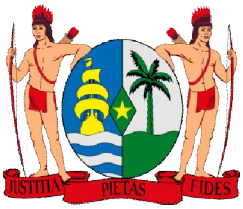

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REPUBLIC OF SURINAME

Second National Communication

to the
United Nations Framework Convention on Climate Change

Office of the President of the Republic of Suriname

March, 2016

PARAMARIBO-SURINAME

REPUBLIC OF SURINAME

Second National Communication

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United Nations Framework Convention on

Climate Change

2008-2012

Office of the President of the Republic of Suriname

March, 2016

PARAMARIBO-SURINAME

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The Office of the President of the Republic of Suriname;
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FOREWORD

Climate change is not a new phenomenon on earth. However, the changes occurring at the present rate have not been evident over the past 100 years. Rapidly rising global temperature, melting of polar ice caps, rising of the sea water level and changes in climate patterns and natural ecosystems are now becoming a daily concern. Especially for Suriname, a young nation with less than 600.000 inhabitants, of which the majority lives in flat coastal areas and heavily relying on natural ecosystems, the impacts are potentially catastrophic and expected to be an enormous setback to the development of the country

Since 1995, the Republic of Suriname participated in the global discussions on climate change and has submitted the first national communication on climate change in 2006. From the time of our entry, the United Nations initiated a negotiation process that brings together experienced negotiators to discuss the twin solution of mitigating greenhouse gas emissions and adapting to a new environment. We noticed that the majority of nations with obligations to reduce emissions have ultimately increased their emission level and lowered their carbon sink potential. These actions are presenting a grey outlook for the overall goal of reducing global Green House Gas (GHG) emissions. The limited ability of the convention to deliver results is of increasing concern to the citizens of Suriname.

The Government of Suriname will not only consider the impacts of climate change but also work on mitigating GHG emission. With about 94% of its land area covered with tropical rainforest and an abundance of water and mineral resources, the Government of Suriname has initiated a path of climate compatible development, in which each Surinamese is responsible to emphasize climate strategies that embrace sustainable development goals and sustainable development strategies that address the threats and opportunities of a changing climate.

As a young developing nation, the Republic of Suriname envisions promoting development while maintaining peace and stability within its unique kaleidoscope of cultures and natural environment. Committed to this path, the Republic of Suriname will take full responsibility for a healthy life of its citizens, and is not willing to transfer this responsibility to the global forum. Suriname acknowledges responsibility to contribute to the global scientific research and development. This report communicates our precarious situation until the year 2012 and

future responsibility in combating the impacts of climate change on our economy, the development of the country and the well-being of our citizens.

Dr. Haydi J. Berrenstein, MSc.

Office of the President of the Republic of Suriname
National Coordinator & Advisor Environmental Policy

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ABBREVIATIONS AND ACRONYMS

ABS	General Bureau for Statistics (Stichting Algemeen Bureau voor de Statistiek)
AdeKUS	Anton de Kom University of Suriname
ADRON	Anne van Dijk Rice Institute Nickerie (Anne van Dijk Rijstonderzoekcentrum Nickerie)
AFOLU	Agriculture Forestry and Other Land Use
ALCOA	Aluminum Company of America
AOSIS	Alliance of Small Islands States
ATM	Ministry of Labour, Technological Development and Environment (Ministerie van Arbeid, Technologische Ontwikkeling en Milieu)
BCEF	Biomass Conversion and Expansion Factor
BOG	Bureau of Public Health Service (Bureau Openbare Gezondheidszorg)
BUZA	Ministry of Foreign Affairs (Ministerie van Buitenlandse Zaken)
CAREC	Caribbean Epidemiology Centre
CARICOM	Caribbean Community
CARIFORUM	The Caribbean Forum of African, Caribbean and Pacific (ACP) States
CCAC	Climate Change Advisory Committee
CCCCC	Caribbean Community Climate Change Centre
CCD	Convention to Combat Desertification
CCDA	Climate Compatible Development Agency
CD4CDM	Capacity Development for Clean Development Mechanism
CDAP	Capacity Development Action Plan
CDM	Clean Development Mechanism
CELOS	Center for Agricultural Research in Suriname (Centrum voor Landbouwkundig Onderzoek in Suriname
CFC	Chlorofluorocarbons
CHM	Clearing House Mechanism
CI Suriname	Conservation International Suriname (NGO)
CIS	Coastal Information System
CMIS	Caribbean Modeling Initiative
COP	Conference of Parties
CPACC	Caribbean Planning for Adaptation to Climate Change
CSNR	Central Suriname Nature Reserve
CZM	Coastal Zone Management
DC	District Commissioner (Districtcommissaris)
Dm	Dry matter
DNA	Designated National Authority
E(S)IA	Environmental (& Social) Impact Assessment
EBS	Energy Company Suriname (NV Energiebedrijven Suriname)
ENSO	El Niño-Southern Oscillation
EWS	Early Warning System
FDI	Foreign Direct Investment
FFF	Foods Fats and Fertilizers
FNC	First National Communication to the UNFCCC
GB	Government Gazette (before independence in 1975) (Gouvernementsblad)
GCCA	Global Climate Change Alliance
GDP	Gross Domestic Product
GEF	Global Environment Facility
Gg	Giga gram
GHG	Greenhouse Gas

GIS	Geographical Information System
GLIS	Land Registration and Information System (Grondregistratie en Land Informatie Systeem)
GLOBE	Global Learning and Observations to Benefit the Environment
GoS	Government of Suriname
GPS	Global Positioning System
GWh	Giga Watt-hour
Ha	Hectare
HFLD	High Forest Cover, Low Deforestation
HVGO	Heavy Vacuum Gas Oil
HWP	harvested wood products
IADB	Inter American Development Bank
ICZM	Integrated Coastal Zone Management
IGRS	Institute for Graduate Research and Studies
IMAC	Inter-Ministerial Advise Commission (Interministriële Adviescommissie)
IPCC	Inter Governmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
ITCZ	Inter Tropical Convergence Zone
KNMI	Royal Netherlands Meteorological Institute (Koningklijk Nederlands Meteorologisch Instituut)
LBA	Large -Scale Biosphere Atmosphere
LBB	National Forest Service (Dienst Landôs BosBeheer)
LULUCF	Land Use, Land-Use Change, and Forestry
LVV	Ministry of Agriculture, Animal Husbandry and Fisheries (Ministerie van Landbouw, Veeteelt en Visserij)
MA	Mitigation Assessment
MAS	Maritime Authority in Suriname (Maritieme Autoriteit van Suriname)
MCA	Multi Criteria Analysis
MDG	Millennium Development Goals
MDS	Meteorological Service (Meteorologische Dienst van Suriname)
MSL	Mean Sea Level
MUMA	Multiple-Use Management Area
MW	Mega Watt
MZ	Medical Mission for the Interior of Suriname (Medische Zending Suriname)
NCAP I/NCAP II	Netherlands Climate Assistance Programme, Phase I and II
NCCAP	National Climate Change Action Plan
NCCR	National Coordination Centre for Emergency (Nationaal Coördinatie Centrum voor Rampenbeheersing)
NCCSAP	Netherlands Climate Change Studies Assistance Program
NCSA	National Capacity Self-Assessment
NH	Ministry of Natural Resources (Ministerie van Natuurlijke hulpbronnen)
NIMOS	National Institute for Environment and Development in Suriname (Nationaal Instituut voor Milieu en Ontwikkeling in Suriname)
NKAP	National Climate Action Plan (Nationaal Klimaat Actie Plan)
NMR	National Council for the Environment (Nationale Milieu Raad)
OAS	Organization of American States
OP	National Development Plan (Nationaal Ontwikkelingsplan)
OW	Ministry of Public Works (Ministerie van Openbare Werken)
PAHO	Pan American Health Organization
PINs	Project Idea Notes
PLOS	Ministry of Planning and Development Cooperation (Ministerie van Planning en Ontwikkelingssamenwerking)

PRECIS	Providing Regional Climates for Impacts Studies, regional climate modeling system
REDD+	REDD+ Reduced Emissions from Deforestation and forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks
RGD	Regional Health Service (Regionale Gezondheidsdienst)
RIL	Reduced Impact Logging
RO	Ministry of Regional Development (Ministerie van Regionale Ontwikkeling)
RGB	Ministry of Physical Planning, Land and Forest Management (Ministerie van Ruimtelijke Ordening, Grond- en Bosbeheer)
RPP	Readiness Preparation Proposal
SAP	Structural Adjustment Program (Structureel Aanpassingsprogramma)
SB	Government Gazette (after independence in 1975) (Staatsblad)
SBB	Foundation for Forest Management and Production Control (Stichting voor Bosbeheer en Bostoezicht)
SCF	Suriname Conservation Foundation
SER	State of the Environment Report
SLR	Sea Level Rise
SMNR	Sustainable Management of Natural Resources
SNC	Second National Communication to the UNFCCC
SPS	National Planning Office (Stichting Planbureau Suriname)
SRD	Surinamese Dollar
SRES	Special Report on Emissions Scenarios
SURALCO	Suriname Aluminum Company
SWD	Solid waste disposal
SWM	Suriname Water Company (Surinaamsche Waterleiding Maatschappij)
TOE	Ton Oil Equivalent
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific & Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
URC	UNEP Risoe Centre
VA	Vulnerability Assessment
VLIR-OI	Vlaamse Interuniversitaire Raad- Own Initiative

GLOSSARY

Abatement	The reduction of sources of GHG emissions.
Afforestation	Planting of new forests on lands that historically have not contained forests
Baseline	Baseline (or reference) is any datum against which change is measured. In this report it represents a ófuture baselineô which is a projected future set of conditions excluding the driving factor of interest.
Biofuel	A fuel produced from dry organic matter or combustible oils produced by plants.
Biomass	The total mass of living organisms in a given area or volume; recently dead plant material is often included as dead biomass. The quantity of biomass is expressed as a dry weight or as the energy, carbon, or nitrogen content.
Bunker fuel	Bunker fuel is technically any type of fuel oil used aboard ships CO_2 equivalent. The concentration of carbon dioxide that would cause the same amount of radiative forcing as a given mixture of carbon dioxide and other greenhouse gases.
Carbon flux	The rate of flow of a carbon per unit area, which has the dimensions [quantity]/([time]·[area].
Carbon sink	A carbon sink is a natural or artificial reservoir that accumulates and stores some carbon-containing chemical compound for an indefinite period. The process by which carbon sinks remove carbon dioxide (CO_2) from the atmosphere is known as carbon sequestration.
Climate variability	Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability). See also Climate change.
Emissions	The release of GHGs and/or their precursors into the atmosphere over a specified area and period of time.
Energy efficiency	Ratio of energy output of a conversion process or of a system to its energy inputs.
Global warming potential	An index, based upon radiative properties of well mixed greenhouse gases, measuring the radiative forcing of a unit mass of a given well mixed greenhouse gas in todayôs atmosphere integrated over a chosen time horizon, relative to that of carbon dioxide. The GWP represents the combined effect of the differing times these gases remain in the atmosphere and their relative effectiveness in absorbing outgoing thermal infrared radiation. The Kyoto Protocol is based on GWPs from pulse emissions over a 100-year time frame.
Greenhouse gases	Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earthôs surface, the atmosphere and clouds. This property causes the greenhouse effect. Water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the earthôs atmosphere.
Hydro energy	The production of electrical power through the use of the gravitational force of falling or flowing water. It is the most widely used form of renewable energy.
Kyoto Protocol	The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) was adopted at the Third Session of the Conference of the

	Parties to the UNFCCC in 1997 in Kyoto, Japan. It contains legally binding commitments, in addition to those included in the UNFCCC. Countries included in Annex B of the Protocol (most countries in the Organisation for Economic Cooperation and Development, and countries with economies in transition) agreed to reduce their anthropogenic greenhouse gas emissions (carbon dioxide, methane, nitrousoxide, hydrofluorocarbons, perfluorocarbons, and sulfurhexafluoride) by at least 5% below 1990 levels in the commitment period 2008 to 2012.
Leakage	The part of emissions reductions in Annex B countries that may be offset by an increase of the emission in the non-constrained countries above their baseline levels. This can occur through (i) relocation of energy-intensive production in non-constrained regions; (ii) increased consumption of fossil fuels in these regions through decline in the international price of oil and gas triggered by lower demand for these energies; and (iii) changes in incomes (thus in energy demand) because of better terms of trade. Leakage also refers to the situation in which a carbon sequestration activity (e.g., tree planting) on one piece of land inadvertently, directly or indirectly, triggers an activity, which in whole or part, counteracts the carbon effects of the initial activity.
Mitigation	Anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases.
Mitigation assessment	A national-level analysis of the various technologies and practices that have the capacity to mitigate climate change.
Peat	Solid fuel formed from the partial decomposition of dead vegetation under conditions of high humidity and limited air access (initial stage of coalification).
Reforestation	Planting of forests on land that have previously contained forests but that have been converted to some other use.
Renewable energy	Energy sources that are within a short time frame relative to the Earthôs natural cycles, sustainable, and include non-carbon technologies such as solar energy, hydropower, and wind, as well as carbon-neutral technologies such as biomass.
Sequestration	The process of increasing the carbon content of a carbon reservoir other than the atmosphere. Biological approaches to sequestration include direct removal of carbon dioxide from the atmosphere through land-use change, afforestation, reforestation, and practices that enhance soil carbon in agriculture. Physical approaches include separation and disposal of carbon dioxide from flue gases or from processing fossil fuels to produce hydrogen- and carbon dioxide-rich fractions and long term storage in underground in depleted oil and gas reservoirs, coal seams, and saline aquifers.
Shifting cultivation	Agricultural system in which plots of land are cultivated temporarily, then abandoned. This system often involves clearing of a piece of land followed by several years of wood harvesting or farming, until the soil loses fertility. Once the land becomes inadequate for crop production, it is left to be reclaimed by natural vegetation.
Sink	Any process, activity or measure that removes a greenhouse gas, an aerosol, or a precursor of a greenhouse gas or aerosol from the atmosphere.
Trend	Tendency of certain elemental characteristics of a system to increase or decrease as one progresses along.

EXECUTIVE SUMMARY

Suriname is located on the Northeast 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. The total land area of Suriname is about 164,000 km^2. In the year 2011 the population consisted of 539,910 inhabitants. Population growth is approximately 1% per year.

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.

Suriname is home to many unique ecosystems. In the coastal plain a complex mangrove ecosystem is found, which is an important breeding, feeding and nursery ground for marine and brackish water fish, marine invertebrates, sea turtles and enormous numbers of migratory birds and water fowls. 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.

The forests cover about 94% 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). The forest is one of the important natural resources in Suriname. Other important natural resources are freshwater, fossil fuel, bauxite, gold, kaolin and other minerals which are not exploited.

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 green house gas (GHG) emissions sharply decreased in 1999 due to the closure of the Aluminum Smelter, but show a relative increase from 2008 through 2012 as field records indicated on behalf of this report. Unless the recorded increase Suriname remains carbon negative.

National Greenhouse Gas emissions in 2008

As part of the Second Communication of Suriname to the United Nations Framework Convention on Climate Change, a national Green House Gasses Inventory with base year

2008 has been made. The IPCC2006 software has been used to produce this GHG inventory. This inventory is compiled for the following sectors: Energy, Industry (IPPU), Agriculture Forestry and Other Land Use (AFOLU) and Waste. Emission data from international bunkers and marine bunkers are also included. For the calculation of carbon dioxide (CO_2) equivalents, use was made of the *4th Assessment Report Global Warming Potential* (IPCC AR4 GWP, 2006) by the Intergovernmental Panel on Climate Change, for 100 yearsô time horizon.

Carbon dioxide accounts for the greatest percentage of emitted GHGs in Suriname. The total emission for the year 2008 equals 5,677.94CO_2Equivalents. The Energy sector with 3,788.15Gigagram carbon dioxide (Gg CO_2), is the largest GHG source, contributing over 66% of the total GHG emission. The sectors agriculture, forestry and other land-use, act like a sink with an absorption of -8,243.05Gg of CO_2 equivalents, making Suriname a net sink for CO_2-2,570.91Gg CO_2 or 1,883.09GgCO_2eq.

The main source of methane emissions is the agriculture sector (653.80 CO_2eq.). Despite this value, the AFOLU sector works as an absorbent and contributes to the net sink character for GHGs. Methane emissions from waste are negligible. Main share in methane emissions from the agriculture sector is attributed to rice cultivation and enteric fermentation.

Nitrous oxide emissions equal about 0.03Gg (7.48Gg CO_2 eq.). Most of these emissions come from the AFOLU sector.

The forests absorb a significant amount of the carbon dioxide, which is about -1,007 Gg CO_2 annually. Furthermore, abandoned crop land also provide a sink of about 7,236Gg CO_2 through the re-vegetation of former productive cropland. In the following tables a summary of the emissions by gas and sector for the inventory year 2008 is displayed.

Vulnerability assessment and adaptation strategy

For the vulnerability assessment critical issues were emphasized in each section. Water resources in Suriname are mainly used for agriculture, in particular, for rice cultivation, energy generation (hydropower) and consumption (eg. potable water). Emphasis is placed on urban areas which are susceptible to flooding as a result of the cumulative impacts of

abundant rainfall, poor drainage, and rising sea and river water levels. Additional attention is paid to excessive rainfall in the Interior which caused severe flooding in 2006 and 2008. Emphasis in the agricultural sector is placed on food security and food safety. Possibilities to increase the production and export of agricultural goods are evaluated as potential adaptation measures. The coastal and geomorphology section focuses on changes of the coastline in relation to the sea level rise and climate change. The assessment is conducted on the basis of ad-hoc studies, experiences gained in this field, and the expert judgment of consultants. The emphasis in the human health section is placed on monitoring dengue and malaria occurrences. Finally, the focus in the socio-economic analysis is primarily placed on existing vulnerabilities among certain groups in society such as women in the Interior and farming communities.

The expected climate change scenario used for the vulnerability assessment in Suriname could be described as follows, whereby projections are made for the year 2100:

- Temperature rise between 2-3 degrees Celsius;
- Rainfall decrease of 10%;
- Increase of weather extremes, including wind;
- A sea level rise of about 1m.

A vulnerability assessment has been conducted, based on the impacts of climate change on water resources, agriculture, ecology & geomorphology, socio-economy and health. Water resources in Suriname may experience stress as a result of climate change, since the combined effect of reduced annual rainfall, increased evapo-transpiration, and prolonged dry periods will exert additional pressure on the existing water resources of the country.

Mitigation Assessment

The GHG mitigation assessment provides an analysis of various technologies and practices that have the capacity to affect energy supply, agriculture, forestry, and transport resulting in GHG reductions.

The mitigation assessment covers projections of GHG emission for the energy and non-energy sector, for the period 2008 to 2025, and uses historical data in order to calibrate the

bases for projections. National studies and policy plans on energy, forest management and agriculture, together with information from key persons within ministries, provided direction and policy contexts for the mitigation assessment.

A low emission development for Suriname has to be driven by the fact that a great part of the population lives in the coastal plain where economic activity exist at or below sea level, which creates extreme vulnerabilities in the event of a natural disaster. The nationôs forests have strong economic value, but are at risk by the rate of deforestation mostly driven by gold mining, infrastructure development and agricultural development. A response to the threat of climate change has to correspond to the countryôs specific needs and resources.

GHG emissions in Suriname for the inventory year 2008 equals -1,883 Gg CO_2eq (Becker et al., 2012). This negative figure indicates that more GHG is sequestered than emitted to the atmosphere, which means that Suriname is a net sink for GHG. The net sequestration is due to the contribution of the forestry and other land-use sectors which sequesters 8,243 Gg CO_2eq. The majority of the countryôs energy needs are met by hydropower and the remainder by burning fossil fuels by using diesel generators, specifically, in the Interior. The Energy sector is the main source for GHG emissions (59%). Mitigation scenarios are therefore tailored to options such as renewable energy, clean transportation and for a lesser part on forestry and agriculture. Lack of data prevented the elaboration on mitigation through a $REDD^+$ scheme but this is definitely an option to be considered.

The mitigation projects, if executed as described in this report, will lead to a reduction of GHG emissions of 38% by 2025 versus the expected baseline value. Without any mitigation action, GHG emissions are predicted to increase with 94% until 2025 relative to the year 2008, whereas emissions per capita are expected to increase with 38% in the same period. With mitigation measures the expected emission per capita will decrease with 13% in the same period without putting a burden on national development. But certain barriers should be tackled, such as lack of availability of finances, technological capacity, training and awareness.

