreasing thereby the contribution to the national economy and the number of jobs. Large losses will be encountered into the various sub sectors as rice, banana, horticulture, livestock, fisheries and aquaculture.

Rice is the main crop in the northwestern part of Suriname. Its growing, development and productivity are stipulated among others by availability of sufficient irrigation water and the climate.

Picture 4-9: The "Van Wouw" irrigation channel (2003)

Changes of these two values determine the level of harvest. As has been concluded earlier, freshwater resources are subjected to decline and the expected sea level rise will further exacerbate these resources through saltwater intrusion. Decrease in the rainfall will further worsen the existing conditions for rice cultivation, as rice cultivation in Suriname is water based (wet rice cultivation).

Climate change, resulting in an increase of UV-B radiation and higher CO_2 concentration, damages leaf tissues in rice seedlings. Leaves become stunted, stomata collapse, and photosynthesis decreases. Some rice varieties appear to be better able than others to withstand the adverse effects of UV radiation. However, intensive studies and experiment are needed to generate new varieties, which can withstand the harmful UV radiation. This research is picked up again after a period of economic recession in the country.
Bananas produced in the northern part of the two coastal districts, Saramacca and Nickerie, will also be affected by the changes in rainfall patterns, high winds and by sea level rise. These changes will result in higher costs, as artificial irrigation and drainage have to be applied. Increase intensity in wind patterns may seriously damage the banana trees.

Picture 4-10: Banana plantation

Horticulture. The production of vegetables in Suriname is dependent on rainfall as the source of water. An increase or decrease in precipitation has therefore detrimental effects on vegetable production. Climate change will also affect the distribution and degree of infestation of insects. A shift to drier and warmer conditions stressed by low and variable rainfall and humidity will indirectly affect hosts, predators, competitors, and insect pathogens.
Further, climate conditions also affect the occurrence of plant fungal and bacterial pests.
The rate of which depends on temperature, humidity, rainfall duration and its intensity and dew.
The fragile socio-economical situation of the farmers is an additional condition to aggravate the vulnerability of the entire agriculture.

Livestock production also will be affected by climate change and indirectly by its impact on the availability and price of animal feed. Since the ambient temperature zone in Suriname is higher than that of the comfortable for cattle, pigs, poultry and small ruminants. A small temperature increase of 1-2 °C could be detrimental to production. Since most of our beef cattle are from the Bos Indicus (Zebu) type, which is well adapted to high temperature, there won't be much thermoregulation problems with beef production. Dairy production however needs adaptations related to housing and management since our dairy cattle is less adapted to high ambient temperature. Ruminants and other herbivorous livestock species will also suffer from indirect effects of climate change on productivity. A higher Carbon dioxide concentration in the atmosphere may raise the carbon-to nitrogen ratio in forages for these animals thus reducing its food value. Grass may become a less nutritious and tasty for many animals.

Fisheries and aquaculture.
The production of this sub sector is declining, due to declining fish and shrimp yields. Especially

in the shrimp sector yields has declined significant. Actually over fishing has a greater effect on fish stocks than does climate change. If climate change develops according to IPCC scenarios, it may become even more important than over fishing in the future.

These changes and its possible effects on fisheries are:
- Changes in wind patterns, which could have large impact on fisheries in the way that they would alter both the delivery of nutrients into the photic zone and the strength and distribution of ocean currents.
- Significant changes in ocean currents will affect the transport of larval stages of fish. Many of the changes however will be very unpredictable since it is not clear how the ocean currents will change.
- Many fish stocks will also suffer because their spawning and nursery grounds in coastal mangroves and lagoons will be engulfed by rising sea levels. Many ocean fish would not feel any change in swamps or wetlands, or in the extent to which seawater intrudes into rivers.
- The expectation is that the principal impact of climate change on fisheries will be a change in species mix and a shift in centers of production.
- For aquaculture a rise in sea level could be an advantage since that means that pumping costs to let water in the ponds can be reduced significantly, especially the production of brackish water shrimps and fish such as (Penaeus vannamei and Tilapia).

Proposed adaptation measures
Possible adaptive measures are the development and/or introduction of rice varieties, which grow well in brackish water, and or the development of high yielding dry land rice varieties for the soils in the interior. Taking costs into consideration this may be a cheaper solution than a replacement of the locations for freshwater intake, which, due to the intrusion of saline water may be disrupted and found in the saline zone.

The Anne van Dijk Rice Institute Nickerie(ADRON) is responsible for rice breeding and the development of new varieties in Suriname. In this respect the following research projects could be initiated and executed:
- development of rice varieties for brackish water
- development of high yielding dry land rice varieties
- development of rice varieties which can withstand the adverse effects of UV-B radiation

Success in these research projects depends on the support of and the cooperation with countries having these technology mastered. Since rice is the main food in the country and livelihood for many farmers, capacity building and technology transfer is highly appreciated. It should be note that during the relatively short period of rice cultivation, Suriname has gained a lot of experience and knowledge in this field, which can facilitate the technology transfer and capacity building in the country.

The following measures could be taken in the banana sector:
The banana trees are very vulnerable to increased wind velocity. It is recommended that windbreaks (shelterbelts) be constructed so as to protect the banana trees against mechanical damage. These windbreaks will have as direct effect on the reduction in the wind velocity, changes in solar radiation and also reduction of the evaporative demands of the crop. Shelterbelts have also been shown to be useful carbon sinks. Fail to take actions in this regard indicate the

lack of experience and necessary support in this field, notwithstanding the damage experienced some years ago, when large part of the banana plantation was destroyed by strong winds.

The proposed adaptation measures in horticulture include the use of greenhouses covered by shadow netting or plastic and irrigated by sprinklers or drip irrigation installations where vegetable production is less vulnerable to climate change.

An adaptation strategy for the livestock may be the introduction of farming systems, based on agro forestry principles. Pastures containing not only grasses but also forage legume trees will supply the animals with tasty forage with a higher nutritive value. For poultry it will be necessary to keep breeds which can perform well under conditions of high ambient temperature or to build controlled environment facilities, which are costly. An advantage of these types of housing is that the animals perform much better (faster growth, lower feed conversion, low mortality due to heat stress) and stocking density can be much higher than in conventional open poultry houses.

Adaptation measures within the fishery and aquaculture sector include the supply of protein, which may be affected by deterioration of coastal water quality. In the light of the expected SLR the following adaptation measures are proposed:

- Establishing of large (semi intensive) aquaculture ponds in the area where no protection measures are proposed. There is a large potential for both brackish- and freshwater aquaculture in Suriname. The Department of Fisheries in Suriname already announced that the Right Bank of the Commewijne area (40,000 ha) would be reserved for aquaculture in the near future.
- A second adaptation measure is the establishment of artificial lakes in the interior of the country for irrigation purposes and generation of hydroelectricity. However, this action might have serious impacts on the fishery which might include a change in fish composition.

4.5 Vulnerability of Socio-economy

Suriname has an extensive natural resource base. Agriculture, forestry, fisheries, mining (bauxite, gold, granite and other minerals) and petroleum resources, characterize the country. The forest harbor a rich variety of biological species. About one fifth of the total forest area is inaccessible and not commercially exploited at this moment. In addition, the country has a considerable potential of hydroelectric power.

4.5.1 Vulnerability of the coastal socioeconomic sector

The coastal zone of Suriname, which is the country's backbone and source of the socio-economic dynamics, is vulnerable to the impacts of climate change. First, because of the sea level rise, and second, because of the impacts on geomorphological changes, water resources, ecosystems, agriculture and human health. These biophysical impacts affect seriously the socio-economy of the country.

Land use areas and population density

A cursory look at the percentage distribution of land use/land cover shows that on the national level, 67% and 14% is covered respectively by open swamp and swamp forests. Of the grown crops, rice and mixed agriculture (annual and perennial crops and grasslands) are by far the

most dominant: 12% of the Nickerie district is used for rice cultivation, while 65% is swamp forest; for the Wanica district the distribution is 86% mixed agriculture and 10% swamp forest. Bauxite mining activities feature importantly in Para District (11%).

As expected the District of Paramaribo, the capital city, is for 55% of the urban area towns including rural areas with a relatively dense population.

The distribution of the population shows that about 70% of Suriname's population lives in the two districts of Paramaribo and Wanica, which are, in addition, the most urbanized of the coastal districts. Urban population is not the type of population that can be expected to access land or even have the time to practice subsistence farming in a substantial way. In addition, no agro-economic surveys are being carried out showing the prevalence and distribution of subsistence farming in Suriname. It is estimated, however, that at the utmost only 1% on average of cultivated land would be earmarked for subsistence production in the coastal districts.

Population density per land use category for the year 2003 shows that, except for the districts of Coronie, Para and Sipaliwini, the urban population occupies the most part of the area for the rest of the coastal districts, with Paramaribo and Wanica showing the highest urban population concentrations, namely, 1,338.2 per km^2 and 193.1 per km^2, respectively. Mixed agriculture also engaged a considerable number of people in these two districts, while rice production and horticulture are the predominant occupations of the population of the Nickerie and Paramaribo districts respectively.

Land and Capital Values. Paucity of data necessitated the assessment of capital values and land values by using investment costs for fixed assets and the production values for each land cover/ land use classes in the different districts. Typical fixed investment costs include major infrastructures such as roads required for the land use type, main canals, pumping stations, sluices, industrial structures (for example, rice mills in rice-growing areas), and settlements in the specific land use types.

4.5.2 Physical effects of flooding, salinity, intrusion and erosion

From the preliminary exercises of the impact of a rise in sea level of one meter the following have been concluded:
At risk will be: Wetlands of about 595 km^2 or 2.2% of the coastal zone, capital values of about US$400 million representing 36.6% GDP, and about 1% of total population of the country

At loss will be land cover/use areas as rice production (Nickerie) and mixed vegetable production (Commewijne), and the entire wetlands area (open swamp, mangrove forest and swamp forest) of about 3,890 km^2, representing 14% of the coastal zone area.
Loss of capital values will reach about US$30 billion being 635% of total GDP. Under these circumstances more than 90% of industrial structures will be located in the coastal districts notably the districts of Paramaribo and Wanica. The population to be moved due to flooding will contribute 82% of total Population in 2030.

4.5.3 Proposed adaptation measures

Given the above-mentioned vulnerability of the coastal zone a combination of the three well-known response options (full protection, adaptation and retreat responses) is suggested to offer the best results in mitigating the adverse affects of the sea level rise. This strategy referred as

a “mixed feasible protection strategy”, involve the implementation of all feasible protection measures designed to minimize risks and losses of land in the coastal zone.

It will also minimize impacts and risks to the inhabitants a well as the capital value of such lands, preserving and protecting as far as possible the present physical, socioeconomic and ecological status and quality of life in the coastal zone. In this regard it is suggested that more research has to be done on the following:

- protective measures as dams and dykes for populated and developed areas
- protection of coastal lines from increased erosion
- protection from flooding through better tide gates and pumping
- retreat and migration measures
- adaptation and adaptability in the changing coastal zone
- management of the coastal zone

4.6 Vulnerability to Human Health

It is expected that the global climate change will both directly and indirectly impact negatively on human health. The direct effects are heat related mortality and morbidity, respiratory illness, physiological disorders, eye cataracts, eye irritation, respiratory illness, cardiovascular illness, skin cancer, etc. Indirect health effects are changes in distribution and seasonal transmission of vector borne diseases increase in toxic algal blooms and food shortages, sanitary practice, demographic dislocations, air pollution impacts, and socio-economic disruptions, etc. Fossil fuel combustion produces except Carbon dioxide also a host of air pollutions as sulphate, ozone, particulate matter (PM), and other pollutants. These pollutions have short-term adverse effects on human health. High temperatures are not expected to play the main role in affecting the human health of the population of Suriname. In contrary, changes in precipitation patterns, resulting in longer dry and shorter rainy seasons, will result in increased negative effects on human health. Moreover, these changes, combined with possible pollution of the water resources, in particular the groundwater resources, may seriously affect the fragile human health of the country. However human health impact assessments and its vulnerability will be focused on impact assessments of public health infrastructure, vector-borne diseases, water-borne diseases, heat related mortality and pollution-related respiratory disease.