Other information

One of the objectives of the Second National Communication is to provide any ôother informationô that Suriname, as a non-Annex Party, considers relevant to the achievement of

the objective of the Convention and suitable for inclusion in its communication. In this report only the main projects and programs concerning the subjects listed below are being discussed:

- Steps taken to integrate climate change into relevant social, economic and environmental policies;
- Activities related to technology transfer;
- Climate Change systematic observations and research/studies to adapt to and mitigate climate change;
- Information on education, training and public awareness;
- Information on capacity-building at the national, regional and sub-regional levels;
- Efforts to promote information sharing (information and networking).

Surinameôs development policy is based on an integrated approach towards economic, social and environmental sustainability. Suriname aims to combat the effects of climate change through its Development Plan (OP 2012-2016) in which a clear need for adaptation measures in Surinameôs low lying coast is articulated as well as a need for a cross-sectoral Climate Compatible Development Strategy**.**

Technology transfer has been incorporated in several adaptation and mitigation projects and programs. Technology transfer plays a significant role in adaptation projects, through mangrove restoration, building climate resilient infrastructure and the use of high-tech solutions for data logging and *Early Warning Systems*. The technologies in mitigation projects are more focused on energy efficiency; renewable energy; emerging low-carbon and energy-generating technologies.

Suriname has a strong focus on capacity building in order to play an active role in climate change issues, as it generates competence, improves the effectiveness of the institutions that work within the context of climate change and promotes an enabling environment. Therefore capacity building is embedded in most of the activities (e.g. studies, project etc.) regarding climate change issues.

Recent and future changes in climate in Suriname have been and are being explored using a combination of observations and climate model projections mostly executed by the Anton de

Kom University of Suriname (AdekUS) in collaboration with other universities from the Caribbean. Because of its high vulnerability to climate change effect, the Government of Suriname carried out several studies containing measures to mitigate climate change, as well as measures to facilitate adequate adaptation to climate change. Different institutions have been involved in conducting and implementing these studies.

Over the past years many key stakeholders (governmental as non-governmental organizations) have acknowledged the fact that education and awareness campaigns are of utmost importance for tackling climate change issues.

Gaps and Constraints

This chapter of the Second National Communication presents an overview of the current constraints and gaps for Suriname in abiding by the requirements of the UNFCCC. The paragraphs 49-55 of the user manual for non-annex I parties provided the framework for this assessment.

Both the First National Communication (FNC), submitted in 2005, and the UNFCCC thematic National Capacity Self-Assessment, submitted in 2008, identified several gaps in meeting the conventionôs requirements. Many of these gaps and constraints are still valid.

A major step taken since the FNC is the continued prioritizing of climate change related policy making by creating a taskforce with the focus on a climate compatible development strategy within the Office of the President. The main impact of the institutionalization of this taskforce will be in the coordinating mechanism it offers for a coherent and focused approach in maximizing the outputs, outcomes and impacts of all programs and projects aimed at either assessment of, mitigation of or adaption to the irreversible effects of climate change. In the previous and current development plan it is clearly stated that due to the vulnerability of Suriname the focus is more on adaptation.

With expertise gained during the previous national communication the local lead experts in the SNC were better equipped to facilitate a more efficient elaboration of subtasks. This capacity building on the individual level needs to be accelerated and merged together with the required upgrading of the legal framework and the capacity building on the institutional and

systemic level. The relatively small scale of the available human, technical and financial resources is quite disproportional to the immensity and complexity of all aspects that have to be dealt with in the field of climate change. The climate change basic needs anno 2012 are:

- Substantially increasing the pool of climate change experts and the institutionalizing of processes of assessment, mitigation and adaptation to climate change;
- Creation of data and information networks and initiate continuous dialogue with the public, NGO and private sector;
- Capacity building in project-development, monitoring and evaluation skills for climate change projects to effectively draw on available funding;
- Building awareness within and among the most vulnerable groups within the coastal zones and the Interior;
- Research on the most feasible adaptation scenarios given the unique challenges with regard to land-tenure and illegal activities on private and government owned property;
- Financial resources for construction of protection mechanisms and other technologies needed for adaptation to climate change;
- Update and adoption of legislation and the availability of resources to effectively monitor compliance to law and regulations;

The various projects initiated and completed since the FNC clearly identified a need within subsectors of the climate change agenda of Suriname. Reflecting on these and other projects still in progress, it is too early to determine the (sustainable) impact of interventions, projects and programs. In the process of putting together the SNC a need was expressed for improvement of interdisciplinary alignment, a further increasing of the pool of experts and the institutionalization of data collection and research processes within climate change.

1 NATIONAL CIRCUMSTANCES

1.1 GEOGRAPHICAL SETTING

The Republic of Suriname is located on the north-eastern coast of the South American continent between 2° and 6° north latitude and 54° and 58° west longitude (see Figure 1.1). A coastline with a length of about 370km forms the northern border with the Atlantic Ocean. Suriname borders the Republic of Guyana in the west, the Federative Republic of Brazil in the south, and the French *Département Guyane* in the east. These borders are historically established in the east and the west by the Marowijne and Corantijn Rivers, respectively, and in the south by the mountain ridge formed by the Acarai, Tumukhumak, en Grens Gebergte. The land area of Suriname is about 166,000 km^2.

Figure 1.1 Geographical setting of Suriname

1.2 GEOLOGY AND GEOGRAPHY[1]

Over 80 % of Suriname consists of the Precambrian Guiana Shield, the deeply weathered, rainforest-covered hill and mountain land stretching east and south to the Amazon River in Brazil and west to the Orinoco River in Venezuela. Eroded material from the Guiana Shield was deposited in the subsiding areas to the north. The oldest outcropping sediments in this coastal area have been deposited during three distinct periods resulting in three different formations:

- The **Zanderij Formation**, consisting of medium to coarse sands to sandy clays, which have been deposited by braided rivers at the foot of the Guiana Shield in the form of alluvial fans;
- The **Coropina Formation**, consisting of fine sandy to clayey marine sediments, which have been deposited north of (and on top of) the sediments of the Zanderij Formation. The marine clays were deposited as extensive clay flats and the marine sands as ridges, which were later severely eroded. The remaining surface deposits of this formation are found as ñislandsò surrounded by the sediments of the Mara Formation;
- The **Mara and Coronie Formations**. The Mara Formation consists of marine clays and peat that were deposited in the eroded areas in between the remnants of the Coropina Formation, and in gullies that had been cut into the former Old Coastal Plain. The Coronie Formation in the coastal plain is predominantly of marine origin, but along the main rivers sediments have been deposited in fluviatile and estuarine environments. The deposits consist of mudflats of marine clays and ridges of sands and shells. The finer sediments (clay, silt and fine sand) originate from the Amazon basin, while coarser sands come from the Hinterland.

The above mentioned formations resulted in the division of Suriname in five main geographic regions which can be identified from north to south as follows (see Figure 1.2):

- the **Near-coastal zone and the Coastline**, formed by extensive mud flats and sandy shell beaches;
- the **Young Coastal Plain**, ranging in width from about 20 km in the east to about 100 km in the west with variations in height of 0ï 4 m above mean sea level (MSL);

[1]This paragraph is largely based on Noordam 2011.

- the **Old Coastal Plain**, formed on remnants of ridges, gullies and mud flats, with variations in heights of 4-10 m above MSL;
- the **Cover Landscape** (also known as the Savannah belt), consisting of coarse bleached white sand and yellowish brown sands to clay loams, ranging from 10-100 m above MSL;
- and the **Interior** highlands, which form the Guiana highland region, with highly weathered Precambrian formations and heights of above 100 m MSL.

The highest mountain of Suriname reaches a height of about 1200 meters. The remainder of the country consists of a monotonous landscape type, reaching heights of about 50 ï 500 meters above the MSL. The coastal zone is a low lying flat area, with many swamps of which some form open waters. All local rivers flow in a general southï north direction, ultimately discharging their water into the sea (see Figure 1.3).

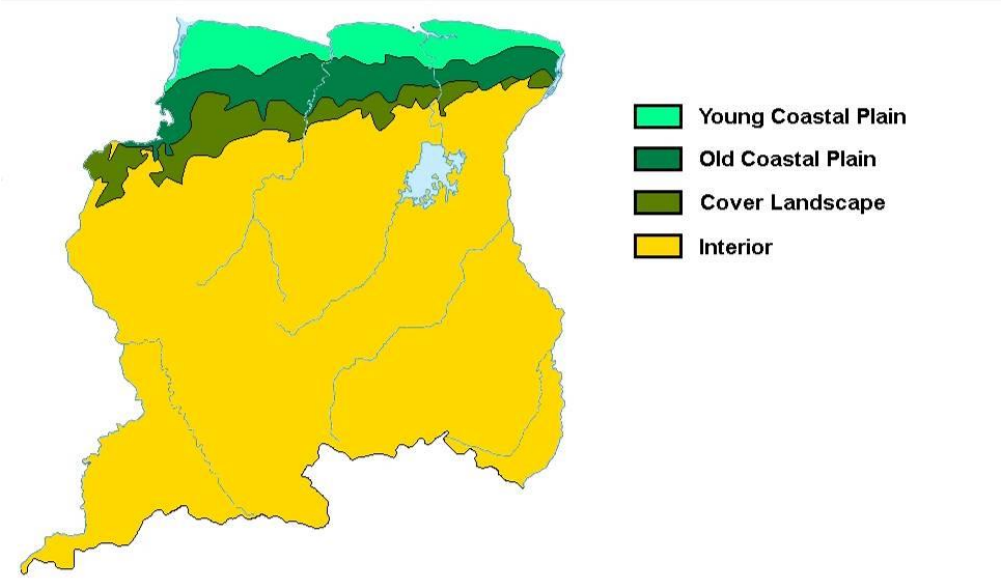

Figure 1.2 Geographic regions of Suriname

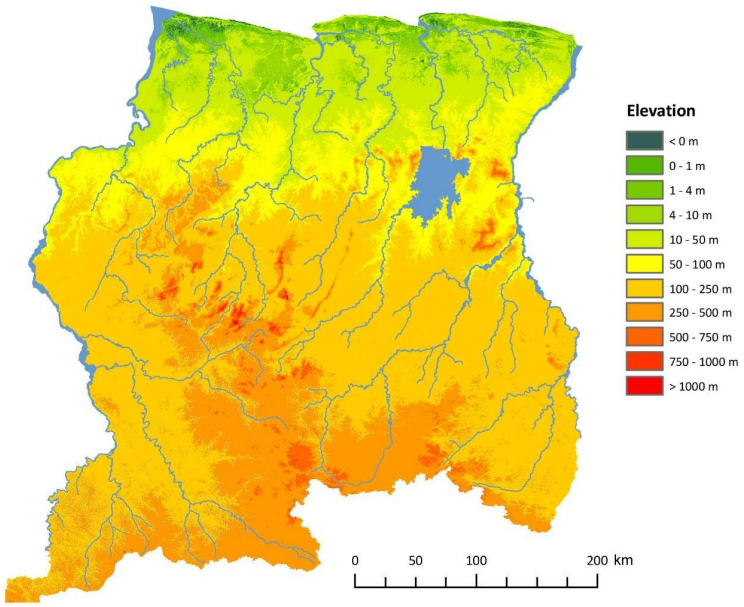

Figure 1.3 Topographical map of Suriname

The coast of Suriname is part of the coastal system, which extends from the mouth of the Amazon River in Brazil to the mouth of the Orinoco River in Venezuela. It is a muddy coastline where mud, including fine sands, from the Amazon Basin are being deposited. The coast is subjected to active geomorphological development, which is determined by a system of cyclic accretion and erosion. Both are linked to the presence of shoreface-attached mudflats and mud banks[2], which continuously migrate to the west. Essentially, the migration is the result of deposition of fluid mud at the west side and the simultaneous erosion of the east side. The mudflats are separated by intermediate troughs. Generally speaking, accretion occurs at locations sheltered by the mud banks, whereas coastal retreat occurs in between mud banks, when the coast is unprotected from waves. Along the coast there are large differences in accretion/erosion rates, with for instance considerable accretion along the Saramacca coast since (at least) 1947, and ongoing retreat around Coronie, and North of Paramaribo.

All four major rivers and their near-coastal subsidiaries have estuarine characteristics. The large volumes of tidal water and the strong tidal currents give these river estuaries a more or less funnel-shape and a wide mouth. They are characterized by mixing up of fresh and muddy

[2] Mud banks have been defined as the subtidal extension of the intertidal mudflats.

saline water, and by relatively large tidal variations. In the river estuaries considerable quantities of marine mud are moved upriver with the intruding tide. Sedimentation of this mud occurs on the river bed and as flats at the inside of river bends. The opposite outer bend, on the other hand, may be eroded by undercutting of the riverbank.

Very locally small sand beaches are found along estuaries. They are known from the Marowijne and the Suriname River. The large amount of sand supplied by a large ñmovingò beach from east Suriname has recently formed ï and is still forming ï a recurved spit that bends from the east into the Suriname River near Braamspunt.

1.3 CLIMATE[3]

1.3.1 PRECIPITATION

Suriname has a tropical climate with abundant rainfall (see Figure 1.4), uniform temperature, and high humidity. The amount of precipitation varies across the country. On average, Paramaribo receives 2210 mm rainfall annually, Coronie and Nieuw Nickerie (north-western coast) respectively 1561 mm/year and 1808 mm/year, Kwamalasamutu (south Suriname) 2109 mm/year and Stoelmanseiland (central east Suriname) 2445 mm/year (see Figure 1.4 and Figure 1.5). Variation in monthly rainfall results in two wet and two dry seasons for the northern part of Suriname. However, in the southern part only one wet and one dry season is distinguished (see Figure *1.6*).

[3]This paragraph is largely based on Amatali 2011.

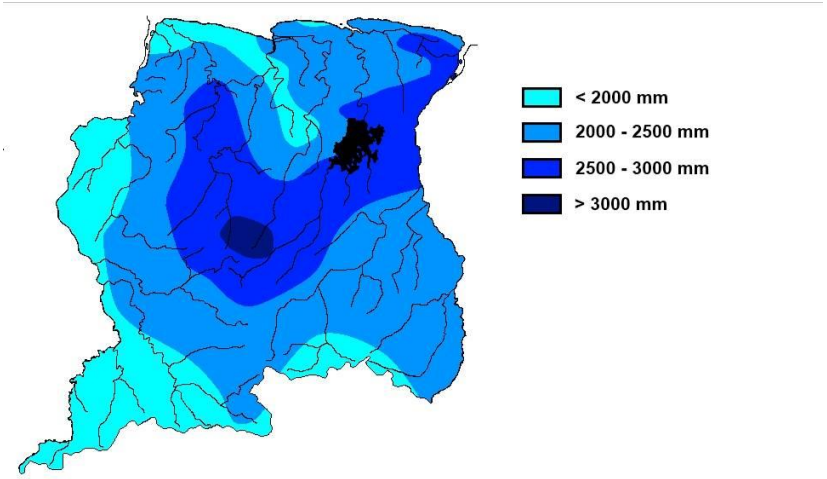

Figure 1.4 Average annual rainfall in Suriname, showing differences across the country

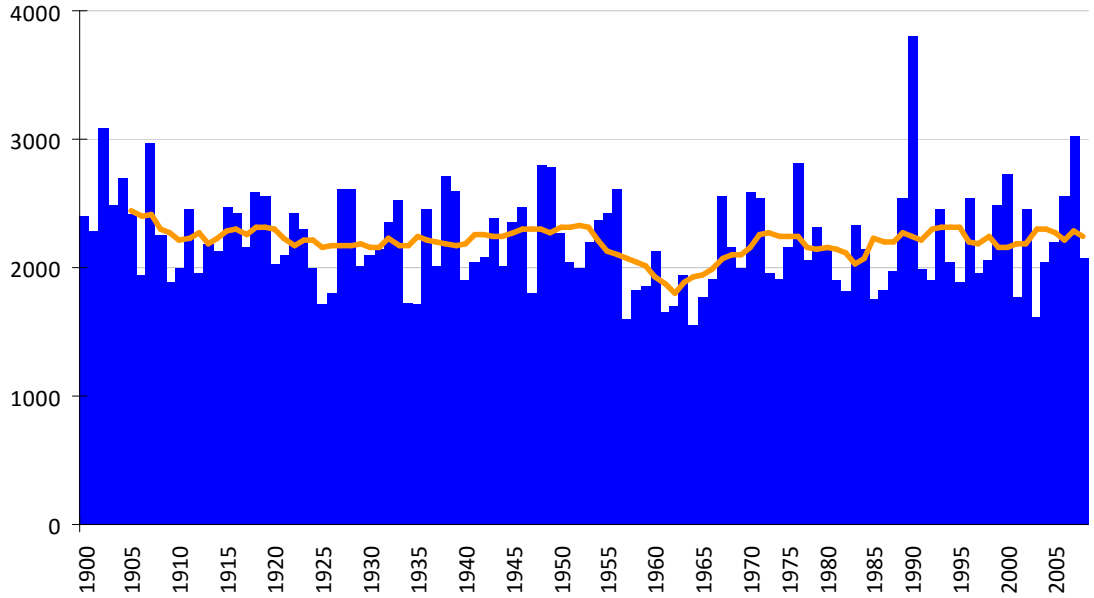

Figure 1.5 Annual rainfall of the period 1900 to 2008 for Paramaribo
A *moving average is added (10 years; orange line).*

1.3.2 AIR TEMPERATURE

The average daily temperature in the coastal region is 27.4º Celsius (ºC), with a daily variation of 5°C. The difference between day and night temperatures in the coastal region can be on average 6-7°C. There is relatively little variation in temperature between the seasons. January is the coldest month (average 26.6ºC) and October the warmest (average 28.5ºC) (see Figure *1.6*). Annual variation of the average temperature is 2-3°C (see Figure 1.7). The

Interior has relatively similar figures, although variation of daily temperature can be larger (10-12 °C).

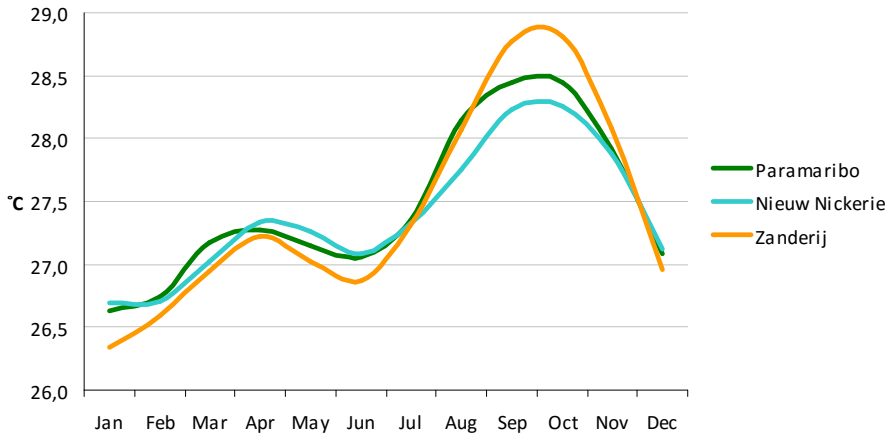

Figure 1.6 *Average monthly temperature for three (coastal) locations based on data of at least 20 years.*

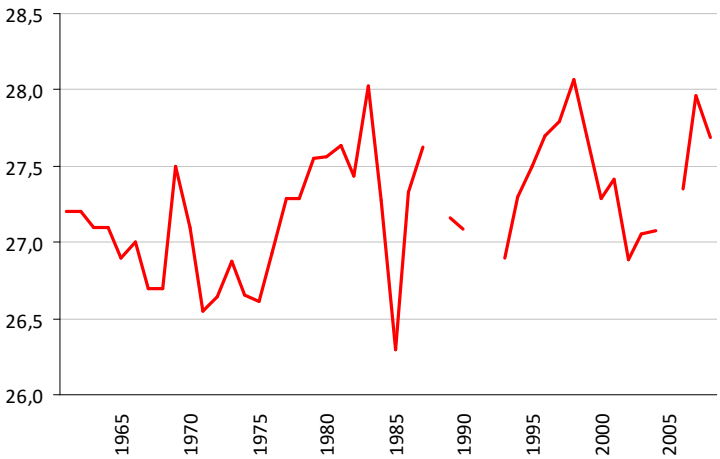

Figure 1.7 Mean annual temperature for station Cultuurtuin (Paramaribo)

(It is should be noted that for decennia now the surroundings of this weather station is strongly urbanized. This may have some influence on the temperature results).

1.3.3 WIND

The wind generally moves in a north-eastern direction, with an average speed of 1.3 Beaufort. Maximum average wind speeds occur during the dry seasons with 1.6 Beaufort in February and a second peak in September and October. Along the sea shore the wind speed is relatively

high, decreasing further inland. Wind speeds of 3 to 4 Beaufort generally occur during the day, dropping dramatically (especially in the Interior) during the evening and night.