Impact assessment of public health infrastructure damage

Paramaribo the capital of the country has, compared with other parts of the country, a good access to health services and quality of medical services. The Bureau of Public Health Service (BOG), responsible for primary public health services in the country, has health centers in every coastal district, a number of which varies depending on the density of the population in the district. In the interior these centers are sparse because of the large distances, which have to be traveled. Poor development of the infrastructure, lack of roads and bridges, act as barriers to access health services, and therefore adversely affect medical care in the interior of the country. In this part of the country the Medical Mission is responsible for the primary health and in the coastal area the Regional Health Service (RGD).

Impact assessment of vector borne disease

Malaria: *Malaria* is endemic in the interior of Suriname, as the main vector, *Anophel darlingi* occurs only in the interior area, located south of the savanna belt. Other potential vectors of

Malaria in Suriname are: *Anophles aquasales* and *A. nuneztovari*. All these vectors of Malaria breed only in still water areas as swamps, creeks and in small streams, impeded by obstacles such as roots and fallen trunks.

It also breeds near the river shores, among floating debris and water plants or protrusions from the riverbank, which provide protection from the current inhabitants that are partially shaded by the nearby forest. Another breeding place of *A. darlingi* is the flooded forest during the rainy season. Here the mosquito breeds in swamps among the emergent plants or floating debris.

Dengue is a viral disease occurring in countries with a warm, moist climate, where the vector *Aedes aegypti* occurs and breeds in man-made breeding sites such as barrels, old tires, etc. This mosquito prefers fresh water breeding sites.

Yellow fever: This serious viral disease characterized by fever and jaundice is transferred by a mosquito of the genus Aedes haemagogus, which lives in the canopy of trees. The breeding places of A. haemagogus are water in stagnant pools of tree holes, bamboo joints and similar locations.
Hence, two types of yellow fever are observed here: (1) the urban and (2) the jungle type. The vector for the urban yellow fever is the *Aedes aegypti* and for the jungle Aedes haemagogus.

Schistosomiasis or Bilharzia: Schistosoma mansoní is the only bilharzia species that occurs in Suriname. The occurrence of this disease is restricted to the coastal region, since the vector snail Biomphalaria glabrata frequently occurs in the region of coastal shell-ridges.

Waterborne disease: These diseases are caused by organisms that survive in water and are ingested when contaminated water is consumed.

Shigellosis: Shigellosis is caused by bacteria and is endemic in Suriname. The bacteria, occurring in the faeces of infected persons, and contaminated food and water infect others indirectly.

Leptospirose (disease of Weil): This disease is caused by the bacteria of the order spirochaetatis. These bacteria are present in the urine of infected rats. When the infected rat urinates in water bodies and people come in contact with the infected water, they become infected with leptospirosis. Most Leptosprosis cases occur in the major rainy season.

Climate change is one of the causes of changes in the pattern of the above-mentioned diseases. Changes in the seasonal rainfall might affect the vector mosquito populations, possibility resulting in the increase of malaria, dengue and others. Especially changes in the short rainy season exacerbate the condition for increased risk exposure of these diseases. For instance, abundant rainfall in the short rainy season will cause large streams, affecting the breeding places adversely. In contrast, less rainfall, with low intensity will affect positively the breeding conditions for these vector mosquitoes. In the long dry season the population of these mosquito's decreases.

The expected sea level rise, corresponding with the inundation of large coastal areas, will have a negative effect on the incidence of Bilharzias, as the vector snail cannot survive in saltwater. In contrast, the rainy season can cause the increase of breeding conditions of the vector snail,

so more Bilharzias cases could occur. Moreover excess water, contaminated with faeces can increase more cases of Shiguella, Salmonella and Leptospirose infections in the country.

Ecological impacts, due to climate change, including sea level rise, will cause an imbalance in the biological equilibrium, as the future predator's population will decrease. Human activities through the use of pesticides also contribute to this change.

Impact assessment of heat-related mortality and pollution related respiratory disease
The increased air temperature will possibly cause heat waves, so heat-related mortality will consequently increase. This would be observed especially during the El Niño years this will be the case when extreme draughts occurs, corresponding with high temperatures, fire outbreaks, etc. However, there is no baseline data on pollution-related respiratory diseases available, so it is difficult to predict the possible effects of these diseases in the future.

Proposed adaptation measures
To suppress the possible risk of the exposure of the above-mentioned disease prevention activities, control, and surveillance programs have to be put in place and if necessary intensified. The existing control and surveillance programs will be improved to higher levels through collaborating with relevant bodies and organizations operating in and/or outside the country. Pertinent and permanent control programs will be established in the future, regarding effective controlling and suppressing of malaria, dengue and yellow fever. Control and prevention programs also should put in place regarding resurgence of emerging infectious diseases as yellow fever, whooping cough, etc.

In general human health in Suriname is very vulnerable to climate change and therefore precautionary measures have to be taken on time. To do this, research studies are needed on a very short term.

In Summary, the impacts of sea level rise on the coastal plain of Suriname are enormous, which might rapidly increase the vulnerability of the coast. As a result tremendous losses and high risks to land and properties will occur. According to assessments presented in the final report of the "project country study climate change Suriname" wetlands at loss might reach as high as 2,500 km^2 or 1.5% of the total area of Suriname. Capital value at loss is estimated about 25,140 million USD, which is 1,150 times the present national GDP. The population to be moved from the inundated areas and or areas at loss and at risks contributes about 80% of the national population. The figure here below taken from the study project just mentioned illustrates the flood impact at 1m sea level rise. Under these circumstances serious measures are needed to mitigate the impact. From the various measures proposed in subsections of this chapter an integrated strategy follows in mitigating the impacts of the sea level rise. This proposed strategy is the "mixed feasible strategy", which implies the combined implementation of adaptation, retreat and protection measures. This strategy will be worked out in the coming years and will be applied as pilot project in the coastal zone to gain more experience and to fine tune the strategy in a way acceptable and feasible to the Stakeholders. The strategy include furthermore not only a (technical) plan to mitigate the impacts of the sea level rise on the coastal zone, but also mechanisms, plans and methodologies to raise awareness among the stakeholders.