Although Suriname falls outside of the hurricane belt, the weather is occasionally affected by tails of hurricanes. Local gales (in Surinamese called ñsibibusiò) appear before storms, generally at the end of the rainy seasons. During such gales maximum wind speeds of 20-30 m/s have been recorded. Such gales occur over the whole country and may destroy trees and houses. No information is available on the frequency of such gales.

1.3.4 AIR HUMIDITY

The daily air humidity is on average 80-90% in the coastal regions. In central and southern regions of the country, daily air humidity is lower and is on average 75%. In forested areas air humidity depends, among others, on the penetration of sun radiation. In Suriname, variation of relative air humidity lies between 70-100% in forested areas and between 50-100% in open areas.

1.3.5 EL NIÑO

The El Niño-Southern Oscillation (ENSO), which occurs once every 2-7 years, also impacts the climate in Suriname. Studies indicate that El Niño events may cause rainfall below or above normal. Generally during El Niño years, when there is excess rainfall on the West coast of South America, it is dryer in Suriname.

1.4 NATURAL RESOURCES

The country is endowed with many natural resources including soil, water, forests and mineral ores. The fertile soil of the young coastal plain, combined with the large freshwater swamps and rivers in the north are favorable for large scale agriculture. However, the largest part of the country (almost 88 % of total land area, see Figure *1.8*) still consists of tropical rainforest, that is not or only marginally used by local people for non-timber forest products. Only 8% of the total land area is cultivated, whilst the remaining 4 % consists of other non-forested natural areas (savannahs, swamps and wetlands). The cultivated area is used for forestry (3.7% of total land area), agriculture (3.2 %), and settlements, mining and hydropower lakes (1.3 %). Taking into account the low historical deforestation rate (between 0.03 and 0.04 % per year), Suriname is identified as a country with a High Forest Cover, and Low Deforestation rate (HFLD-country).

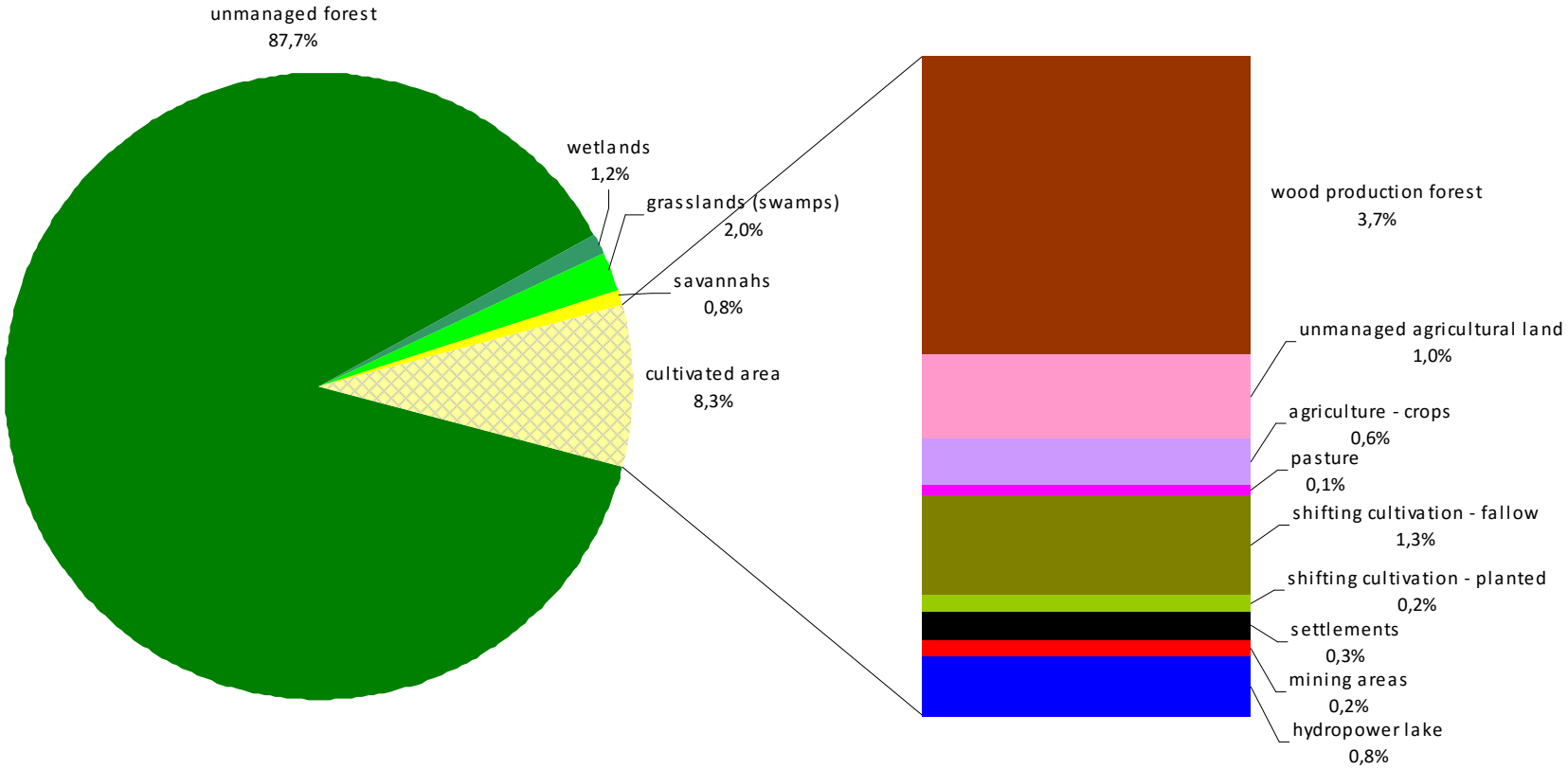

Figure 1.8 *Land use in percentage of total land area of Suriname (based on Playfair, 2011)*

1.4.1 SOIL AND MINERALS

The Young Coastal Plain (consisting of marine clays, peat, sands and shells) is the most fertile zone of Suriname, and has served the development of large-scale agricultural activities. The soils of the Old Coastal Plain (generally composed of clay, sandy-clay or clayey-sand) offer good opportunities for agricultural development, in particular, horticulture. The cover landscape consists of non-bleached sands to clay loams and bleached coarse sand, which have high infiltration and percolation rates and are less fertile. Agricultural activities are therefore limited to the cultivation of some small-scale dry crops. However, this area plays an important role in the maintenance of drinking water reserves, because the greatest amount of rainfall percolates into the ground here, recharging the freshwater aquifers. These aquifers are the main resource for potable water in the coastal areas (mainly around the capital). The Interior is more hilly and mountainous, mainly composed of weathered and eroded Precambrian rocks with a generally moderately thick regolith layer. Agriculture in this area is mainly limited to shifting cultivation practices. Human activities, such as, selective logging, shifting cultivation, exploitation of other natural resources easily affects the degradation of these relatively poor soils.

Exploitation of crude oil, sand and shells is taking place in the northern part of the young coastal zone. Although the Interior of the country is mineral-rich containing a number of important deposits of bauxite, beryl, copper, diamond, gold, platinum, iron ore, manganese, pegmatite and tin, exploitation of minerals mainly concentrates on bauxite and gold. Historically, extraction activities of mineral ores mainly occurred in the northern parts of the Interior but mining activities have increasingly been moving further south over the last decennia.

1.4.2 WATER RESOURCES

The main fresh water source is the abundant annual rainfall, which, together with the topography, soil types and land cover has resulted in many streams and large wetlands. Seven main rivers, originating in the Interior of the country, annually convey about 4,800 m^3/s of fresh water into the Atlantic Ocean, which is about 30% of the annual rainfall. The Marowijne and the Corantijn Rivers contribute 70% to the total discharge. Of the remaining rainfall, the largest part evaporates and only a small part percolates to the aquifers, recharging ground water reserves.

The hilly to mountainous Interior has a dense network of streams, while the low-lying coastal area has extensive swamps and fewer streams. Some of these swamps have salt or brackish water. Surface water resources (rivers, creeks and swamps) are mainly used for irrigation (e.g. for rice and banana cultivation) and for the generation of hydropower. Groundwater is mainly used for potable purposes. However, excessive extraction in some areas results in increased intrusion of saltwater.

1.4.3 ECOSYSTEMS[4]

The terrestrial ecosystems of Suriname can be characterized as follows (see also Figure 1.):

- **Ecosystems of brackish water** are influenced by coastal changes and tidal action. This area (also known as estuarine zone) consists of mangrove forests, locally interrupted by salt to brackish lagoons and low vegetation of succulent salt plants and brackish herbaceous swamps. Mangrove forests protect the coastline and riverbanks against erosion and stimulate accretion. They are nursery grounds for many species of marine fish and shrimp and contain a high degree of biodiversity. The estuarine zone of Suriname is a wetland of international importance as it contains the feeding and nesting sites for Caribbean coastal birds and feeding grounds for migratory birds from North America[5]. Along the coastline, mainly in the eastern part of the country, sand and shell beaches are found. These beaches are nesting places of international importance for four species of sea turtles.
- Slightly more landward, **freshwater swamps** or freshwater wetlands dominate the Young Coastal Plain and part of the Old Coastal Plain. These wetlands play an important role in supplying freshwater to the estuarine zone, thus contributing to the maintenance of the brackish condition of these waters. The swampy areas are inundated throughout most of the year, allowing a peat layer to accumulate on top of the mineral soil.
- **Low swamp forest**, also known as swamp wood, including palm swamp forest. Low swamp forests cover about 3% of Suriname and if no forest fires occur, it develops into high swamp forest.
- **High swamp forest and creek forest** are found in the shallow freshwater swamps of the coastal plain where strong fluctuations in surface water levels occur. This ecosystem is the

[4] This paragraph is largely based on Teunissen 2003
[5]Suriname is party to the Western Hemisphere Shorebird Reserve Network and the Ramsar Convention on Wetlands.

climax vegetation in the ecological succession of wet areas. Similar forests (known as creek forests) are found along creeks and are enriched by a large number of species from the surrounding high dry land forest.

- **High marsh forest** (seasonal swamp forest), is found on poorly drained soils. During the rainy seasons, the soil may be totally inundated. In the dry seasons the soil does not desiccate. Species diversity is intermediate between that of the high swamp forests, and the high dry land forests. Marsh forests are usually rich in palms.
- The largest part of Suriname, about 80%, is covered by **high dry land forest** which is found from sea level up to 400-600m. The general characteristics are the presence of a high and dense canopy at 25-45m with emergent trees up to 50-60m. Tree species diversity is enormous (between 100-300 species per hectare). High dry land forest is an important habitat for large mammals and at least 500 bird species.
- On higher elevations (above 400m), **high dry land forest of highlands** are found. These forests are frequently covered in clouds, which reduces the average number of sunshine hours. Temperatures are furthermore lower and the average humidity is higher than in high dry land forest of the lowlands. Epiphytes (such as mosses, ferns, orchids and bromeliads are abundant in both numbers and species. The flora and fauna of these montane forests is quite different from those of the lowland forests.
- Most **savannah forests** (xerophytic forests) are found in savannah areas. This type of forest commonly grows on excessively drained soils and on permeable soils resting on impermeable subsoils, hard pans and rocks. As a result, there is a water shortage in the soil during dry seasons. This vegetation type can also be found in the hilly/mountainous areas in the IInterior. Especially where laterite caps, conglomerates, dolerite and granite rocks and sandstones are covered with a thin layer of soil. Here they are known as mountain savannah forest.
- **Open savannahs** can be considered as remnants of the extensive Pleistocene climate savannah, that once covered Suriname almost entirely. Savannah ecosystems only survived where they were frequently burnt. At present, ten different types of savannahs have been distinguished in Suriname. Most savannahs are found scattered over the savannah belt. In the absence of fire, savannah vegetation eventually develops into forest.

Forest exploitation is mainly concentrated in high dry land forest, savannah forest and high marsh forest. As Surinameôs forests are poor in number of commercial timber species, only selective logging is practiced by the forestry sector. Timber resources are exploited in the Old

Coastal Plain and northern part of the Interior, with an annual logging capacity of approximately 200.000m^3. The total area of forest that is selectively logged is estimated at 15.000ha per year.

The diversity of biological species in Suriname is high. The number of species which have been identified in Suriname thus far are (ESS 2007):

- Approximately 5100 plant species (mosses, ferns and spermatophytes - seed producing plants);
- 318 freshwater fish species (and approximately 360 marine fish species);
- 102 amphibian species (mainly frogs and toads);
- 175 reptile species (lizards, snakes, turtles and caimans);
- 715 bird species, from the coast, the savannahs and closed rainforests;
- 192 mammal species in the sea (dolphins and whales), in freshwater (manatee, otters), and terrestrial (deer, cats, monkeys, bats, etc.).

Suriname has three types of protected areas: i) Multiple Use Management Areas (MUMAôs), in which economic activities are allowed as long specific protection goals are not threatened, ii) Nature parks, in which light forms of exploitation (mainly recreation) are allowed, and iii) Nature Reserves, in which specific species or ecosystems are protected, and human activities are limitedly allowed. Almost the entire coastal area of Suriname is protected by means of MUMAôs for the protection of e.g. endangered shore birds and sea turtles. Furthermore, representative terrestrial and aquatic (fresh water) ecosystems including the endangered species that live in these areas are protected in Nature Reserves and Nature Parks across the country. The Central Suriname Nature Reserve (CSNR), a 1.6 million ha of pristine rainforest in the center of Suriname is preserved and put on the World Heritage List of the UNESCO. In the CSNR not only the forest is protected but also the Coppename River Basin with its branches and creeks containing freshwater of good quality. Furthermore, a large population of biological species both aquatic and terrestrial species (including endangered species) are preserved in this Nature Reserve. The protected areas cover approximately 13% of the land surface of Suriname (see Table 1.1 and Figure 1.).

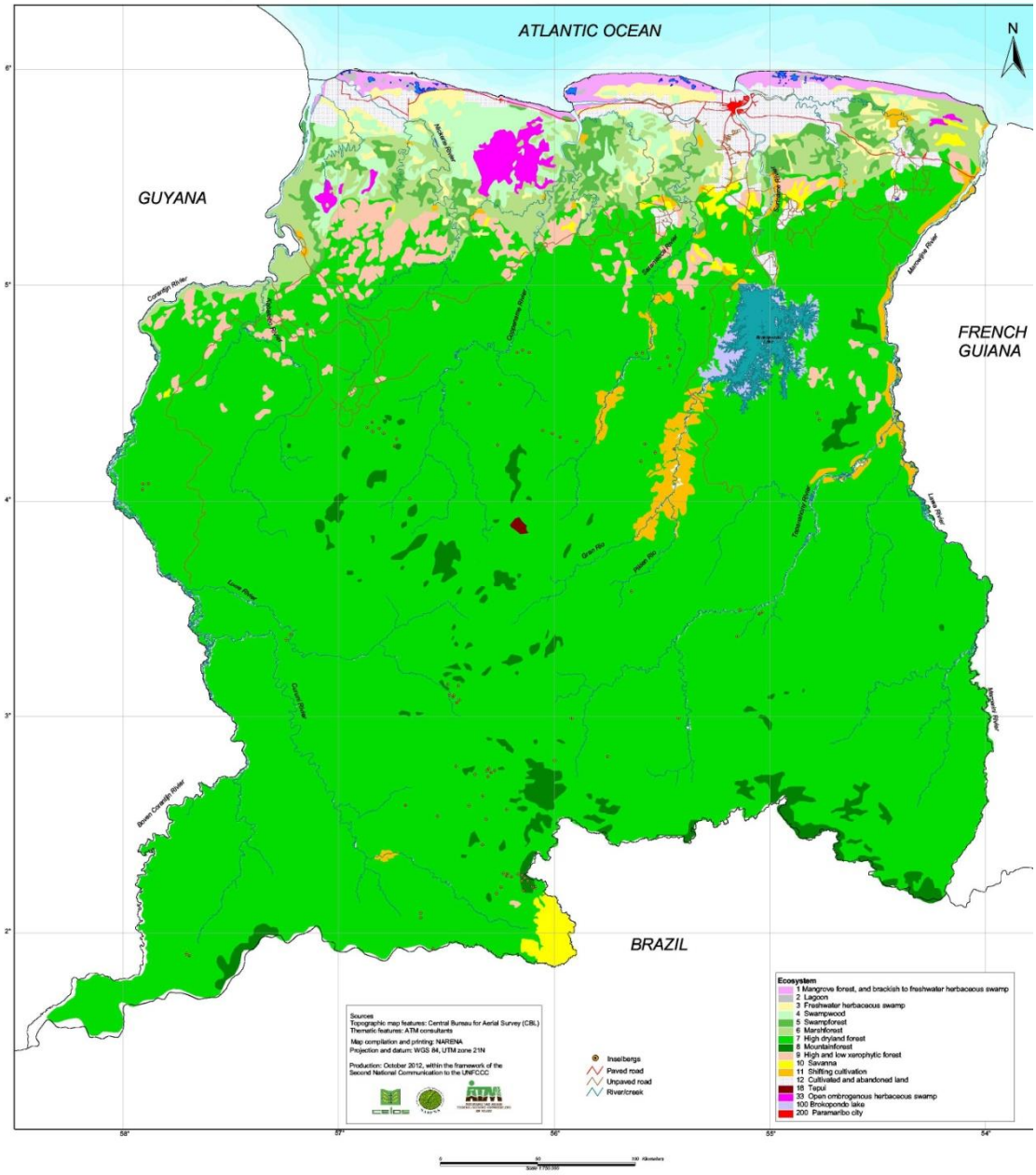

Figure 1.9 Ecosystems of Suriname

Table 1.1 Protected Areas of Suriname and their size

Site name	**Total terrestrial area (hectares)**
Nature Reserve	
Boven-Coesewijne Nature Reserve	27,000
Brinckheuvel Nature Reserve	6,000
Central Suriname Nature Reserve	1,592,000
Copi Nature Reserve	28,000
Coppename Monding Nature Reserve	12,000
Galibi Nature Reserve	4,000
Hertenrits Nature Reserve	100
Peruvia Nature Reserve	31,000
Sipaliwini Nature Reserve	100,000
Wane Kreek Nature Reserve	45,000
Wia-Wia Nature Reserve	36,000
Nature Park	
Brownsberg Nature Park	12,200
Multiple Use Management Area (MUMA)	
Bigi Pan Multiple Use Management Area	67,900
Noord Coronie Multiple Use Management Area	27,200
Noord Saramacca Multiple Use Management Area	88,400
North Commewijne - Marowijne Multiple Use Management Area	61,500
Total	**2,138,300**

Figure 1.10 Protected Areas of Suriname

1.5 POPULATION

In 2008, Suriname had a total population of 517,052 (ABS), largely concentrated in Paramaribo, the capital of the country. Surinameôs colonial history has played a major role in the multi-ethnic composition of its population. Until the abolition of slavery (in 1863) Western Europeans imported slaves from the African West Coast. After abolition of slavery migrants were attracted from China, India, and Indonesia to work on the plantations. Surinameôs population consists of the following ethnic groups: Amerindians (the indigenous people), Maroons (descendants of run-away slaves), Creoles (of African or mixed descent), Hindustani (from the Indian sub-continent), Javanese (from Indonesia), Chinese, Lebanese, Brazilians, descendants of European settlers and mixes between these ethnic groups (see Figure 1.).

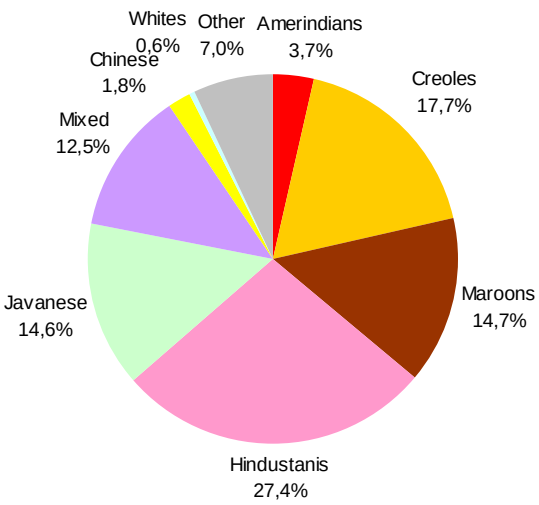

Figure 1.11 Ethnic diversity of Suriname's population

The official language is Dutch. Sranang Tongo, the *lingua franca*, and English are widely spoken as well. Most of the ethnic groups also use their own languages. All major religions such as Christianity, Judism, Hinduism and Islam are practiced, next to traditional religions.

In 2004 about 67 % of Surinameós total population was concentrated in the capital, and 20 % in the other coastal districts. The remaining 14 % was concentrated in small (mainly) tribal communities along rivers in the Interior (see Figure 1.12). The overall population density was 3.0 people per km², which makes Suriname a very low populated country. The most densely populated districts are Paramaribo and Wanica with a population density of 1335 and 194 people per km^2 respectively.