Figure 4.1: Impact of the sea level rise on the coastal zone of Suriname

5 EDUCATION, TRAINING AND PUBLIC AWARENESS

5.1 Introduction

One of the commitments following from the signing of the Framework Convention on Climate Change, is to "Promote and cooperate in education, training and public awareness related to climate change and to encourage the widest participation in this process, including that of non-governmental organizations".

Over the last few years, environmental outreach and educational efforts have evolved significantly. Suriname, as most developing countries, is confronted with a variety of challenges with respect to its environment, biological diversity and land degradation.
Key environmental concerns are:

- Coastal zone management. Human impacts include: over fishing, deforestation of mangrove for aquaculture projects etc.;
- Uncontrolled forest logging;
- The impacts of mining on the environment such as deforestation, disturbance of the

hydrological surface and underground regimes, and climate;
- Degradation of agricultural and non-agricultural land;
- Mercury pollution of rivers and mercury contamination of aquatic ecosystems, fauna, soils and humans due to the small scale gold mining;
- Urban waste pollution;
- Uncontrolled use of pesticides.

These concerns and occurrences clearly indicate a negative correlation between resources based economic activities and the general state of the environment. Insufficient appreciation or understanding of the state of the environment will not only result in further damage to the environment, but will also inhibit sustainable future development and socio-economic growth. Therefore, environmental education serves an important role in the preservation and improvement of the environment, as well as in the sound and balanced development of communities.

The science and politics of global climate change, and its potential devastating impact, implies a new challenge for the citizens and in particular the coastal communities in Suriname. The concentration of human livelihood and economics activities within the low-lying coast are areas vulnerable and at risk to changes in climatic conditions and sea level rise.

In order to take action in mitigating the environmental problems in Suriname, the task ahead is to build a stronger public awareness and knowledge of climate change processes, increased greenhouse gas emissions and its direct and indirect impacts on the biophysical and socio-economical systems. This understanding will enable decision makers and people potentially at risk to interpret complex scientific information more accurately and make better decisions about how to reduce their risks by creating new behavioral patterns.

To deal with the increased pressures on the environment, the Government of Suriname has created an environmental management structure consisting of four actors:
- the Ministry of Labor, Technological Development and Environment, which is responsible for the development of environmental policy;
- the National Council for the Environment (NMR), which is an advisory body towards the Government and
- the National Institute for Environment and Development In Suriname (NIMOS) as the technical working arm of abovementioned ministry.

5.2 Existing and Recent Related Initiative

Governmental Outreach

The Government of the Republic of Suriname, motivated by national interest and international diplomacy, has understood the need for adequate measures and initiatives towards protecting the environment. In achieving this goal, in particular as a signatory and a Party to the United Nations Framework Convention in Climate Change, several steps have already been taken in recent years:

- Suriname has participated in the first phase of The Netherlands Climate Change Studies Assistance Program (NCCSAP) in 1996, which was initiated by the Dutch Government as a result of the obligation of UNFCCC that developed countries will provide assistance towards developing countries for the implementation of climate change studies and the realization of

a climate policy. The first phase of NCCSAP produced four (4) reports on country climate studies. The second phase of this climate change assistance programme, now in preparation and coordinated by the Ministry of ATM, will mainly focus on the preparation, formulation, implementation, and evaluation of climate change policy. One of the outputs of NCCSAP-2 will be raising public awareness at the policy making, community and school system levels through posters, flyers, promotional literature and the designing and launching of a website. A climate change workshop was organized in July 2003 by the Ministry of ATM to provide more information about NCCSAP-2 and on the Kyoto Protocol and its benefits for Suriname to the direct involved stakeholders.

- During implementation of the Project, *Enabling Suriname to Prepare its Initial National Communications in Response to its commitments to the UNFCCC*, NIMOS conducted various training workshops in GHG emission inventory and abatement, vulnerability and adaptation to climate change. These workshops, facilitated by a team of Canadian consultants, have enabled researchers, representatives of the government, public agencies, non-governmental organizations, and members of the media to obtain valuable knowledge and training materials in the area of climate change.

- NIMOS has also edit the first State of the Environment Report (SER), which is an authoritative and comprehensive account on the state of the environment of Suriname, including the current situation regarding climate change issues. The SER will be edited and published by NIMOS in close collaboration with the Ministry of ATM on an annual basis in both Dutch and English.

NIMOS has recently developed a flyer regarding climate change especially for schoolchildren and is now in the process of designing a "student's page" on the NIMOS website, where this flyer will be included.

Non- Governmental Outreach

In addition to outreach conducted at governmental level, a growing movement of nongovernmental outreach efforts has proven to be very effective in engaging the public and industry on the climate change issue.

Although outreach activities may vary from NGO to NGO, most of them share the common goal of increasing environmental awareness to protect and improve the environment for present and future generations.

A number of NGO's have taken climate change as an issue, and are bringing it to the attention of the public at large. For instance, "The Foundation for a Clean Suriname", writes about climate change issues in their column in the local newspaper. In the context of The Central Suriname Nature Reserve, which comprises more than 1.6 million hectares of protected area, Conservation International Suriname conducted a study on the economic benefits to Suriname for carbon sequestration.

The different environmental awareness institutions and departments have organized themselves in the "Natuurweb" to jointly organize environmental activities on a national level on certain environmental days as "World Ozone Day" or "World Environment Day". These collaborative efforts have proven to be very effective to draw attention of the public and the media.

With regard to the education system in Suriname, the University of Suriname has started a four

year course in Environmental Sciences at B.Sc. level. In close collaboration with the Ministry of Education, Conservation International Suriname has developed environmental education materials to be incorporated in the education system at all levels (primary, secondary, high schools, Teachers Trainings Institute (IOL) and at University level).
They have also published a training manual on education in biodiversity for teachers.

Industry
Industry is also playing an increasing role in climate change outreach and education. The main bauxite mining companies, Suralco and Billiton, and Suriname's State Oil Company are engaging the public at large with their news-info magazine, which contains regular updates on how they are dealing with the environment, including energy efficient measures. There is also support for workshops and seminars, whereby information is provided about proper management systems for environment, security and health.

5.3 New Public Outreach Activities Proposed

In order to ensure a well-planned and coordinated public awareness, education and outreach program, the Climate Change Steering Committee (CCSC), which was established by the Ministry of ATM to coordinate and monitor all projects and activities related to climate change and climate change issues, will also commit itself in this regard to:

1. the dissemination of information to relevant organizations
2. give advice on environmental management with the focus on the development of an appropriate and effective public outreach program and on its implementation.

Priority audiences and sectors targeted for public participation, education and outreach programs include governmental officials, industrial leaders, students, farmers, resource mangers, the media and others.

Activities for raising awareness should further include:

- The preparation of national strategies and actions intended at incorporating environment as a separate subject in the education system. An important initiative should include the development of textbooks, pamphlets and audio-visual material to be used in schools.

- Of further value is the provision of assistance to the Ministry of Environment to expand the environmental curriculum of schools with information on climate change.

- The stimulation of the media to engage in reporting in climate change issues. This can be achieved by inviting the media to conferences, workshops, trainings, fieldtrips, and other events, and by providing assistance to the media for special programs, articles, and series.

- The establishment of a national center of environmental information including information on climate change, which will serve the general public, policy makers, schools etc. It will provide answers to public questions, requests, complaints and ideas, and conduct polls to monitor public opinion on environmental matters.

- Reaching out to local communities in close cooperation with community services, youth

and sports organizations, NGO's and neighborhood associations. This can be done through tools such as newsletters, brochures, meetings and media campaigns. Outreach must become evident in the shared participation in environmental management.

- The organization of climate change exhibitions for schoolchildren and the general public. NIMOS has an exhibition floor, which is suitable for such events. Last year NIMOS coordinated exhibitions regarding freshwater and the protection of the ozone layer. Exhibits have proven to be an effective tool to raise public awareness.

- The strengthening of, NGO's that are active in environmental awareness in local communities, by supporting them to set up well-managed organizations and in their needs for means and finance.

- The strengthening of the educational units of the several departments of ministries involved in environmental awareness.

- The stimulation of climate change awareness by introducing awards for sound industrial practices, promoting the training of labor and industrial professionals, and by providing information about the concept and the applicability of clean production technology.

- The regular use of the media to disseminate information to government, industry, commercial interest, transportation, residential sector and schools. The NIMOS web site, with links to major local companies and national and international organizations that already have an environmental action programs, will also contribute in disseminating "breaking news.

- The institutionalization of functional structures fully capable to identify, design, and implement market-based and other approaches to reduce greenhouse gas emissions, and at the same time develop options for adapting to the effects of climate change.

Because of these efforts, more citizens will understand the climate change issue with a higher level of sophistication. And as people are becoming more familiar with the problem, they are also beginning to appreciate the impacts of society's actions on climate change.

5.4 Opportunities for Institutional & Regional Cooperation

Suriname will continue to build on existing relations with the Secretariat of the United Nations Framework Convention on Climate Change. In this regard, the concept of modular-style national reporting format is a particularly relevant tool to ensure continuity of national efforts. The UNDP "Climate Change" project has provisions for training and special education. Another useful initiative will be the translation, publication and dissemination among all schools of Suriname of the brochure "Understanding Climate Change: A beginners Guide to the UN Framework Convention".

Developing constructive working relationships with appropriate regional bodies or programs that have an interest in climate change should be fostered. In this regard, the Association of Small Island States (AOSIS), CARICOM, the Caribbean Community Climate Change Center (CCCCC), the Amazon Cooperation Treaty, the European Union, and the Organization of American States (OAS) are to be approached as strategic partners with great significance

for Suriname's objectives. Within the context of CARICOM's regional program "Caribbean Planning for Adaptation to Climate Change (CPACC)", important information material with special relevance for Suriname should be used. In this regard, brochures, information packages, posters, pamphlets, audio-visual materials etc. are usable items.

6 SCIENTIFIC RESEARCH AND SYSTEMATIC OBSERVATIONS

6.1 Present situation: Observation networks & relevant science in Suriname

Observation networks in Suriname

Climatic observations: In Suriname weather and climatic observations are undertaken by the Meteorological Service Suriname. Records on temperature and rainfall are available from the year 1900. By the end of the sixties about 175 meteorological observation stations, were operational. However, for the larger part, the meteorological stations do not have records exceeding a 30-year period. This shortcoming is among others due to the civil war, which led to the closure of all stations in the hinterland. At present observations are made at 21 stations, 5 synoptic stations, 11 climate stations and 2 automatic stations. The observed data are published and key climate data are sent to World Meteorological Organization Centers as part of the global network. Data are also exchanged with the Regional Organization for South America where Suriname is a member.

At the Meteorological Service Suriname's observation of optical density of the atmosphere has been started in March 1998 in cooperation with NASA. In the same year the international Large-scale Biosphere Atmosphere (LBA-Claire) research programme has been carried out, aiming to develop an integrated and quantitative understanding required for determination of net exchanges of important gases and aerosols between the atmosphere and the Amazon region and to understand the processes that regulate these exchanges._

Research on Atmospheric Dynamics and Chemistry in Suriname (RADCHIS), dealing with Atmospheric transport, dynamics, chemistry and validation of satellite measurements in the Tropics has been carried out in close cooperation with the Netherlands.

Increasing scientific interest for the tropical atmosphere has led recently to the formulation and implementation of a new project "Support for Topical Atmospheric Research". In this project Paramaribo station, equipped with additional and appropriate instruments and facilities, fills an important gap in the global observation network by sending these international networks necessary data regarding the atmosphere and its composition.

Research in the area of Climate Change

Together with other Departments and Institutions the Meteorological Service Suriname was also involved as Coordinator in the "Country Study Climate Change Suriname" from July 1997 to December 1999. The research is a product of a joint contribution of the Netherlands and Surinamese scientists and has been carried out in the light of the commitment done by developed countries to the UNFCCC to assist the developing countries in carrying out their country programs. This project was a first attempt that dealt with GHG inventories and assessments of impacts of future climate change.