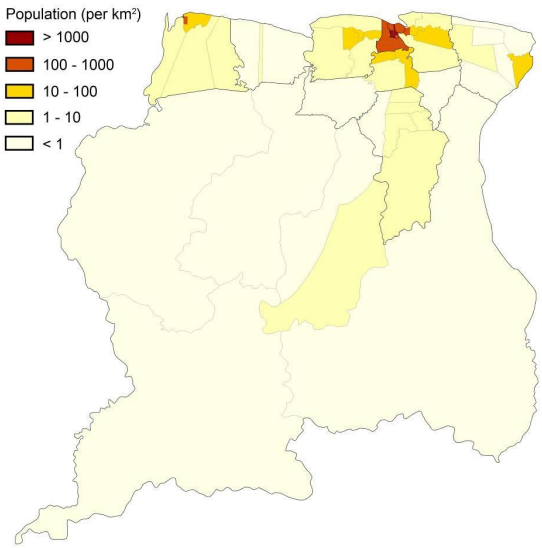

Figure 1.*12 Population distribution and density per administrative resort (ABS 2004)*

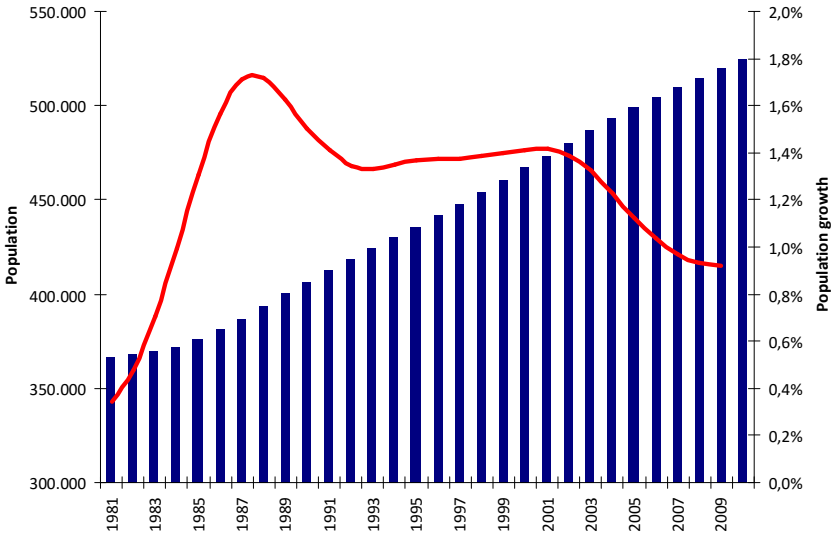

Figure 1.*13 Population of Suriname between 1981 and 2010 (Based on World Bank figures; the blue bars present total population, the red line presents population growth)*

The rate of population growth for Suriname has varied over time (see Figure 1.13). For the past 20 years, however, the growth rate has remained fairly constant, shifting between 1.0 and 1.5 %. Figure *1*. presents the age and gender distribution of the population in 2008. There are slightly more men than women below the age of 55, while the age category above 55 is dominated by women. According to the 2008 figures, almost 62% of the population was between the ages of 15 and 59 years, whilst 29% was younger than 15 and 9% was 60 or older

(see Figure 1.14). Life expectancy for males is 67.7 years and for females 71.9 years (MDG 2009).

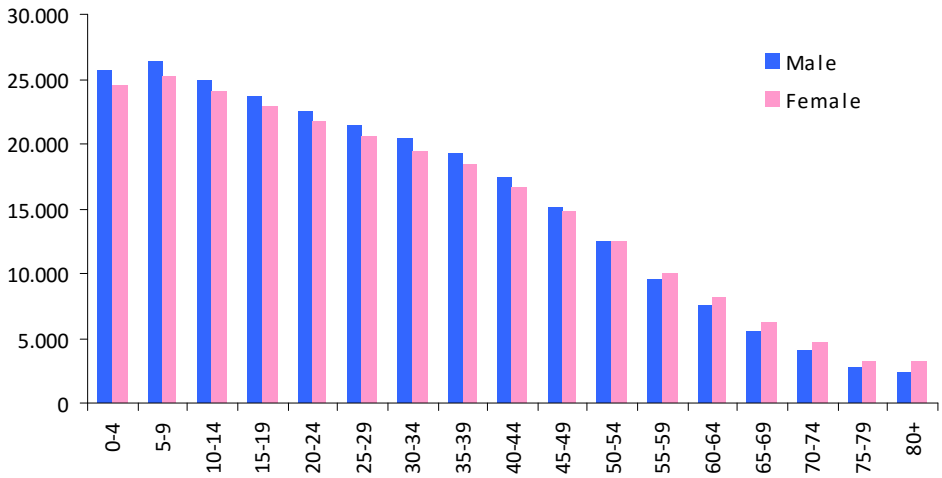

Figure 1.14 Population characteristics: gender and age distribution (ABS 2008)

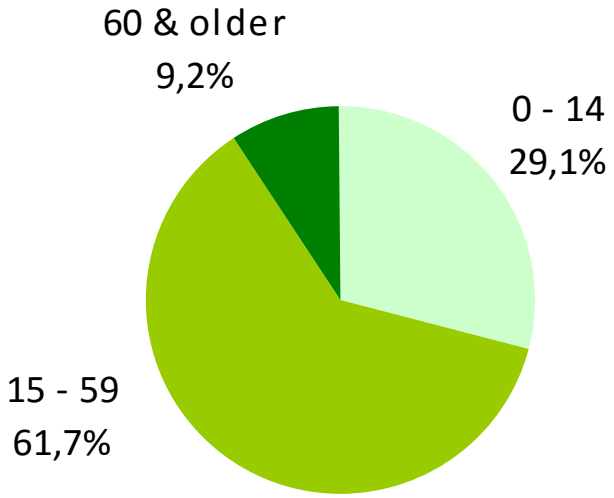

Figure 1.15 Age distribution (ABS 2008)

1.6 GOVERNMENT[6]

Suriname has a constitutional democracy with a president who is both the chief of state and the head of the government. The 51 members of the national assembly are elected by popular vote for five years. The president and vice president are elected by the assembly by a two-thirds constitutional majority. There are 10 administrative districts: Brokopondo, Commewijne, Coronie, Marowijne, Nickerie, Para, Paramaribo, Saramacca, Sipaliwini and Wanica. Local representation in the political structure is generally weak partly because political representatives outside of Paramaribo lack political power. District council members are elected locally and are required to work with the District Commissioner (DC) in addressing issues of general concern, although they have no operating budget. An ongoing decentralization process (started in 2002) is supposed to provide an operating budget for the DC and council but this has not been implemented yet.

1.7 ECONOMY AND DEVELOPMENT

Since the establishment of Suriname in 1667 as a Dutch colony it has been exploited for mainly sugar and coffee production on plantations. The history of Surinameôs economy is therefore a plantation economy, which was build up by several hundreds of plantations established along the rivers of the coastal area. Although the plantation economy had already declined in the 19th century, it mainly came to its end in the first half of the 20th century. The gold rush (around the second half of the 19th century) was a new economic activity of importance, but soon declined due to disappointing gold finds and high exploitation costs. Efforts to introduce rubber and wood production in the first decades of the 20th century did not reach the expected results.

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 1960ôs onwards exports of bauxite, alumina, and aluminum have accounted for 70 ï 80 % of total export revenues, forming 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

[6]This paragraph is largely based on Nijbroek & Meaney, 2011

independence, the bauxite sector continued to dominate in terms of its contribution to the economy as a whole. To marshal the development of the small and undiversified economy, the government received an enormous grant aid from the Netherlands upon its independence.

On account of these two pillars, the economy grew at average rates exceeding 3 % per year 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. A civil war (1983-1987) in the Interior destroyed much of the economic infrastructure of Eastern Suriname, such as roads, bridges and some rural economic activities (e.g. palm oil production).

The early and mid-nineties (1992-1995) were characterized by the implementation of a Structural Adjustment Programme (SAP), designed to revitalize the economy, arrest negative growth rates of GDP, and avert pauperization of the population. As a result, GDP first showed a negative growth, but recovered to high positive results in the late nineties. The first ten years of the 21st century are marked by a stable growth of the economy and GDP. In the nineties annual GDP growth rates fluctuated between -7 % and +6 %, but reached a more stable rate of slightly more than 4 % in the past five years (see Figure *1.9*). National income per capita does also show a stable growth in the past ten years (see Figure *1.10*).

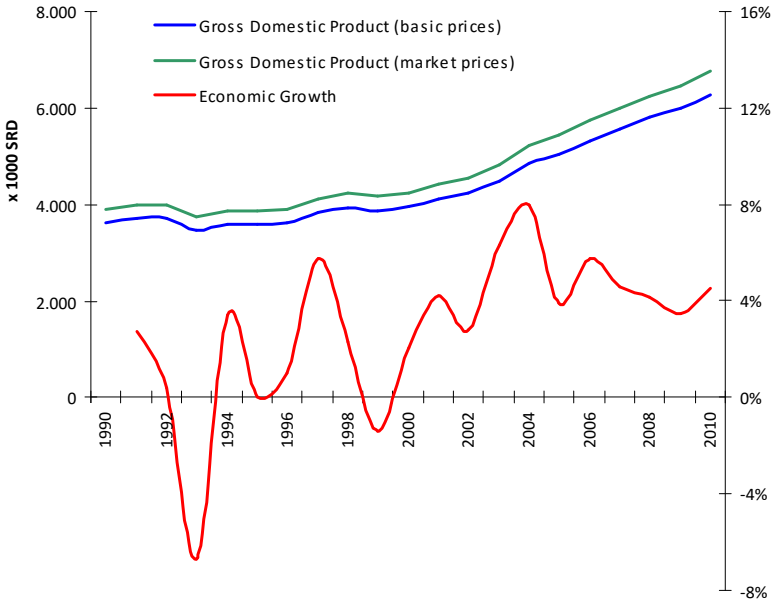

Figure 1.9 *GDP and GDP growth rate between 1990 and 2010 (Based on ABS 2010; figures include the informal sector and are inflation corrected (1990 = 100)).*

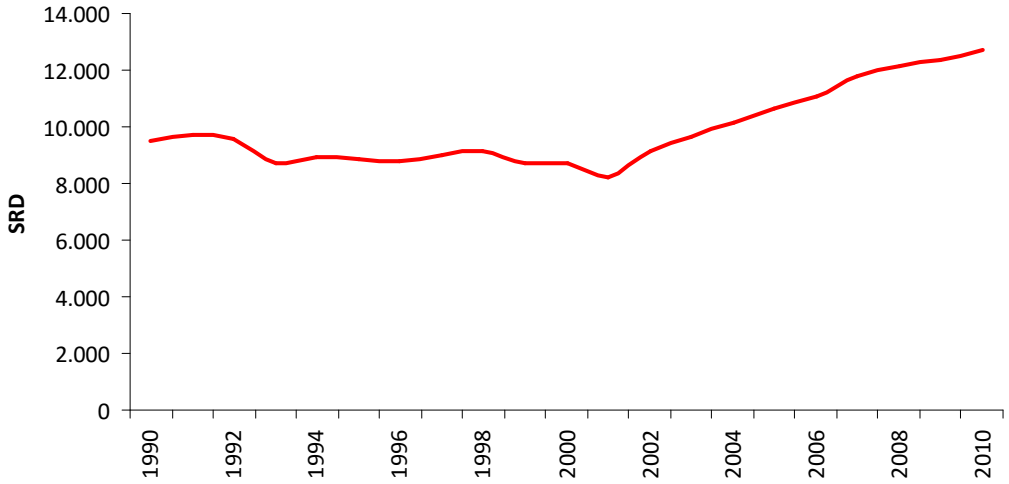

Figure 1.10 *National income per capita (Based on ABS 2010; these figures include the informal sector, are presented in Surinamese Dollars (SRD; SRD 1 = Sf 1000), and are inflation corrected (1990=100)).*

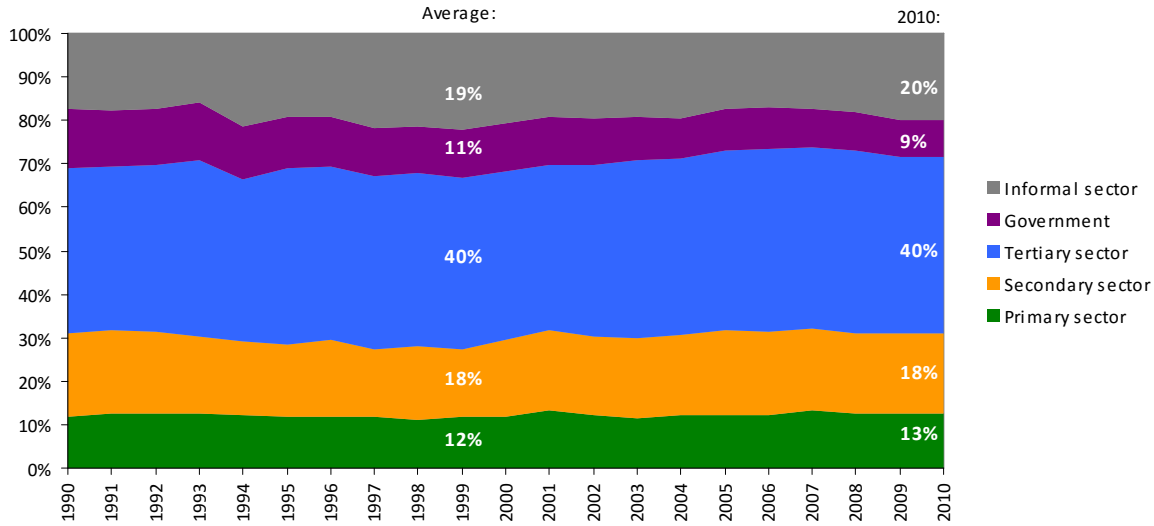

Figure 1.11 Relative contribution of different sectors to GDP in the period 1990 – 2010 (based on ABS 2010).

Primary sector: agriculture, hunting, forestry, fishery, mining, quarrying

Secondary sector: manufacturing, electricity, gas and water supply, construction

Tertiary sector: wholesale and retail trade, hotels, restaurants, transport, communication, financial intermediation, real estate, renting and business activities, other community, social and personal activities

Government: public administration, education (government), health and social work (government)

The economy can be characterized as beyond transitional, with a large tertiary sector that is not yet developed. There is relatively too much income inequality compared with the EU (0.36) or the USA (0.46), with a Gini Coefficient of 0.5467, but compared with Brazil (0.57) or Colombia (0.58), Suriname is doing better (Nijbroek & Meaney, 2011).

Although the bauxite sector still plays an important role in the economy of Suriname with regard to foreign exchange earnings and government income, Surinameôs economy is currently less dependent on mining than is often cited. On the other hand, the economy is not well-diversified either; a large percentage of bank capital is committed to unproductive sectors (mainly trade), companies face long bureaucratic procedures, state owned or semi-governmental companies are loss-making, the public sector is functioning inefficiently and there is little large scale manufacturing. In recent years, however, tourism, construction and financial services ï and related personal consumption ï have played a role in the diversification of the economy away from over-reliance on the export of raw materials (Nijbroek & Meaney, 2011). Figure 1.11 presents the relative contribution of the different sectors to GDP and shows that the tertiary sector contributes most (40 %), followed by the informal sector (20 %) and secondary sector (18 %). It furthermore shows that very little changed in the past twenty years: the contribution of the tertiary sector increased slightly, while the governmentôs contribution decreased slightly.

1.8 OTHER SOCIOECONOMIC FACTORS[7]

The number of employed and unemployed individuals in 2009 was 126,370 and 12,525 respectively (unemployment rate of 9 %), although in reality the unemployment rate is much higher. There is a much higher participation in the economy by men than by women, and the total participation ratios are low (only 56% of the working age population claims to be formally employed). Many individuals work in the informal sector. The number of households in 2004 was 123,463. Male heads of households are approximately double the number of female headed households. Table 1.2 presents some headline socioeconomic indicators for Suriname. On a general level, these show a relatively robust development path since 2003.

[7]This paragraph is largely based on Nijbroek & Meaney, 2011

Table 1.2 Average socioeconomic indicators over the period 2003-2008 for Suriname (Based on Nijbroek & Meaney, 2011)

Indicator	Indicator value	Reference period
Births per thousand	19.68	mean 2003-2008
Deaths per thousand	6.93	mean 2003-2008
Immigration per thousand	4.38	mean 2003-2008
Emigration per thousand	1.05	mean 2003-2008
Absolute numbers in poverty Indigent (onvermogenden)	38,003 55,516	2003 2008
Underprivileged (minvermogenden)	87,207 117,541	2003 2008
Poverty line	SRD 697 SRD 1424	(2003) (2009)
Unemployment rate	9.8 %	mean 2003-2007
Adult literacy	93%	2007
Employment to population ratio	36%	2008
% population cellular subscription	127 %	2008
Internet users per 100 population	13	2008
Unemployment 15-24 years	22 % (males 15 %, females 40 %)	2008
Urban unemployment 15-24years	22 % (males 13 %, females 40 %)	2008

1.8.1 TRANSPORT

Transport occurs mainly by road in the coastal area and by water, on the roughly 1200 kilometers of rivers. There is also an extensive network of airfields and several small airline companies that provide service by small aircraft to the Interior. Economic progress during the last decade led to an increase of private car ownership and a highly congested road system in Paramaribo during peak times.

The port system is of tremendous importance for Surinameôs economy. Ports are located at Nieuw-Nickerie, Paramaribo, and Paranam. Freight from Paranam has been steady since 1988, Nieuw-Nickerie has declined in importance, while Paramaribo has grown significantly. The port of Paramaribo is responsible for only 27 % of exports and 75 % of imports (by weight). Freight is also dispatched by air, but recent data is not available.

1.8.2 WASTE

There is solid waste collection service, but it does not cover all households in urban areas and many people resort to burning household waste or dispose their waste off in open spaces or rivers. Existing landfills are unlined and can pose a serious threat to groundwater pollution. There is only one waste water treatment plant operational in Suriname at the *Fernandes Softdrinks bottling plant*. Wastewater from households is directed to septic tanks in peopleôs backyards. Wastewater from downtown Paramaribo is released directly into the Suriname River.

1.8.3 HEALTH

Approximately one third of the population is currently receiving free health care under a government plan. While there is a strong cadre of health professionals, the supporting network is vulnerable. There is currently one emergency room in Paramaribo and only one new hospital has been built (in Nieuw-Nickerie) over the past decades while population has continued to grow.

1.9 POLICY AND LEGAL FRAMEWORK

The Constitution of the Republic of Suriname (1987) provides the legal basis for a sustainable environmental policy in its Article 6g: *"The social objective of the State is focused towards the establishment and stimulation of conditions required for the preservation of nature and the safeguarding of the ecological balance."* Adherence to these principles is witnessed through participation in the major environmental conventions. To address the climate change issues in general and the UNFCCC commitments specifically, some legislation, policy documents, and action programs have been developed.

The following existing laws do provide a basis for the protection of carbon stocks and regulate land use planning and sustainable management of the natural resources:

- Nature Preservation Act (1954), putting in place arrangements for the protection and maintenance of nature monuments;
- National Planning Act (1973), providing provisions for national and regional planning, e.g. land-use policy issues;
- Forest Management Act (1992), providing a framework for forest management, and sustainable utilization of the forest resources;

- Government Decree on Nature Protection (1998), establishing the Central Suriname Nature Reserve.

An Environmental Framework Act that will regulate amongst others pollution, waste management and environmental impact, is being prepared. The governmentôs development policy is based on an integrated approach towards economic, social and environmental sustainability. A Climate Change Strategy is also being prepared, as well as a National Climate Action Plan (NKAP), which focuses on mitigation and adaptation measures to cope with the (expected) effects of climate change, and stresses the importance of integrated coastal zone management and spatial planning.

Climate change issues are increasingly incorporated in Surinameôs policy. In the latest OP, for instance, the following policy measures are mentioned for the period 2012-2016:

- Improvement of environmental governance and control, and improvement of cooperation between organizations and ministries with mandates and responsibilities in relation to the environment;
- With regards to international cooperation and diplomacy: increasingly focusing on climate change effects;
- Enhancing the ability of the coastal region (current and potential economic zones ï urban areas, agricultural lands, infrastructure) to cope with climate change effects, e.g. by developing and taking the necessary adaptation measures to protect this region against a potential sea level rise. This includes (amongst others) the development of a Climate Compatible Development Strategy, protection of aquifers and surface waters, promotion of the sustainable use of water resources and ecosystems, development of a complete dewatering regime of fertile land, and the construction of sea walls;
- Supporting research and assessments of surface water quality and carbon sequestration in forests; next, investigating the economic value of forests, and participating in mechanisms to attract economic sources, such as *Reducing Emissions from Deforestation and Forest Degradation (REDD+), Payment for Ecosystem Services* (PES) and *Public Private Partnership* (PPP);
- Increasing the implementation and use of renewable and alternative energy sources; e.g. by means of constructing hydropower plants to respond to the increasing demand for electricity, improvement of transmission and distribution facilities to reduce energy

losses, promotion of alternative energy sources and sustainable energy production, and support of energy saving projects.

1.10 ENVIRONMENTAL MANAGEMENT STRUCTURE

The environmental department of the Ministry of Labour, Technological Development and Environment (ATM), until March 2015, was responsible for the development of an overall environmental policy and the coordination and monitoring of all activities regarding these policies, including the implementation of the major environmental conventions: UNFCCC, UNCBD and UNCCD. This was done in collaboration with governmental and non-governmental bodies and institutions. The National Council for the Environment (NMR) supports the GoS on its national environmental policy and serves as an advisory body for the ministry of ATM. The National Institute for Environment and Development in Suriname (NIMOS) functioned as the technical arm of the Ministry of ATM. In 2011 the government established the Climate Compatible Development Agency (which was incorporated in ATM in 2012). This agency was responsible for attracting climate change funding and the development of climate change policies.

There are several other ministries and semi-governmental organisations functioning as key agencies with specific global environmental management mandates relevant to the UNFCCC implementation.

- The Ministry of Physical Planning, Land and Forest Management (ROGB) is responsible for the formulation of the national policy on land use planning, sustainable forest use and nature conservation, and has several sub-divisions responsible for the regulation, implementation, monitoring and control;
- The Ministry of Finance has a National Planning Office (SPS) in charge of preparing the National Development Plans (OPs). It has a sub-directorate *Environment and Spatial Planning* that is responsible for the coordination of physical planning and environment in Suriname. It updates an inventory of data relating to land and soil, natural resources, existing infrastructure and land allocation. It also maps the structural characteristics of urban and rural areas and keeps record of geographic data in order to map the environment in terms of ecosystems as well as socio-demographic and physical indicators;

- The Ministry of Natural Resources (NH) provides control of the exploitation and management of minerals, water and energy and regulates domestic, public and commercial energy use;
- The Ministry of Agriculture, Animal Husbandry and Fisheries (LVV) regulates the agrarian production sector and the proper use of agricultural lands and waters;
- The Ministry of Public Works (OW) is responsible for planning and implementation of civil technical and infrastructural works, water management and drainage, hydrological and meteorological services, and waste management. The ministry developed a master plan on drainage of Paramaribo, incorporating climate change concerns and issues.
- A National Climate Change Steering Committee was installed in 2004, consisting of representatives from different relevant sectors such as energy, industry, agriculture and forestry. Also the Meteorological Services and the Anton de Kom University of Suriname (AdeKUS) are represented. With this committee the GoS aimed at effective coordination of climate change issues in Suriname in order to formulate a balanced climate policy with broad support. The Committee is responsible for guidance, monitoring and evaluation of climate change related projects and programmes (initiated by the GoS). Currently the formal status of the Steering Committee has expired, but a continuation of the Steering Committee (or something alike) is intended.

Although the different ministries (ATM: now obsolete), RGB, NH, LVV, OW) are charged with nation-wide policies and promoting the interests of their sector, on the district level, the District Commissioner (DC), functioning under the Ministry of Regional Development (RO) 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. Table 1.2 presents an overview of stakeholders, describing their relation to the convention and how their role is being implemented.

Table 1.3 Stakeholders to the implementation of the UNFCCC in Suriname[8]

Stakeholder name	**Stakeholder interests, position and official mandate**	**Relation to the implementation of the Convention**	**(Possible) role in the implementation of the Convention**
Mandated ministries and institutions with a clearly described responsibility in the implementation of the Conventions' requirements			
Ministry of Labour, Technological Development and Environment (ATM): replaced by National Coordination of Environmental Policy within the Office of the President of the Republic of Suriname as of March 2015.	Responsible for formulation of environmental policy and implementation of ratified conventions	Core stakeholder, because of public mandate	Delegation, coordination, management and monitoring of activities
NIMOS	Awareness, technical assistance to ATM	Core stakeholder, because of specific implementing tasks regarding environmental issues	Regulating environmental impact, and implementation of specific activities
National Council for the Environment (NMR)	Advisory body to GoS	Public mandate	Advising implementing agencies
Ministries, institutions with clearly described tasks in the national implementation of the convention			
Ministry of Physical Planning, Land and Forest Management (ROGB)	Responsible for physical planning, land allocation, forest use and nature conservation	Core stakeholder in forest policy and spatial planning	Regulating forest use and land allocation

[8]Largely based on Van Dijk & De Wolf, 2008.

Stakeholder name	Stakeholder interests, position and official mandate	Relation to the implementation of the Convention	(Possible) role in the implementation of the Convention
Ministry of Public Works (OW)	Responsible for collection and management of solid wastes, hydrological and meteorological services, and civil technical and infrastructural works	Important environmental management agency in public health related matters	Data provider, public awareness roles and supervisory role in the implementation of measures
Ministry of Natural Resources (NH)	Responsible for the use of mineral natural resources and water	Public mandate regarding exploitation of energy sources	Regulating generation and distribution of energy
Ministry of Agriculture, Animal Husbandry and Fisheries (LVV)	Responsible for agricultural development	Agriculture sector and issues are critical to GHG emissions and mitigation issues, and vulnerable to climate change effects	Data provider, technical advisory and awareness roles
Ministry of Transport, Communication and Tourism	Responsible for transport development and regulation	Public mandate regarding developments in the transport sector	Regulating emissions of transport sector and public awareness roles
Planning Office (SPS)	Responsible for developing development plans (OP), district plans and responsible for environmental project planning and management	Specific tasks (planning)	Coordination of integrated planning, provision of related data
Meteorological Service (MDS)	Responsible for collection, analysis, and distribution of atmospheric information	Meteorological information central to all aspects of climate change	Data provider, technical advisory and awareness roles
Maritime Authority in Suriname (MAS)	International marine legislation and monitoring	Specific task regarding marine traffic	Data provider
Foundation for Forest Management and Production Control (SBB)	Responsible for sustainable forest management and production control	National forestry regulator	Protection and sustainable use of carbon storage in forests

Stakeholder name	Stakeholder interests, position and official mandate	Relation to the implementation of the Convention	(Possible) role in the implementation of the Convention
Ministries, institutions and organizations affected by the implementation			
Ministry of Health	Responsible for management and delivery of health services	Health policy and management agency	Data provider, public awareness and participation in technical roles
Energy Company Suriname (EBS)	Sole public distributor of electricity, emission due to fossil fuel use	Vital to GHG emissions and mitigation measures	Data provider and technical roles (implementation of measures)
Suriname Water Company (SWM)	Public supplier of potable water	Water management issues will be critical impact of climate change	Data provider and technical roles (implementation of measures)
National Coordination Centre for Emergency (NCCR)	Responsible for disaster response coordination and management	Information source for climate risk and vulnerability and implementation role for adaptation	Data provider, public awareness and participation in project technical advisory roles
General Bureau of Statistics (ABS)	Provider of statistical data, archiving centre	Important in providing data	Data provider
STAATSOLIE	Crude oil producer	Growing potential in fossil fuel products	Data provider
Mining companies (Suralco, Iamgold etc.)	Large energy users and GHG emitters, and exploiter of the current hydropower plant at Afobaka (Suralco)	Important users of energy and GHG emitters	Data provider, decreasing energy use
Oil import companies (Sol, Texaco etc.)	Importer of aviation fuels and other petroleum products	Important distributor of petroleum products	Data provider
AdeKUS (including its research institutes)	Research and education	Knowledge, expertise and equipment for inventories and (innovative) technological development	Data provider, public awareness and technical advisory roles

Stakeholder name	Stakeholder interests, position and official mandate	Relation to the implementation of the Convention	(Possible) role in the implementation of the Convention
Land Registration and Information System (GLIS)	Responsible for land registration	Important in providing land data	Data provider

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2 NATIONAL GREENHOUSE GAS EMISSIONS 2008

2.1 INTRODUCTION

As mentioned in chapter 1, about 87% 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 economic 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.

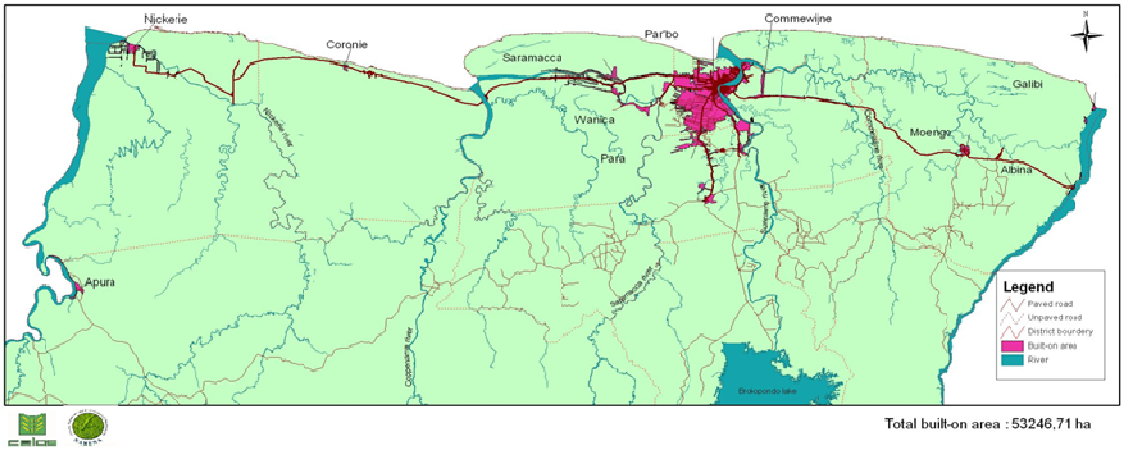

Figure 2.1: Overview inhabited areas coastal region

The agriculture sector, which is predominantly developed in the northwestern part of the country, produces mainly rice and bananas. The Indigenous and Maroon tribes, living in the Hinterland and the Interior, practice shifting cultivation, mainly for subsistence. In the north-central part of Suriname other agricultural products and commodities are dominant, such as vegetables and fish. Land-use changes occur more frequently in the coastal area than in the Interior of the country. Forestry and gold mining are the major economic activities in the Hinterland of Suriname and have shown a steady increase in the production and occupation of land over the years. The activities that use energy from combustion of fossil fuels and the emissions from land use and land use changes are the two most significant sources for CO_2 emission.

2.2 METHODOLOGY

The 2006 IPCC guidelines were used to compile Surinameôs emission estimates for carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). For the energy sector two approaches based on the Intergovernmental Panel on Climate Change (IPCC) guidelines were used to establish the GHG inventory: the reference and sector approaches. ôThe Reference Approachô combines the emissions data from all sectors, whilst the ôSector Approachô focuses on gathered data for each individual sector. Data for the inventory were obtained from governmental sources and private companies and processed with the IPCC 2006 software. Due to *lack of country specific parameter*, default IPCC values where used for most of the inventory. For calculating CO_2 equivalents, the guidelines of the fourth Assessment Report (AR4) IPCC have been used. It should also be noted, that estimations for activity data were unavoidable for those sectors or part of sectors, where data were incomplete or missing. The inventory was compiled for the following sectors: Energy, Industry, Agriculture Forestry and Other Land Use (AFOLU), and Waste. Emission data from international bunkers and marine bunkers, reported separately, is given in accordance with the IPCC guidelines.

2.3 EMISSION INVENTORY OVERVIEW

Carbon dioxide accounts for the greatest percentage of emitted greenhouse gasses in Suriname. The total greenhouse gas (GHG) emission for the inventory year 2008 equals 6,365.75CO_2 Equivalent. The energy sector, with an emission of 3,788.15 CO_2, is the largest GHG source, contributing over 59% of the total GHG emission. Parts of the sector agriculture, forestry and Other Land-Use, act like a sink with an absorption capacity of -8,243.05Gg of CO_2 equivalents, making Suriname a net sink of 1,883.09Gg CO_2eq.).

Table 2.1 below presents a breakdown of the emissions and sinks within the AFOLU sector. Figure 2.2 presents the emission balance by each sector.

Table 2.1: Overview of CO_2 sinks of the year 2008

Sinks	GgCO_2		Emissions	Gg CO_2
Forestland Remaining Forestland	-1007.071		Grassland	81.054
Cropland Remaining Cropland	-7241.770		Other Land	1740.200
Total sinks	**-8248.858**			

Within the category Industrial Processes and Product Use (IPPU) GHG emissions are released as a result of alumina production. For Suriname, the Mineral Industry does not contribute to the GHG emissions for the Industry sector.

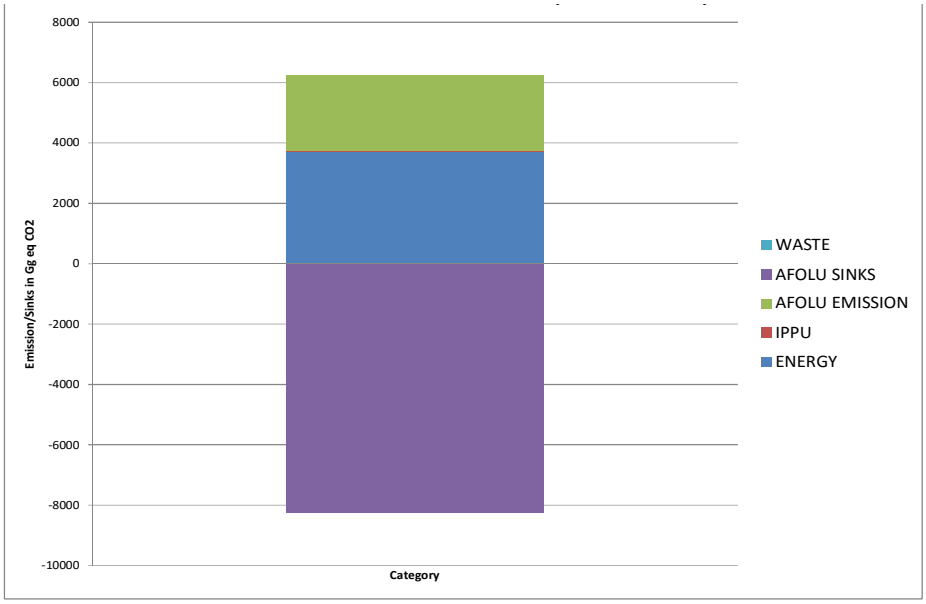

Figure 2.2: Emission balance from 2008(sinks included)

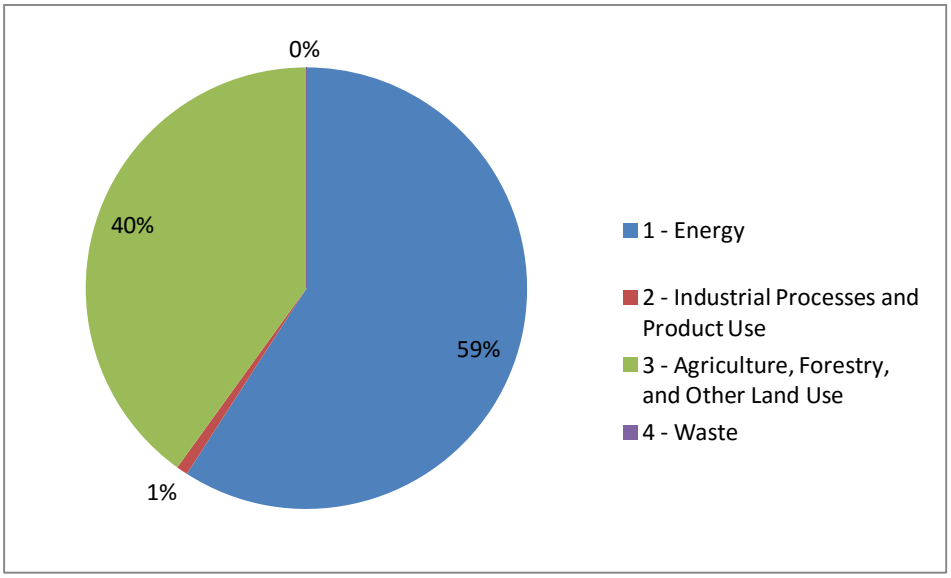

Figure 2.3: Overview 2008 emission distribution (in CO_2 equivalents; sinks not embedded)

The figures above show that the energy sector is the main source of GHG emissions, contributing to about 59% of the total emissions. Emissions from the AFOLU sector are due to the utilization of tropical forests for wood logging purposes, including logs for the export. Forest clearing for shifting cultivation and deforestation for gold mining purposes also contributes to the GHG emissions of this sector. Taking into account that the forest is a main sink, the overall contribution of the AFOLU sector is much smaller than that of the energy sector.

2.4 GHG INVENTORY BY SECTOR

2.4.1 EMISSIONS FROM THE ENERGY SECTOR

The Energy Sector is the most significant contributor to GHG emissions. Hydropower, hydrocarbons and bio-mass are utilized as primary energy sources. The majority of hydropower is generated by the hydropower plant in the district of Brokopondo. Since the closure of the aluminum smelter in 1999, most of the energy from this power plant is delivered to the local energy company (EBS).

The energy demands of the coastal zone are met by hydropower and thermal power stations. On the other hand, the Hinterland has no professional continuous energy supply system. Electricity is provided through the use of diesel generators.

Within the energy sector, road transportation is the main consumer of fossil fuels. Most of the HFO delivered by the local oil company (Staatsolie NV) is used for electricity generation and as input for the bauxite industry. Some export and international bunkering also exists.

The various contributors to the 2008 GHG emissions within the energy sector are given in the following Table 2.2 and Figure 2.4. The Manufacturing Industry and Construction sector is the largest contributor. The main contributors within this sector are ôNon-specified Industryô (1,451.52 Gg CO_2) and ôMining and Quarryingô (209.28 Gg CO_2).

Table 2.2: GHG contribution from the various energy sectors in Gg CO_2 equivalents from the year 2008

Categories	Emissions (Gg) in CO_2 Equivalents							Total
	CO_2	CH_4	N_2O	NOx	CO	NMVOCs	SO_2	
International Bunkers	102.24	0.02	0.06	NE	NE	NE	NE	102.32
1.A.3.a.i - International Aviation (International Bunkers) (1)	102.23	0.02	0.06	NE	NE	NE	NE	102.31
1.A.3.d.i - International water-borne navigation (International bunkers) (1)	0.01	NE	NE	NE	NE	NE	NE	0.01
1 - Energy	**3788.15**	**3.36**	**7.48**					**3798.99**
1.A - Fuel Combustion Activities								
1.A.1 - Energy Industries	**120.54**	**0.01**	**0.03**					**120.94**
1.A.1.a.i - Electricity Generation	120.54	0.07	0.00	NE	NE	NE	NE	120.94
1.A.2-Manufacturing Industries and Construction	**2912.47**	**2.83**	**6.75**					**2922.05**
1.A.2.c - Chemicals	0.01	NE	NE	NE	NE	NE	NE	0.01
1.A.2.e - Food Processing, Beverages and Tobacco	3.01	NE	0.01	NE	NE	NE	NE	3.02
1.A.2.i - Mining (excluding fuels) and Quarrying	209.28	0.21	0.50	NE	NE	NE	NE	209.99
1.A.2.k - Construction	0.03	NE	NE	NE	NE	NE	NE	0.03
1.A.2.m - Non-specified Industry	1451.52	1.41	3.36					1456.28
1.A.3 - Transport	**622.46**	**0.01**	**0.20**					**622.67**
1.A.3.a - Civil Aviation	116.16	0.02	1.04	NE	NE	NE	NE	117.22
1.A.3.a.ii - Domestic Aviation	13.93	NE	0.12	NE	NE	NE	NE	14.05
1.A.3.b - Road Transportation								
1.A.3.b.i - Cars	598.49	NE	NE	NE	NE	NE	NE	598.49
1.A.3.d.ii - Domestic Water-borne Navigation	0.08	NE	NE	NE	NE	NE	NE	0.08
1.A.3.e.ii - Off-road	5.02	0.01	0.08	NE	NE	NE	NE	5.11
1.A.4 - Other Sectors	**132.68**	**0.40**	**0.25**					**133.33**
1.A.4.a - Commercial/Institutional								
1.A.4.b - Residential	37.99	0.08	0.02	NE	NE	NE	NE	38.09
1.A.4.c.i - Stationary	19.12	0.06	0.05	NE	NE	NE	NE	19.23
1.A.4.c.ii - Off-road Vehicles and Other Machinery	10.07	0.03	0.02	NE	NE	NE	NE	10.13
1.A.4.c.iii - Fishing (mobile combustion)	65.50	0.01	0.01	NE	NE	NE	NE	65.88

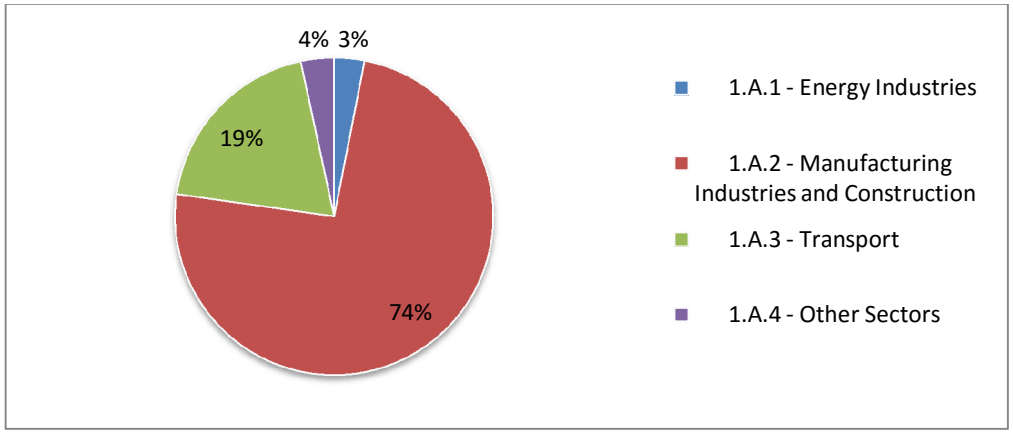

Figure 2.4: 2008 GHG distribution Energy sector in CO_2 equivalents

2.4.2 EMISSIONS FROM INDUSTRIAL PROCESSES

The Surinamese economy is dominated by three industries: namely bauxite, oil and gold. These three industries together generated approximately 90% of Surinameôs export figures for 2008.