Relevant science in Suriname

Energy Sector: The energy sector consists of energy from hydropower plants, locally produced crude oil, energy from biomass, solar energy, imported petroleum and natural gas. In general the current energy situation in Suriname is highly dependent on fossil fuels, except for the aluminum industry, where energy from the hydropower plant is used. The energy sector has therefore the largest potential for CO_2 mitigation.

There are different organizations and departments involved with these energy resources, however, relevant studies of research options for achieving this potential are insufficient.

In many cases in Suriname energy generation through the use of diesel is still cheaper than energy generation through the use of Photo Voltaic or Micro-hydropower. Regarding energy provision for the hinterland of Suriname the emphasis is, however, on small-scale hydropower generation e.g. the micro and the pico hydropower. In year 2004 a hydraulic laboratory has been established at the University of Suriname for education, research, and demonstration purposes and hence to make use of the potential hydropower for social and economic purposes in the interior of Suriname.

In the past a micro hydropower was established in Pokettie, at the river Tapanahony, with a capacity of 40 kW, however, due to technical and other problems this power station has never functioned properly and has therefore been closed now for several years. A detailed analysis of the problems is still needed. In this sector technical and financial assistance is needed to explore the potential of micro hydropower in the interior of Suriname. In this respect, the Ministry of Natural Resources, responsible for energy development in Suriname, will, with the help of the University of Suriname, other governmental departments and NGO's, be able to implement micro hydropower stations in the remote areas of Suriname within a range of 5-500 kW. The magnitude of the funding for these micro hydropower stations lays within the range of about 100,000 to 1 million US dollars.

Mitigative actions in reducing Greenhouse Gases

In the framework of meeting the demands of the Climate Change Convention steps have been taken and/or are under way. These steps, which include among others reduction of GHG emissions, involve efforts made by multinationals as well as efforts from the government. The closure of the aluminum smelter by SURALCO in 1998 contributed to the reduction of GHG emissions. Presently the Company is studying the possibility of installing a new aluminum smelter, which will be more efficient and cleaner than the closed smelter.
In the forestry sector, fundamentally new processes, including resources use efficiency and substitution of materials, are being proposed at the Bruynzeel site. Here an installation of a cogeneration power plant is planned, as well as within the rice sector in the district Nickerie.

Transportation

The emissions related to the road can be mitigated, or lowered, if a significant improvement in efficiency and/ or change in the life style and in the behavior is to be observed. The overall expected growth in transport related GHG emissions, tends to increase strongly, reduction of which depends on the foreign technology. Relevant to Suriname are the infrastructural development (roads and ways). The present infrastructure is being rehabilitated to a level of acceptance. The organization "Wegen Autoriteit" is responsible for the infrastructure policy in Paramaribo. Studies to improve transportation efficiency would be valuable.

6.2 Needs

Observation networks and research

Monitoring and research require well-equipped and staffed observation networks, which at the moment is not the case in Suriname. Policy makers increasingly recognize the importance of

such networks. In this regard preparatory work is underway within the Meteorological Service Suriname to strengthen its observation network, but is being delayed due to financial and staffing problems. The same is true for other observation networks such as those for freshwater resources, ecosystems and pollution. Hence, data necessary for monitoring and research is lacking and therefore research projects are experiencing difficulties.

In particular is this the case for freshwater resources, which is potentially sensitive to climate change and vulnerable to interannual fluctuations, when associated with El Niño events. Droughts, especially in the coastal area, are likely to increase, resulting in degradation of ecological, natural and artificial systems, and biological diversity. Climate variability and climate change also affect markets for goods, constructions, fossil fuel production (including offshore drilling), hydropower generation, tourism and recreation. Industries localized in coastal and flood prone areas also would likely be affected by climatic variations indirect. Such activities include agro-industries and fisheries, which will be affected severely. The ultimate impact of climate change is the deterioration of the living conditions of the population involved. In this regard serious studies and research programs are needed.

Training and Capacity Building

Notwithstanding the fact that Suriname's coastal region is vulnerable to sea level rise, a large part of the population living and working in this area are not fully aware of the possible danger accompanying this sea level rise. In this regard much has to be done to increase the awareness of the population. Attempts are being made through many organizations including NIMOS to raise the awareness. Prior to this step a training of personnel is required for providing climate forecasts and advice on climate change to the government. Data with high quality are therefore required, which together with global climate diagnostics information (such as the state of the El Nino – Southern Oscillation), can be compiled into a summary and outlook bulletin for use by agencies, companies and individuals.

Particularly, in the forestry sector, among the many advances, increasing or maintaining Carbon sinks has major interests. For this goal appropriate technology and know-how related to the corresponding technology is necessary. For instance, the adoption of forestry options is subjected to technical, financial and institutional barriers. Technology, including "software" (such as methods for monitoring forest area and protected area management practices) as well as the "hardware" (logging or processing equipment), large-scale adoption of forest conservation, reforestation and sustainable forest management options is lacking. Development of these skills in Suriname is needed.

In this way priorities should be given to the following fields:

- Rehabilitation of the existing networks for meteorological and hydrological measurements, and establishment of clearly related new observation networks for ecosystems, forests, pollution and socio-economics.
- Training, research, and public awareness, including increased understanding of the scientific processes underling climate change, advanced understanding of the sensitivity of human activities and natural ecosystems to climate change and preparation of professional staff and postgraduate students for implementing climate change action plans through regional training programs.
- Establishment of a comprehensive database integrating relevant data of all sectors into one coordinating agency

The potential key research areas could be summarized as follows:

- Impact assessments of changing climate on ecosystems, and the development of the corresponding adaptation and prevention strategies.
- Water resources and related ecosystems, which focuses on research on the impact of climate change on the hydrology and ecology of lake, river, swamp and marine ecosystems, and also covers interaction between the atmosphere, hydrosphere and biosphere.
- Swamp and or forest ecosystem research involving studies of the effects of climate change on agriculture and forestry, and on the biochemical cycling of carbon in peat lands.
- Studies on the social and economic impacts of climate change and assessments of how to limit greenhouse gas emissions in a cost effective manner.