There is little production in the category of food and beverages, but otherwise, almost all consumer goods - especially electronics - are imported. This is reflected in the GHG inventory for Industry. With very little industrial activity, emissions in this category are found to be low.

The mineral industry does not produce any emission of significance, while the alumina production is the only producer of process determined emissions in the metal industry. About 53.20 Gg CO_2 is being emitted yearly.

In 2008 asphalt paving could have potentially lead to 270.6 ton asphalt, which is equal to 86,59 kg NMVOC or 86.59Gg NMVOC[9].Although this seems higher than the amount which is actually used, it gives the scope of maximum impact from this industrial activity.

2.4.3 GHG EMISSIONS FROM AFOLU SECTOR

As mentioned before, the AFOLU sector forms the only sink of GHGs for 2008. With an absorption figure of -8,243.05 $GgCO_2$, this sector compensates for all the emissions from other emitters.

2.4.3.1 GHG EMISSIONS FROM THE AGRICULTURAL SECTOR

The majority of agricultural activities take place in the Young Coastal Zone. The main emission sources in this sector are rice and banana cultivation in the coastal zone. Incineration of organic residues in agricultural fields and the processes of enteric fermentation and manure management associated with the livestock sector are also major contributors. These emissions do not include emissions resulting from energy use in the sector. The agricultural sector was responsible for 952.57 $GgCO_2$ equivalents. The small

[9] One tonne asphalt produces 320 kg NMVOC

increase (10 ha annually) of the shifting cultivation area in the Interior has very little effect on the total GHG emissions in this sector. The Figure 2.5 offers an overview of the distribution of GHG's from agriculture.

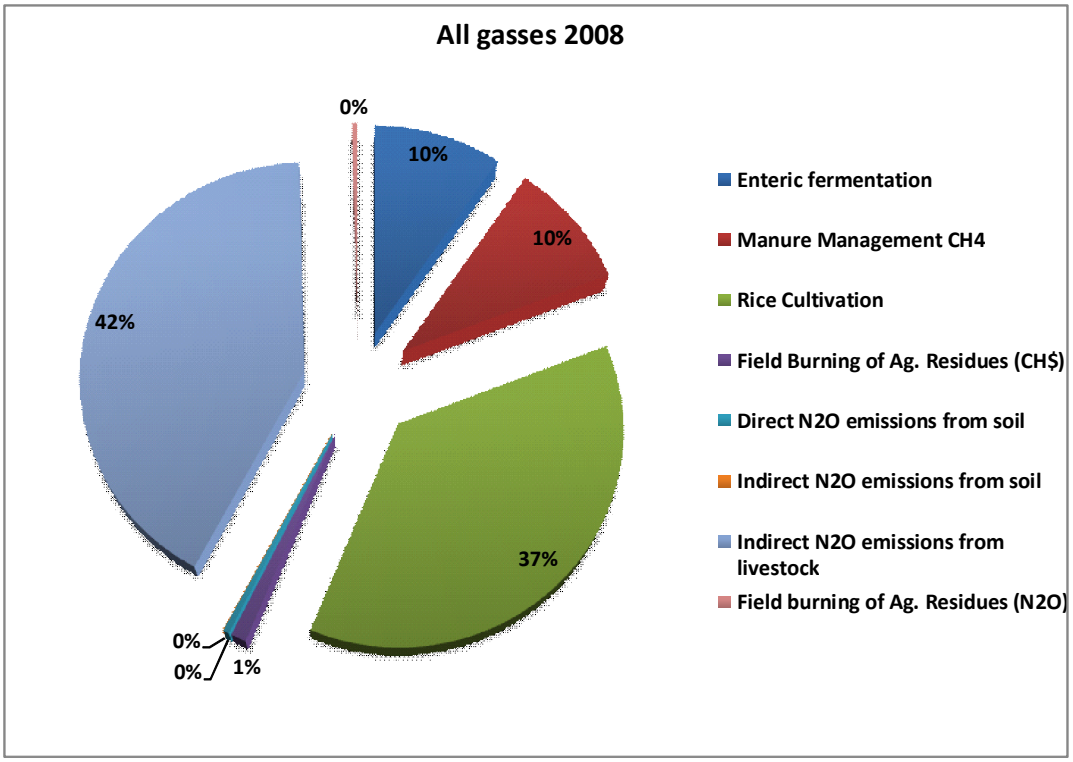

Figure 2.5: Distribution of GHG's within the agriculture section from the year 2008

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 to about 474.53Gg CO_2 eq. 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 released equals 31.5 Gg and 0.44 Gg nitrogen.

Methane Emission from Animals

The total emission from domestic livestock amounts to 89.33GgCO_2 equivalents with cattle,

both dairy and non-dairy and comprising 46% and 48% of the total with regard to enteric fermentation, respectively. With regard to manure management the distribution is different; the largest contribution comes from dairy cows. This is reflected in the Figure 2.6 and Figure 2.7.

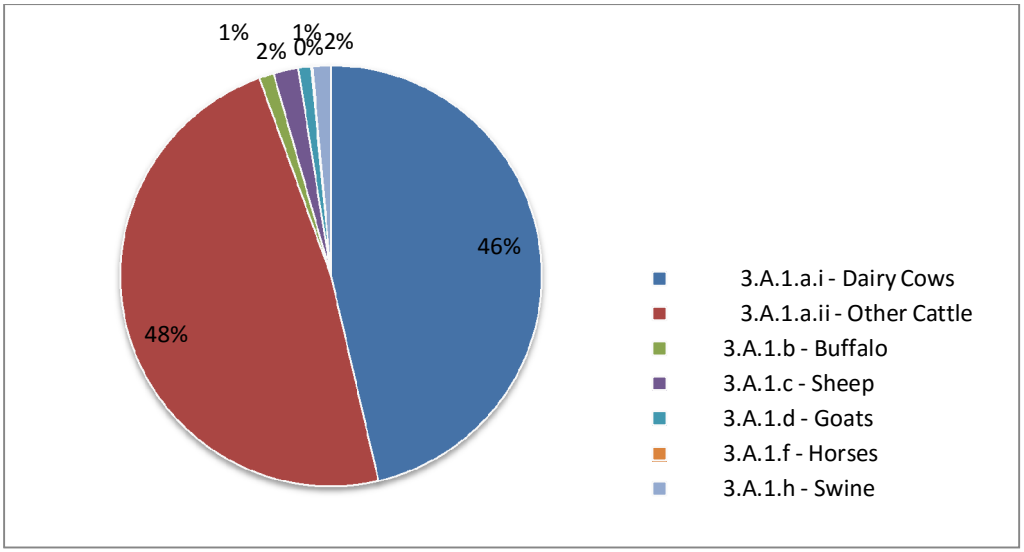

Figure 2.6: Livestock emission in CO2 equivalents (enteric fermentation) from the year 2008

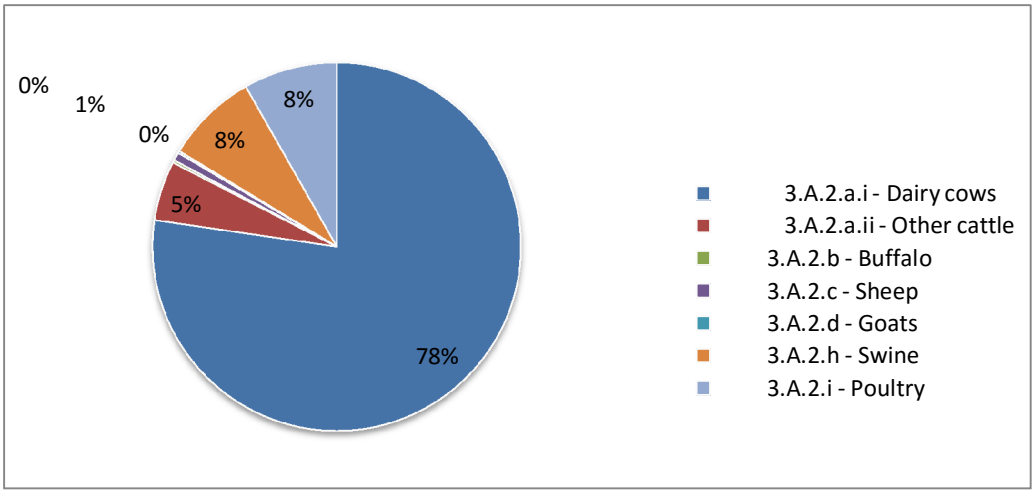

Figure 2.7: Emissions from livestock in CO_2 equivalents (manure management)from the year 2008

2.4.3.2 EMISSIONS FROM FORESTRY AND OTHER LAND USE

The GHG inventory for the AFOLU sector entails the collection of data from the agricultural sector, the forestry sector and data on land use. In addition, a section for aggregate sources

and non-CO_2 emission sources on land and a section on harvested wood products (HWP) are part of the inventory. The latter is not included in this inventory, because no long term data on wood production, export and import are available.

Priority gases from the AFOLU sector are CO_2 for land use and the non-CO_2 trace gas CH_4 for the aggregate sources.

Land-use activity data was collected by using approach 2 of the IPCC guidelines, since spatially-explicit location data was not available with the registered changes. Surinameôs lack of a national data base for land management proved to be a constraint in the data collection. In the absence of a central unit, land use data are collected and presented by sector institutions responsible for the monitoring of the specific land use category.

The effective forest production over the last forty years for the category *Managed Forest land* is calculated to be 500,000 hectares in total. The long term average annual production of round wood was 180,000m^3 and the average production per hectare 12-15m^3 for this period. The re-vegetated sites of the mined out bauxite areas with trees which have not yet reached maturity (in total 650ha in 2008) are also included in the calculations for managed forest.

Information on the area with *Managed Cropland* is derived from the statistics of the ministry of Agriculture, Animal Husbandry and Fisheries (LVV). The permanent cropland in the coastal zone (88,800 ha) is calculated on the basis of FAOôs long term statistics for Suriname. The farming practices carried out in the Interior can be categorized as shifting cultivation. Through remote sensing the area under cultivation was estimated at 238,630ha in 2000. The abandoned palm oil plantations cover an area of 1,900ha.

Data on *Managed Grassland* was derived from the statistics of LVV. These figures show that pasture land in the coastal region covered an area of 27,000ha and 1,300ha in the Interior in the year 2000. The total land area of grass and herbaceous savannas, which are subject to regular burning by the Indigenous population, was estimated to be 124,900ha through remote sensing.

The hydro energy lake is the only *Managed Wetland* in Suriname. Through remote sensing the open water area of this lake (excluding the islands) was estimated at 125,500ha.

Extraction of peat is expected to occur to a certain extent, but only scattered and on a minor scale.

The area in the land use category *Settlements* constitutes of both the villages and other settlements in the Interior and the urban areas of the coastal region.

The mining areas fall under the category *Other land* and were calculated to be 8,600ha in 2000 using remote sensing. Additional information on land use for bauxite mining in the Moengo area was made available by the Suralco.

Land use changes in the time period 2000- 2008 are: 1) the removal of mesophytic forest for the purpose of gold mining (3,100 ha per year) or shifting cultivation (10 ha per year), 2) reforestation of the mined out bauxite areas (50 ha per year), and 3) changes in carbon content of grassland when converted back into unproductive agricultural land (on average 1,100 ha per year).

Although there were some very small and dispersed increases in both the urban settlements and villages in the Interior in the period 2000-2008, these were not clearly detectable on the satellite images used for the inventory (Landsat and Google Earth). Therefore, the changes in the land use categories *Settlements* and *Wetlands* were negligible for this inventory period.

In the category *Forestland remaining Forest land,* the biomass calculations in the wood production area are done for losses in biomass due to: 1) timber production (with a total quantity of 197,000m^3 round wood in 2008), 2) fuel wood removals (450m^3 in 2008) and 3) disturbances of forests. In addition to the commercial extraction of fuel wood in the production forest some subsistence collection of this assortment occurs in the category *Forestland converted to Cropland* (in the shifting cultivation areas). However, no information on the collected volumes is available. Furthermore, there is no evidence of loss of carbon through wood and fuel wood removals in the conversion of bauxite mines to Suralco plantations.

Losses from disturbances by fire, insects, diseases, or other disturbances are only calculated if these are of anthropogenic origin. There is no evidence of significant disturbances in the category *Forest Land* in the inventory period.

To calculate the total biomass losses, the higher range of the IPCC default value for the biomass conversion factor and expansion factor for humid tropical natural forest with a growing stock level of more than 200 m^3/ha is used for Surinameôs natural forests; (BCEF = 1.1). To calculate the carbon content, a higher wood density of 0.65 than the IPCC default value (0.6 ton/m^3) is used as an average for the commercial wood species in Suriname.

The biomass increase in the category *Forest land remaining forest land* occurs in the wood production area (calculated on approximately 612,800ha in 2008) which will re-grow after harvesting and in the re-vegetated bauxite mined out areas of Suralco. In 2008 this area covered 650 ha. To estimate this aboveground biomass growth increment - because of the country specific situation of low harvesting volumes per hectare and a consequent low rate of re-growth - the CELOS figure (1 ton annual increment/ha) of *de Graaf* is used.

The default assumption of the IPCC for belowground carbon stock change in the category *Forest land remaining Forest land* is zero. Annual increase of biomass in the plantation forest is calculated through the annual carbon increase figure of 20 to dry matter per hectare (IPCC default for plantations).

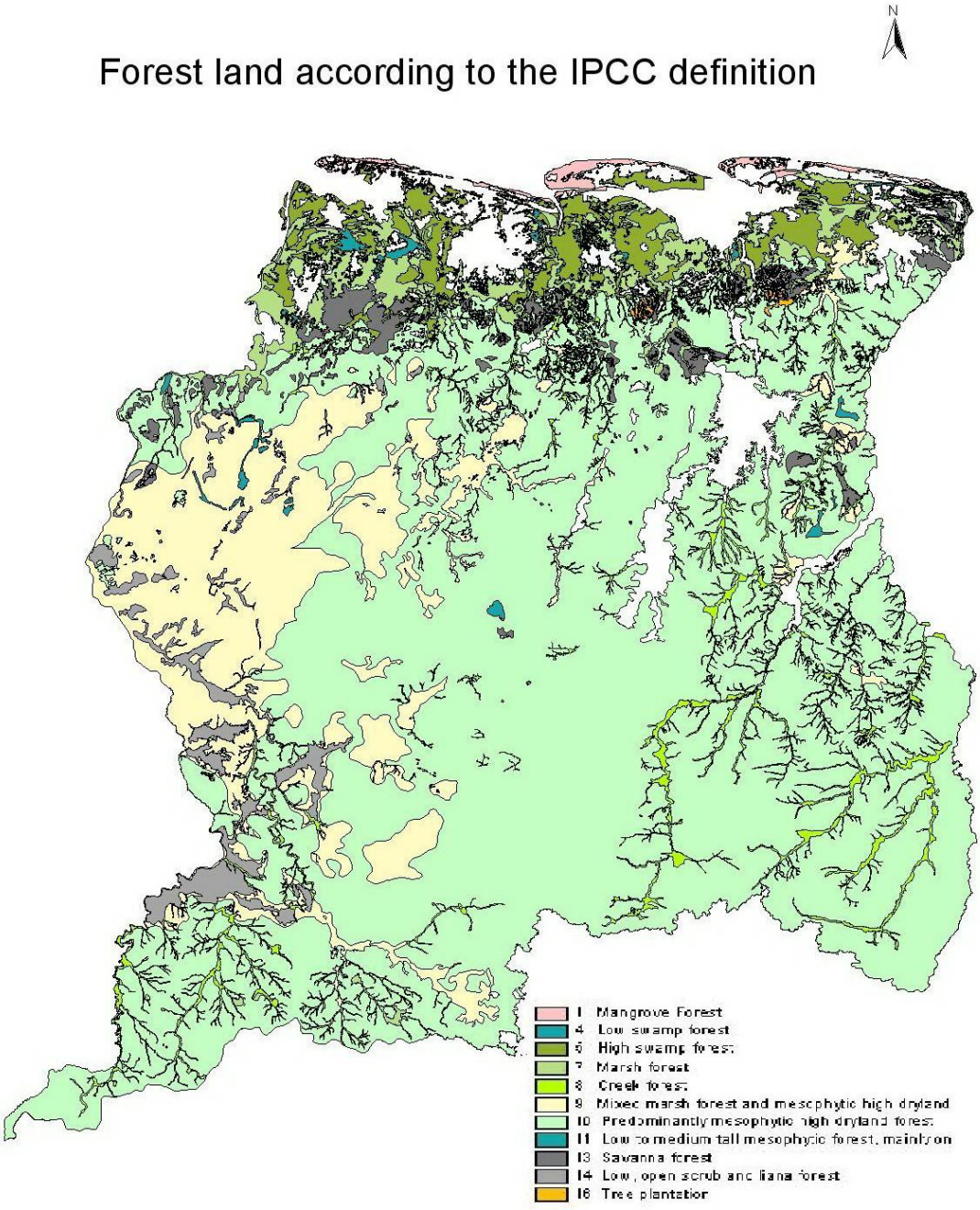

Figure 2.8: Total forest land

For *Cropland remaining Cropland* the calculations of changes in above ground biomass in *Cropland* are only made for perennial woody crops. The aboveground woody biomass is estimated at 50 ton/ha[10] for each single crop type. For the shifting cultivation areas the IPCC default factor for South America Humid Tropical (low) agro-silvicultural systems of 70.5 ton/ha is used.

The assumption is made that dead wood and litter stocks are not present or at equilibrium.

No estimates of the carbon stock changes for these pools are made. With regard to the below-ground biomass in the Tier 1 method the default assumption is that this is not changing for perennial trees in agricultural systems.

The carbon fluxes in the land use category *Cropland* depend on crop type, management practices, and soil and climate variables. From the different crops loss of biomass through harvesting of products occurs for the crop types of fruit trees and coconut. No information is available on the quantities of the harvest in the shifting cultivation fields. An estimate is made of 5 ton C/ha/year which could be extracted from the fields. With a carbon fraction of dry matter for aboveground biomass of 0.47 ton C (ton dm) and an average annual harvest of approximately 10 ton dm per ha, the biomass carbon loss due to harvest for coconut and fruit trees plantation are also calculated on 5 ton C/ha/year. There is no harvesting from oil palm and abandoned areas. Biomass carbon loss due to gathering or disturbance in each of the crop types is set at zero. The net annual growth rate in each of the crop types is estimated at 10 ton C/ha/year. For the mature oil palm plantations, the net annual growth rate is estimated at zero.

To estimate fluxes in soil carbon stocks in the absence of country data the IPCC default values for the stock change factors of crop types are used. The time dependence of the stock change factors is by default (IPCC) set on 20 years. In addition to the productive cropland an area estimated in the inventory year at 47,500 ha, which is currently not in production, is re-growing to a form of fallow vegetation. The net annual growth rate is estimated at1 ton C/ha.[11]

[10]IPCC default factor for cropping systems containing perennial species in tropical wet climates.
[11]IPCC default value for tropical shrub land

In GHG inventories, where a Tier 1 method is used, it is assumed that at the conversion to cropland all carbon contained in the biomass which is killed will be emitted directly to the atmosphere and none is added to the dead wood and litter pools. It is furthermore assumed that the entire carbon quantity in the dead wood and litter pool are lost in the year of the transition.

This is not really true in the case of deforestation for shifting cultivation, and to a certain extent for mining. However there are no national data available to use a higher Tier.

Grassland

For *Grassland Remaining Grassland* carbon fluxes are the result of changes in management practices on carbon stocks. In Suriname no significant changes in the type or intensity of management of grassland has been the case in the inventory period. Therefore Tier 1 method is used which assumes that there are no changes in the biomass content.

Cropland converted to grassland in the current inventory period is the case when unproductive polder land is replaced by grassland (almost solely herbaceous vegetation). An average of 60 ha polder land per year was converted to grassland with herbaceous vegetation in the inventory year.

Other land use categories

Inventory of the Land use category *Wetlands* is restricted to the managed wetlands. The most important land type under this land use category in Suriname is the hydro energy lake, officially known as the Brokopondo Lakeô. However, for *Flooded Land Remaining Flooded Land* no methodologies are provided in the IPCC guidelines and therefore no further calculations are made for emissions from this land type.

Peat land, as a second potential source of carbon fluxes, exist in Suriname under the geomorphologic land unit ñthe Mara landscapeò in the coastal zone. The total area of the peat land is estimated at approximately 450,000 hectare. Extraction of peat however, is rare and this land type is therefore not taken into consideration in this inventory.

The land types in the category *Settlements* in Suriname (the urban and the rural settlements) are considered to be established on mineral soils. Both the urban and the rural settlements contain in some parts a substantial amount of vegetation with woody and herbaceous components. However, no data is available on the extent and the changes which occur in the vegetation in this land use category. The Tier 1 method is therefore used, which assumes that the growth and losses of the biomass are in balance. Furthermore it is assumed that the dead wood and litter stocks are at equilibrium and that soil C stocks do not change.

With regard to the land use category *Other land* the emissions in this inventory are calculated from the conversion of *Forest land* to *Other land* which are solely represented by the mining areas in this inventory period. It is assumed that the forest vegetation is removed entirely and no biomass remains on the land after conversion.

Suralco has reported that the land disturbed for bauxite mining in the Mungo area is estimated in December 2010 at approximately 2418ha. Of this land about 1,150ha is re-vegetated.

In addition, forest land converted to gold mining areas in the inventory year is estimated at 27,900ha in total. The following Figure 2.9 shows the areas with gold exploitation activities.

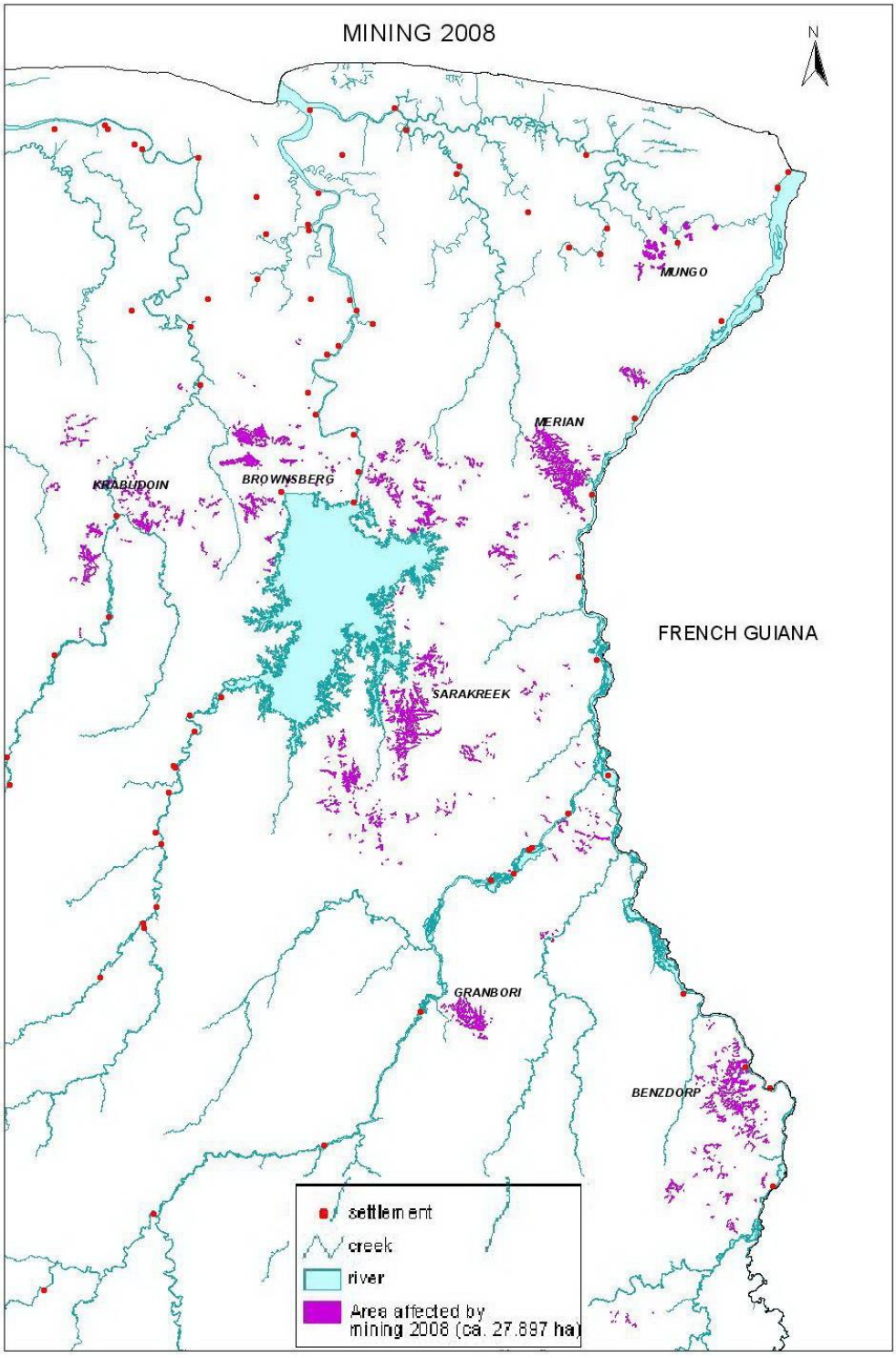

Figure 2.9: Gold Mining activities across the country

To calculate the annual change in carbon biomass for the forestland converted into mining area the carbon content before conversion is set at 300 ton dm per ha (tropical forest of Suriname) with a carbon fraction of dry matter of 0.5 ton C per ton dm. Since the total amount of biomass is removed and no re-growth takes place, the annual loss of biomass carbon is assumed to be 300 ton dm per ha and the re-growth zero.

Non-CO_2 emissions

Non-CO_2 emissions are usually associated with burning of biomass. In the category Cropland this is represented by the burning of agriculture residues whereby only the crop type rice goes through regular burning. Furthermore, sometimes small scale farmers with permanent cropping systems in certain (usually mixed) crop types also use burning as part of their land preparation. The total rice area, which is estimated in the inventory year at 43,700ha, is burned. The shifting cultivation area burned in the inventory year is calculated at16,000 ha and for the crop types legumes, vegetables and other annual crops is assumed that not more than 10% of the land in production is burned. In the land use category *Grassland* the native savannah is burned on a regular basis to maintain the savannah structure. It is estimated that 2% of the area is burned in the inventory year. There is no burning in the managed forest land (production forest and Suralco rehabilitated areasô) and in the land category *other land*. In the land category *Settlements* it is expected that some burning of biomass has occurred but no data on the extent of this practice and the volumes involved are available. The IPCC default values for fuel biomass consumption, the combustion factor and emission factor are used to calculate the emissions.

Results

Total annual CO_2 removals are calculated at 5,409.83Gg. The major categories for carbon fluxes identified are:

1. Forest land Remaining Forest land (1,007.07Gg CO_2); and
2. Cropland Remaining Cropland (7,241.77Gg CO_2) as the two main sinks;
3. Forest Land converted to Other Land, due to forest land converted to mining area, is the main emitter (-1,740.2 Gg CO_2).

Emissions from biomass burning are calculated at 3.56Gg CH_4 with as major source biomass burning of cropland due to the conversion of forest land into shifting cultivation fields. The gases N_2O, NO_x, CO en NMVOCs are not applicable to this GHG inventory subcomponent.

The following Figure 2.10 and Figure 2.11 show the distribution of the 2008 emissions and sink sources by land use type. The rice cultivation areas represent the largest amount of CO_2 equivalent emission, while grassland remaining grassland is the largest sink.

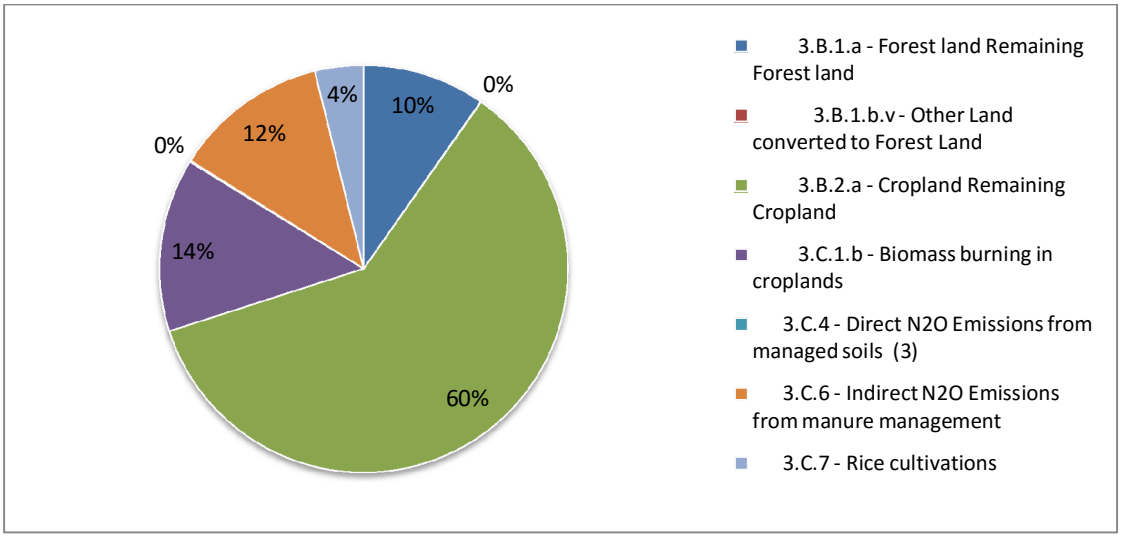

Figure 2.10: Emissions by land-use type (CO_2 equivalents)from 2008

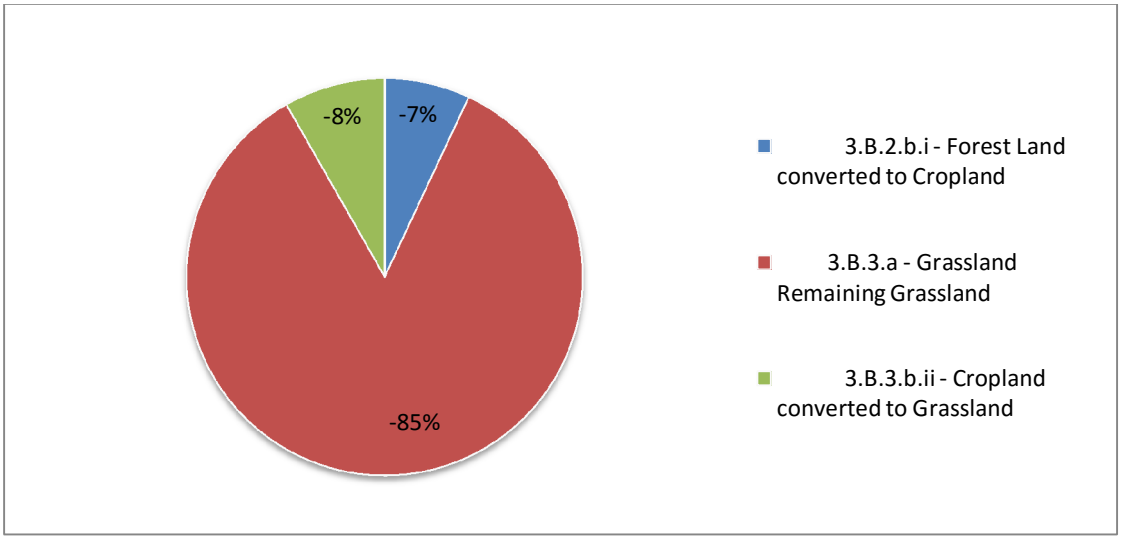

Figure 2.11: Sink sources in CO_2 equivalents from 2008

2.4.4 EMISSIONS FROM WASTE

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 through 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 less than one Gg. In the remaining area, including the Hinterland, where the population concentration is extremely low, methane emission from solid waste is negligible. To date wastewater management and/or treatment are not practiced in Suriname, making it impossible to determine possible emissions.

2.5 GHG EMISSIONS BY GAS

2.5.1 EMISSIONS OF CARBON DIOXIDE (CO2)

The total carbon dioxide emissions in 2008 were about 3,783.21Gg. This amount is based on emissions emitted by the energy sector through combustion of fossil fuels (about 2,442Gg, using the reference approach), urea application and liming within *Agriculture* and *Other Land Use* (about 8.59Gg) and emissions emitted through industrial process (about 53Gg).

2.5.2 EMISSIONS OF METHANE (CH_4)

Methane emission originates mainly from the agricultural sector. The CH_4 emission for 2008 has been calculated to be 26.15Gg. The following table and figure show, that most of these emissions comes from aggregate sources and non CO_2 emissions on land. Rice cultivation is the largest contributor within this group (18.98Gg). Emissions from waste are negligible.

Table 2.3: CH4 emissions in 2008

2008 CH_4 Emissions by (sub)sector	Gg
Energy (total)	0.13
Livestock	3.57
Aggregate sources and non-CO_2 emissions sources on land	22.58

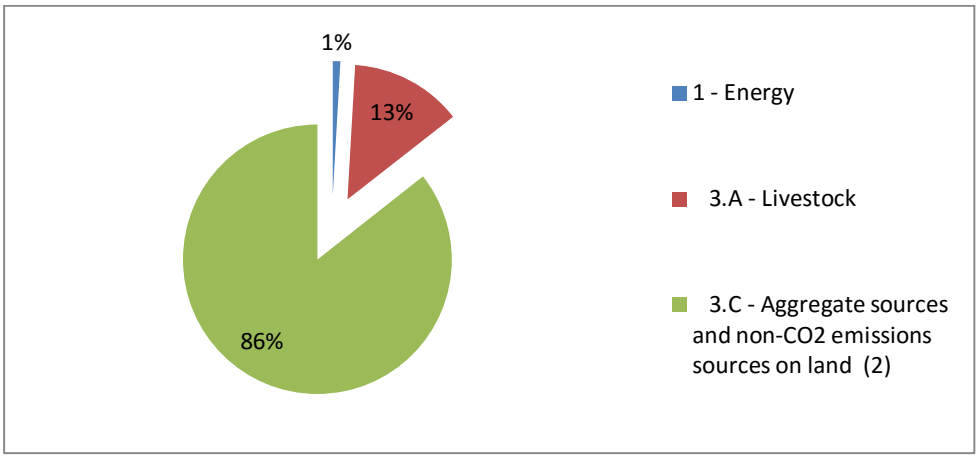

Figure 2.12: CH_4 Emissions by Sources in 2008

2.5.3 EMISSIONS FROM OTHER GASES

The other emission figures, although some have a large global warming potential, are relatively small. This is reflected in the following table. The N_2O emission comes mostly from manure management.

Table 2.4: N_2O emissions by source in 2008

Categories	N_2O emissions in Gg
Electricity Generation	0.005
Non-Metallic Minerals	0.010
Mining (excluding fuels) and Quarrying	0.002
Non-specified Industry	0.011
Fishing (mobile combustion)	0.001
Direct N_2O Emissions from managed soils	0.063

2.6 KEY CATEGORIES

The top ten emitters are compiled in the table and figure below. The subsector *Manufacturing Industries and Construction* leads this list with 2,922.05Gg CO_2 equivalents. Although almost half of these emitters fall within the AFOLU group, there are a few remarkable players in this top ten list. The AFOLU as a whole is a net sink in the GHG inventory, but the second largest emissions in the country come from the subsector "Other Land'. The transport sector is the third most important emitter. Within the sector ñManufacturing Industries and Constructionò the most important emitter is ñNon Specified Industriesò

followed by ñNon Metallic Mineralsò and ñMining and Quarryingò. Other sectors within this group are negligible.

Table 2.5: Top ten emitters of 2008

Top emitters 2008	TOTAL CO_2 equivalent
1.A.2 - Manufacturing Industries and Construction	2922.05
3.B.6 - Other Land	1740.2
1.A.3 - Transport	622.20
3.C.7 - Rice cultivations	474.53
1.A.4 - Other Sectors	133.33
1.A.1 - Energy Industries	120.94
3.C.1 - Emissions from biomass burning	93.94
3.B.3 - Grassland	81.05
3.A.1 - Enteric Fermentation	71.89
2.A.4 - Other Process Uses of Carbonates	53.20

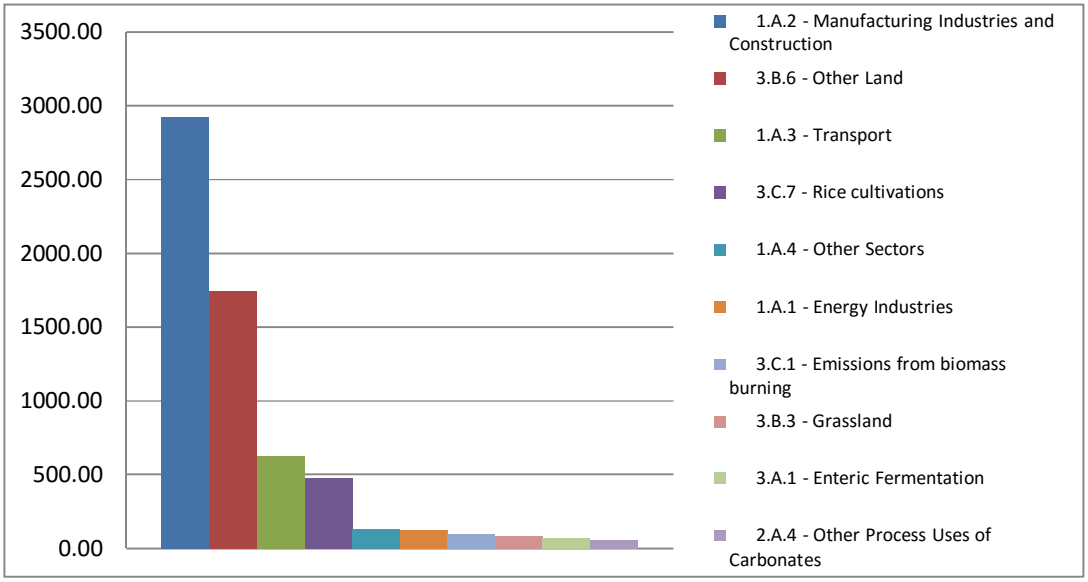

Figure 2.13: Top ten emitters for 2008

2.7 UNCERTAINTIES

An uncertainty analysis for 2008 has been completed for the most significant gases (CO_2, CH_4 and N_2O) of the 2008 emission for the *energy sector*. For this analysis 2005 has been

used as the base year. Generally the activity data uncertainties are within a 5 ï 12% range. The emission factor uncertainties are also in this range, which makes the combined uncertainties between 7% and 17%. The highest uncertainty values are found in the *manufacturing Industries* for both CO_2 and CH_4 emissions from the use of liquid fuel.

Uncertainty introduced into the trend in total national emissions, show to be very low (less than 0.01%). Only in the manufacturing industries this uncertainty is about 9%.

2.8 CO_2-EMISSIONS (REFERENCE APPROACH)

For the estimation the CO_2 emissions, the IPCC default values of the carbon emission factor and combustion efficiency were used, as provided by the IPCC-manuals. In the table 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 2008. The calculated total emissions using the *Reference Approach* is 3,249.91Gg CO_2.