7 LINKAGES BETWEEN INTERNATIONAL CONVENTIONS

7.1 Introduction

Suriname is party to a number of international conventions to make a worthy contribution that can serve the world to face the challenges posed by alarming human related global environmental changes. These changes are potentially specially threatening to the most vulnerable nations of the developing countries. The threats include among others the loss of biodiversity due to the rapid pace of natural resource exploitation and land use changes, global climate change from human related emissions of greenhouse gases and the loss of stratospheric ozone from release of ozone damaging chemicals.

It is scientifically proven that these global environmental changes are related to each other and are reflected on the national level; as one of the adverse effects of climate change is the change of rainfall characteristics resulting in rainfall decrease which will affect Suriname's biodiversity pattern and will certainly lead to scarcer vegetation, thereby leaving the land more susceptible to land degradation. Also the ongoing natural resource exploitation activities (wood logging, gold and bauxite mining) in Suriname will further enhance land degradation. Rainfall with high intensities, caused by climate change, will even worsen the extent of land degradation.

Under these circumstances the water retention capacity of the soil decreases and groundwater reserves will be depleted. In the coastal areas these resources are already seriously under threat by the ongoing SLR. As mentioned the coastal zone is of immense economic value for Suriname, since the concentration of the population (about 80 %), fertile land, complex ecosystems (various species and habitat), and natural resources (fresh water, fisheries and crude oil) are situated in this part of the country.

7.2 Linkages

Due to the fact that climate change has among others influence on our biodiversity, land and water resources, it is important to assess what actions are taken by the Government of Suriname to implement the above-mentioned conventions. For Suriname with a limited number of experts in relevant fields it is of particular importance to recognize the close interrelations between these conventions. A changing climate, in particular, can have profound effects on biodiversity, desertification, ocean currents, shorelines and resources of the coastal zone. Since climate change is expected to occur at a much faster rate, disequilibrium between these issues will occur, having obviously negative impacts on the ongoing development within the country. At the same time, proper action will be needed to protect and enhance the natural resources as for instance the tropical forests, which if restored, can remove carbon dioxide from the atmosphere and thereby impede the climate change. This complex environmental problem requires an integrated approach to understand the physical processes and to adopt on the basis of this understanding a comprehensive view in what can be done and what can be expected.

7.3 Synergies

Climate Change is probably the most complex and challenging environmental problem to face. The priority issues in climate change, biodiversity and land degradation has considerable cross-convention similarities and offer significant opportunities for integrated and synergistic approaches.

Apart from linkages, there are thematic issues that overlap between the conventions:

- Data gathering, inventories and national reporting and information exchange.
  The organization of information forms the basis for the further implementation of the convention. National reporting also provides faster access to information, prevents duplication of work, facilitates comparisons of information and knowledge and generates new information.

- Public Awareness and education.
  The principles of the conventions are diverse and usually unknown to the society. The issue of the increasing of awareness is important to gain understanding of the civil society and, most of all, to educate them to prevent damage to the environment

- Public Participation.
  The importance of public participation varies between the conventions. However, public participation processes are usually the key to success for implementation of conventions.

- Scientific and Technical cooperation
  In order to achieve the goal of the convention it is necessary that parties to the convention will cooperate with each other.

In order to fully implement the convention, it is important that the country has the technical expertise. Therefore most of the conventions have provisions with regards to training of scientific or technical personnel, international training program, and exchange of personnel for field training, etc. It is necessary to explore all the opportunities that these conventions provide, in order to effectively benefit from them, and be able to comply with the obligations of the conventions.

7.4 Efforts made by the Surinamese Government

Currently Suriname is in different stages of implementing the related Conventions.
Efforts have been made by the Government to ensure compliance with the stipulations established by the Conference of the Parties.

The preparation of the initial national communications to the UN Framework Convention on Climate Change is the first step of the Government in fulfilling its obligations under the convention.

In the field of biodiversity much has been done so far. A number of nature reserves have been established with the purpose to enhance the protected area system. As to able to efficiently and effectively manage this system, the Suriname Conservation Foundation (SCF) was established. Funds from this organization are also used to finalize the National Biodiversity Strategy, which is the responsibility of the Ministry of ATM. Linked to the strategy, the national Biodiversity Action Plan is also being formulated by the National Institute for Environment and Development. A forest sector environmental assessment has been undertaken, which resulted in a forest action plan. Furthermore, a formal forest policy has been formalized in close collaboration with stakeholders.

However, there are some developments in the field, which will hinder further enhancement of the efforts as for example gold mining, destroying the biodiversity of certain parts of the country, leaving behind unfertile, degraded land. The changing pattern in the rainfall (long dry periods, rains with high intensities, etc) will generate impacts superimposed on these existing negative impacts.

With regard to desertification, Suriname has produced a national report on land degradation in Suriname. Recently the Ministry of ATM has taken significant steps to start with the preparation for the development of a National Action Plan (NAP) and is now in the process of starting with its implementation. The NAP will form the basic government policy document for setting out strategies and policies to address the issues of land degradation. At the same time also preparations have started for the development of a Medium Size Project proposal that will focus on building capacities and mainstreaming of land management issues in national policy. This MSP is being funded by the GEF and is targeting LDC and SIDS countries that are party to the UNCCD. For Suriname the main concern for combating land degradation presently are the mining and the agriculture sectors.
In 2004 a regional environmental assessment was done for the greenstone belt area in Suriname. The green stone belt is a geological formation rich in minerals, including gold, and at the same time, is rich in biodiversity and inhabited by a variety of tribal communities and covers approximately 15% of Suriname's landmass. The purpose of the study was to identify and promote environmental friendly gold mining and gold processing procedures, including minimization of land, water, and ecosystem degradation. An environmental management plan is also part of the study. Implementation of this management plan would contribute to reaching the goals set by the different international environmental conventions ratified by Suriname.

A number of Suriname's funding partners share interests in investing in the protection and management of the countries environmental and natural resources. The objective of the environmental management plan is to receive a sympathetic hearing from these organizations. The large international environmental NGO's also have considerable experience in Suriname as well as elsewhere in forming joint ventures with local NGO's to implement smaller projects.

Currently the Ministry of ATM is finalizing the draft framework law for environmental management. This draft law has a broad scope and will surely contribute to further fulfilling our obligations under the various environmental conventions.

In 1997 Suriname ratified the Vienna Convention and the Montreal Protocol. Currently projects under this protocol are being implemented by NIMOS. Within this institute an Ozon Unit has been set up to implement a program for phasing out ozone depleting substances in Suriname.
According to the program a regulatory framework should be developed to achieve accelerated phase-out of Ozone depleting substances (ODS) in Suriname. A training program for custom officers and policy makers will be implemented. Also refrigeration service technicians will be trained into good practices of refrigeration to minimize the use of ODS's and mitigate their emissions into the air during the service of refrigerators.

It is important that the Government continually seeks to harmonize the national efforts towards a more efficient implementation of these conventions.

The goals and objectives of the conventions come together in efforts to maintain the biological habitat, protecting the soil and keep its fertility, safeguard the water resources and enhance proper land use and land use management.

In order to establish linkages and synergism between the UN Conventions dealing with climate change, ozone protection, biodiversity and land degradation the following management structure is in place:

- The Ministry of Labor, Technological Development and Environment (Ministry of ATM), responsible for the preparation of the coordination for an environmental policy and focal point for a number of environmental conventions, is functioning as an executive body, to oversee and coordinate projects resulting from the abovementioned UN conventions. The Ministry will be responsible for the formulation of policies related to the implementation of these conventions.
- The National Institute for Development and Environment in Suriname, which functions as the technical working arm of the Ministry of ATM, will be responsible for the implementation of some components of projects resulting from the abovementioned conventions.

Being party to the environmental conventions brings a lot of opportunities for the country namely:

- Participation in Clean Development Mechanism (CDM). The CDM in the Kyoto Protocol is a mechanism that involves developing countries. It aims to direct private sector investment into emissions-reduction projects in developing countries while promoting sustainable development in these countries.
- Technical and scientific cooperation, access to and transfer of technology in order to reach sustainable development will ultimately be beneficial for Suriname.
- Suriname will also benefit from the Clearing House Mechanism (CHM); it provides faster access to information prevents duplication of work, facilitates comparison of information and knowledge.

The following climate change related conventions with their status of implementation are given here below:

Conventions related to Climate Change to which Suriname is party are:

1. United Nations Convention on Climate Change.
   Objective: To achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system
   Date of ratification: 14 October 1997
   Relevance to Climate Change: The Convention provides an overall framework for intergovernmental efforts to tackle climate change
   Implementation status: Suriname's first National Communication should be finished in the first quarter of 2005.
   Currently the Ministry of ATM started with the implementation of phase 2 of the Netherlands Climate Change Assistance Programme (NCAP), which will identify adaptation measures as to reduce vulnerability of livelihoods in the coastal zone.

Responsible Ministry/Institution: The Ministry of ATM is the national focal point of the UNFCCC and is also the executing agency for the NCAP. NIMOS is the executing agency of the project "Enabling Suriname to prepare its initial communication in response to its commitments to the UNFCC" funded by UNDP/GEF.

2. Kyoto Protocol
   Objective: To achieve reduction of GHG emissions by developed countries in a specified period.
   Date of ratification: The Ministry of ATM is in the stage of assessing what the consequences of ratification would be with regards to Suriname and how the country could benefit from ratifying the protocol. At the moment the Ministry has finalized this process and has developed a Policy document in which ratification of the Kyoto Protocol has been advised to the Government.
   Relevance to Climate Change: The reduction of the harmful effects of Green House Gases on climate conditions.
   Implementation status: Not Applicable
   Responsible Ministry/Institution: Ministry of ATM

Conventions related to protect the Ozone layer

1. Vienna Convention on the protection of the Ozone layer
   Objective: Protection of the Ozone layer, especially in connection with the manufactured chlorofluorocarbons (CFC's) (General)
   Date of ratification: 14 October 1997
   Relevance for Climate Change:
   Implementation status: NIMOS is currently implementing the Montreal Protocol
   Responsible institution: NIMOS

2. The Montreal Protocol on substances that deplete the ozone layer
   Objective: To eliminate the use and production of substances which destroy the ozone layer.
   Date of ratification: 14 October 1997
   Relevance for Climate Change: ODS and greenhouse gasses both have an impact on the atmosphere
   Implementation status: Implementation of the Country program for phasing out ozone depleting substances in Suriname
   An Ozone Unit within NIMOS is established, the regulatory framework in order to achieve accelerated phase-out of Ozone depleting substances in Suriname will be developed. A training programme for custom officers and policy makers will be implemented.
   Responsible Institution: NIMOS

Conventions related to protect biological diversity

1. Convention on Wetlands of international importance , especially as waterfowl habitat (RAMSAR)
   Objective: Preservation of waterfowl and their habitat on an international basis
   Date of ratification: 18 March 1985
   Relevance to Climate Change: Our coast is of international importance since a lot of waterfowl from North America are wintering in this area. It is an area, vulnerable to the effects of climate change (sea level rise).

Implementation status: The Coppename Monding Nature Reserve was included in the list of wetlands of international importance for waterfowl. Ratification of the Paris protocol (amendment to convention) is still pending.
Responsible Ministry/Institution: The Nature Conservation Division of Ministry of Natural resources

2. UN Convention on Biological Diversity
   Objective: Conservation of biological diversity
   Date of ratification: 12 January 1996
   Relevance for Climate Change: Preserving the forest reserves climate change because of the sinks.
   Implementation status: GEF project implemented by NIMOS
   Responsible Ministry/Institution: Ministry ATM, NIMOS

Conventions related to land degradation

1. UN Convention to Combat Desertification
   Objective: To combat desertification and mitigate the effects of drought in countries experiencing serious drought and or desertification
   Date of ratification: 1 June 2000
   Relevance for Climate Change: Climate change impacts
   Implementation status: the National report has been submitted in 2002 to the Secretariat of UNCCD by NIMOS. Currently we have started the process for preparing the framework for the development of a National Action Plan to address the issues of land degradation, which is coordinated by the Ministry of ATM.
   Responsible Ministry/Institution: Ministry of ATM

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