Table 2.6: Apparent consumption and actual CO_2 emissions (Reference Approach).12 for 2008

	Apparent Consumption	Actual CO_2 Emissions
	TJ	$GgCO_2$
Crude Oil	0.000	0.00
Motor Gasoline	72.200	340.30
Aviation Gasoline	0.574	1.76
Jet Gasoline	36.630	113.64
Jet Kerosene	0.842	0.88
Gas/Diesel Oil	127.000	521.89
Residual Fuel Oil	710.320	2177.16
Liquefied Petroleum Gases	14.000	40.72
Naphtha	4.460	12.21
Lubricants	9.600	35.34
Total		**3249.91**

[12]In this list crude oil produced by Staatsolie is embedded in Residual Fuel Oil according to IPCC guidelines.

The domestic emissions from energy sources in 2008 accounted for 3,788.15Gg CO_2. The emissions from international bunkers[13]were 101.23Gg CO_2. There is negative difference of about 548Gg compared to the sector approach. This difference can be explained with the uncertainties of the different datasets. The uncertainties are in line with those of previous years.

2.9 INTERNATIONAL BUNKERS

According to IPCC guidelines emissions from international bunkers are excluded as from the total emissions. The total CO_2 emissions from international bunkers equals 101.23Gg and is composed of emissions from *Aviation and Marine* with an emission of 101.22Gg and 0.007Gg of CO_2 respectively (see Table 1.1 below).

Table 2.7: Emissions from international bunkers in Gg for 2008

Category	CO_2	CH_4	N_2O
International Aviation (International Bunkers)	101.22	0.015	0.062
International water-borne navigation (International bunkers)	0.007	0.000	0.000

2.10 EMISSIONS FORECASTS

2.10.1 ENERGY

Although the energy demand has increased in the past years, fuel combustion activities show a very inconsistent behavior over the past four years with reliable data. Especially CO_2- emissions show a strong increase from 2005 to 2006. Almost the same increase of about 450.00Gg CO_2 equivalent can be observed from 2007 to 2008. These changes reflect the variation in climatological conditions in the country. Years with abundant precipitation allow increased production of hydropower and lower the use of hydrocarbons.

[13] International bunker fuels under the UN Framework Convention on Climate Change (UNFCCC), are not included in national emission totals, but are to be reported separately based upon location of fuel sale

It should be mentioned here, that despite the relative óstableô emissions as showed by the reference approach, the energy use has increased in the past years. A shift from electricity production to other sectors can be observed. Especially the sector *Manufacturing Industries and Construction* shows a strong growth in this period. This is reflected in the Table 2.8 below. Figure 2.14 shows that in the future the demand for energy for this sector will increase up to 823MW by 2025. This development is described in the Mitigation chapter. However, only less than 9% will come from fossil fuel combustion.

Table 2.8: GHG gases from Energy sector for the period 2005 - 2008

	2005			2006			2007			2008		
IPCC 2006 Categories	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Reference approach	**3003.00**			**2853.00**			**3019.00**			**3018.52**		
Fuel Combustion Activities	2356.06	0.08	0.01	2795.14	0.08	0.01	2679.78	0.08	0.01	3783.21	0.08	0.01
Electricity generation	182.00			504.00			453.00			120.54		
Manufacturing Industries and Construction	1576.99	0.06	0.01	1655.62	0.06	0.01	1637.61	0.06	0.01	2912.47	0.06	0.01
Chemicals	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.07	0.00	0.00
Food Processing, Beverages and Tobacco	2.38	0.00	0.00	2.60	0.00	0.00	2.54	0.00	0.00	3.01	0.00	0.00
Mining (excluding fuels) and Quarrying	137.71	0.01	0.00	185.39	0.01	0.00	177.72	0.01	0.00	209.28	0.01	0.00
Construction	0.03	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00
Non-specified Industry	1436.86	0.06	0.01	1467.61	0.06	0.01	1457.32	0.06	0.01	1451.52	0.06	0.01
Transportation	446.00			504.00			453.00			617.52		
Other Sectors	151.08	0.02	0.00	131.52	0.01	0.00	136.17	0.01	0.00	132.68	0.01	0.00
Residential	38.00			37.00			39.00			37.99		
Agriculture/Forestry/Fishing	113.08	0.02	0.00	94.52	0.01	0.00	97.17	0.01	0.00	94.69	0.01	0.00
Stationary	18.74	0.00	0.00	19.00	0.00	0.00	18.36	0.00	0.00	19.12	0.00	0.00
Off-road Vehicles and Other Machinery	8.20	0.00	0.00	8.36	0.00	0.00	7.95	0.00	0.00	10.07	0.00	0.00
Fishing (mobile combustion)	86.14	0.01	0.00	67.15	0.01	0.00	70.86	0.01	0.00	65.50	0.01	0.00

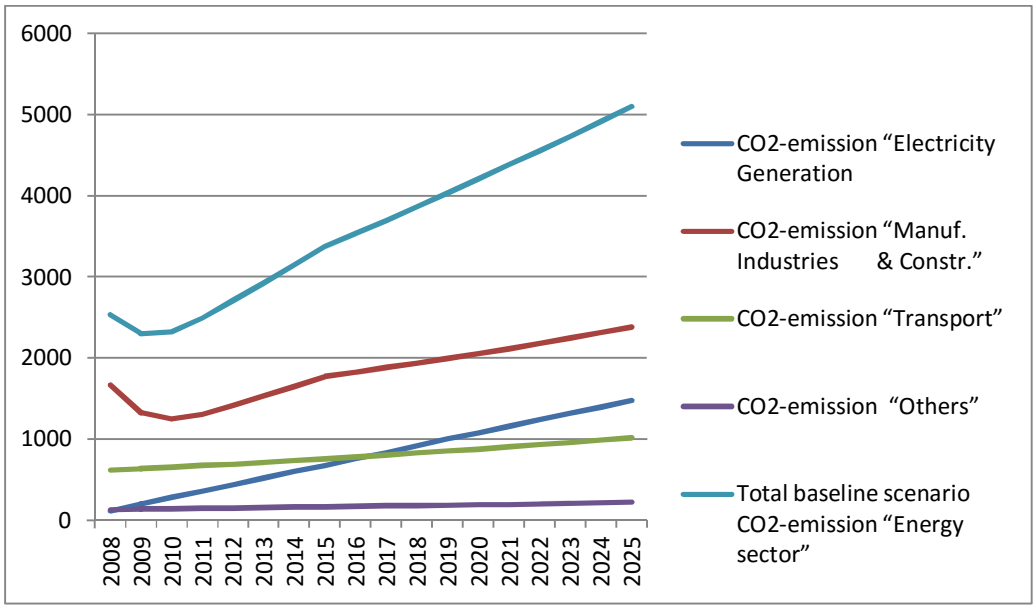

Figure 2.14: Future emission development for the period 2008- 2025 for the energy sector

It is expected, that only in the manufacturing industry and electricity generation, important expansion of GHG emission will occur.

2.10.2 MANUFACTURING

Within the category *Industry*, emissions are heavily dominated by the *Bayer process* of Suralco; in which limestone (lime) is used for the production of Alumina. Products that contain fluorinated gasses (air-conditioning, refrigerators and aerosols) undoubtedly have an effect. It has, however, not been possible to quantify those accurately.

Changes within the bauxite industry are not expected in the near future. Based on a defined bauxite quality, Suralco has a maximum capacity of 2.2 million tons of Alumina per year, which was almost reached in 2007 and 2008. Neither the use of white spirits nor fluorinated gasses is expected to increase significantly in the near future. On the contrary, heavy fluorinated gasses will slowly start to phase out because of stricter worldwide regulations. There are some NMVOC emissions associated with asphalt production, as well as the use of white spirit containing products. Emissions from *Asphalt* however, might increase in the near

future. As Suriname has started some ambitious road projects, a rough calculation indicates NMVOC emissions could increase significantly.

2.10.3 EMISSION FROM AGRICULTURE FORESTRY AND LAND USE

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

Table 2.9: Emissions from agriculture for the period 1994, 2002 - 2008

Gas Source	1994	2002	2003	2004	2005	2006	2007	2008	2009
CH_4 (Total)	33.52	2521	31.83	20.96	22.84	22.57	21.65	26.15	28.93
Enteric Fermentation	6.19	6.27	6.17	2.54	2.23	2.57	2.6	2.87	3.66
Manure Management	2.07	2.23	2.24	0.62	0.22	0.25	0.25	0.69	0.93
Rice Cultivation	24.29	16.22	22.8	17.21	19.81	19.23	18.3	18.98	23.69
Field burning of Agricultural Residues	0.71	0.48	0.62	0.58	0.54	0.53	0.5	0.52	0.65
N_2O (Total)	1.9	1.99	1.73	1.95	1.95	1.96	2	1.51	2.03
Manure management N_2O	0	0	0	0	0	0	0	0	0
Direct N_20 emissions from soils	0.02	0.07	0.07	0.08	0.07	0.06	0.06	0.06	0.08
Indirect N_2O emissions from soils	0	0	0	0	0	0	0.01	0	0
Indirect N_2O emissions from manure	1.85	1.91	1.64	1.85	1.87	1.89	1.91	1.43	1.93
Field burning of Agricultural Residues	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.02
Harvested Rice	60000	40050	52425	49020	45563	44232	42087	43654	54492
CH_4 Rice	24.29	16.22	22.8	17.21	19.81	19.23	18.3	18.98	23.7
Avail Area	49000	49350	48350	50790	50790	50790	50790	50790	50790

Total livestock CH_4 emissions in 2008 were 2.9 Gg. Dairy cows remain one of the largest contributors of CH_4 emissions from enteric emission, accounting for 46.3% in 2008, 73.5% in

1994, 71.0% in 2002, and 78.7% in 2003. However, emissions of CH_4 from other cattle in 2008 accounted for 48.1%, 26.0% in 1994, 25.2% in 2002 and 19.4% in 2003. The CH4 emissions from swine, cattle, sheep, goat, and buffalo did not show much variability from 1994-2008.

From 1990 to 2008, total emissions from enteric fermentation have decreased by 53.6%. Generally, methane emissions decreased from 2002 to 2008, though with a very slight increase from 2006 to 2008. This is expressed in the *Table 2.10: CH4 Emissions from Enteric Fermentation (Gg)* below. This decreasing trend was mainly due to decreasing populations of both beef and dairy cattle as a result of excessive slaughtering of female dairy cows and cattle over the years.

Table 2.10: CH4 Emissions from Enteric Fermentation (Gg)

Livestock Type	1994	2002	2003	2004	2005	2006	2007	2008
Dairy cows	4.46	4.46	4.46	1.18	1.04	1.18	1.19	1.33
Cattle	1.58	1.58	1.58	1.22	1.08	1.23	1.23	1.38
Buffalo	0.04	0.02	0.02	0.01	0.02	0.03	0.06	0.03
Sheep	0.06	0.06	0.05	0.06	0.05	0.06	0.05	0.06
Goats	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03
Horses	0.01	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Mules & Asses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Swine	0.00	0.04	0.03	0.04	0.01	0.04	0.04	0.04
Total	6.19	6.27	6.17	2.54	2.23	2.57	2.60	2.87

Estimates of CH_4 emissions in manure in 2008 were 0.71Gg, and 66.6% lower than in 1994. This is a result of decreasing dairy and cattle population in Suriname due to excessive slaughtering in the dairy cows and cattle population. Emissions decreased on average by 76.9 % annually over the period 1994-2008.

In 2008, total N_2O emission has been calculated to be 2.13Gg. These values include both direct and indirect N_2O emissions from manure management. N_2O emissions have remained somewhat steady since 1994. Small changes in N_2O emissions from individual animal groups exhibit the same trends as in the animal group population, with the overall net effect that N_2O emissions showed a 16.4% increase from 1994 to 2008 and a 25.7% decrease from 2007 through 2008. This is reflected in the table below.

Table 2.11: CH4 Emissions (in Gg) from manure management for the period 1994, 2002 – 2008. Totals may not sum due to independent rounding. 14

Livestock Type	1994	2002	2003	2004	2005	2006	2007	2008
Gas/Animal Type								
CH_4[1]	2.07	2.23	2.24	0.62	0.22	0.25	0.25	0.69
Dairy cows	2.03	2.03	2.03	0.54	0.14	0.16	0.16	0.61
Cattle	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03
Buffalo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sheep	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Goats	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Horses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mules & Asses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Swine	0.01	0.17	0.16	0.05	0.06	0.06	0.06	0.05

Rice cultivation is an important source of CH_4 emissions for Suriname. In 2008 emissions from rice cultivation were 8.65Gg. During the years 1994 and 2008, there was an overall annual decrease of 32.5%. However, emission levels decreased to 61.5 and 64.4% in 2007 and 2008, respectively, due to the fact that considerably less rice was planted.

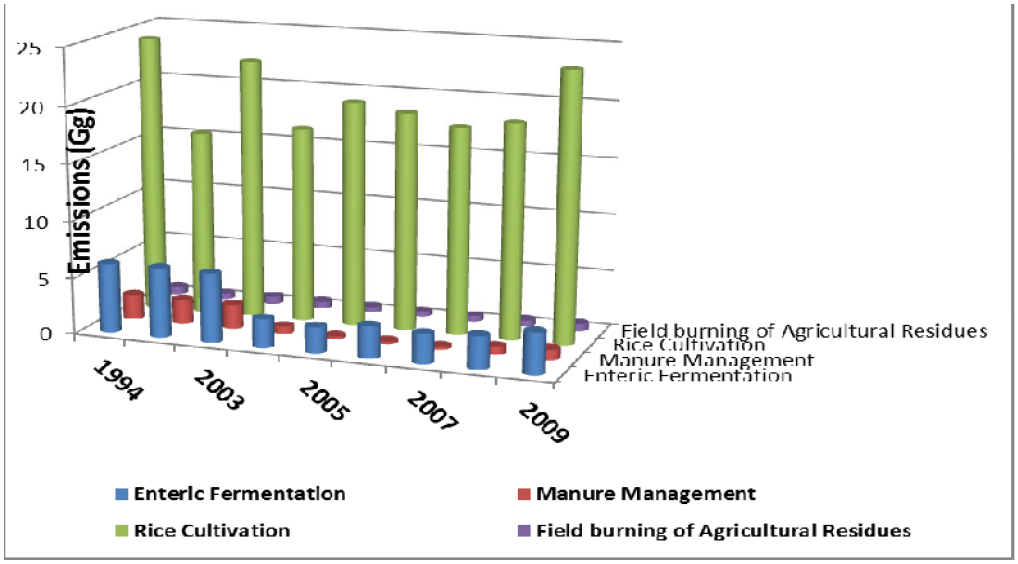

Figure 2.15: CH4 emissions agriculture period 2002 - 2008

[14]Includes CH4 emissions reductions due to anaerobic digestion

It is apparent that non-CO_2 emissions generated in agriculture in 2008 are relatively small and have considerably decreased, when compared to the GHG emission in agriculture in Suriname in 1994. In 1994, for example, CH_4 emissions were a result of rice cultivation and enteric fermentation in the livestock and manure in the agricultural sector and accounted for 32.39Gg and only 12.87Gg in 2008.

With regard to mitigation efforts, it is recommended to utilize the GHG emissions generated in 1994 in agriculture. This, in light of the fact that agriculture in Suriname has the ability to adapt based on its resources, technologies, available information, management and infrastructure, and therefore is able to efficiently engage in rice production (harvest 73,000 ton annually on a plant area of 60,000ha.). It is very realistic that all livestock types will increase by 10% annually.

It is estimated that in 2015, CH_4 emission, based on livestock types (cattle and dairy), and a harvested rice area of about 60,000ha, will reach about 50.76Gg. If taken into account the plans of the government, the harvest rice area should grow up to 150,000,000ha, which would make the emission from rice production increase up to 122.45Gg CH_4.

The national inventory was calculated using rough estimations due to lack of adequate activity data, and applying indirect default emission factors. Suriname needs to develop the capacity to develop emission factors for local conditions so that uncertainties in the future may be reduced.

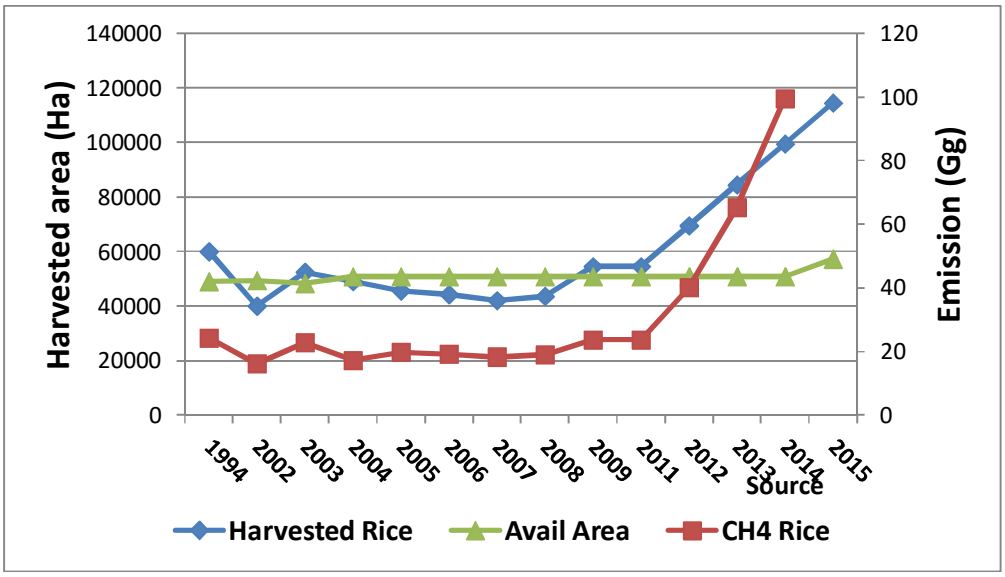

Figure 2.16: CH_4 emission forecast from rice cultivation

With the expected increase of harvested rice also the N_2O emissions from biomass burning will increase. N_2O may double by the year 2015, showing a figure of about 50Gg.

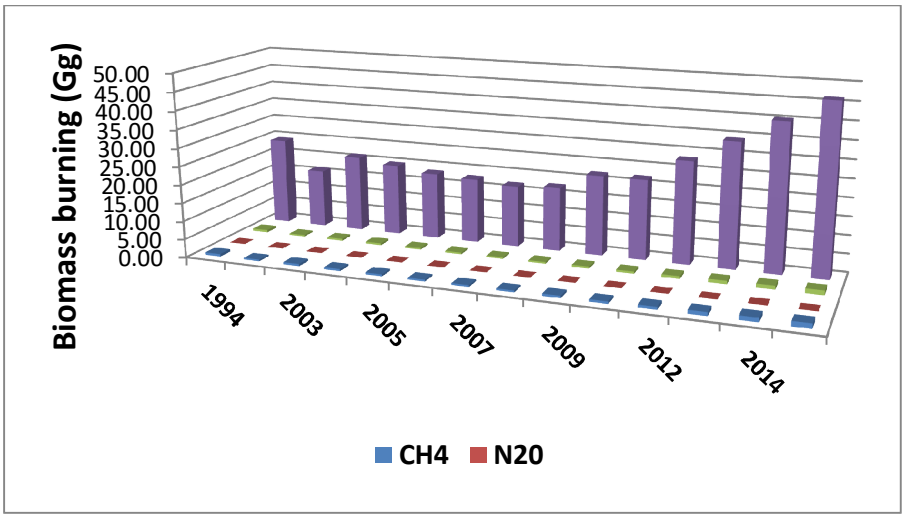

Figure 2.17: N_2O emission forecast

2.10.4 WASTE

There is no controlled waste management in Suriname. Therefore emissions from waste should be calculated from default values and population numbers. Due to the low population (less than 0.5 million) and the low birthrate in Suriname, emissions based on population figures cannot produce an emission number. There are also no signs that a waste management system will be in place in the coming years. Until then it will not be possible to produce emissions figures with regard to waste.

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3 VULNERABILITY ASSESSMENT AND ADAPTATION STRATEGY

3.1 INTRODUCTION

To date several national assessments of climate change vulnerability have been conducted in Suriname. The Netherlands Climate Assistance Program (NCAP1) started in 1996. This program focused specifically on vulnerability assessment of the coastal zone with regard to sea level rise. The NCAP1 findings were subsequently used to write Surinameôs First National Communication (FNC) to the UNFCCC (2005). A second phase (NCAP2), which was focused on the urban areas Paramaribo and Wanica, was completed in 2008.

The FNC chapter on vulnerability and adaptation focuses on the following sections:

- Coastal erosion and land loss
- Vulnerability of water resources
- The freshwater zone ecosystems
- Vulnerability of the agriculture sector
- Vulnerability of socio-economy
- Vulnerability to human health

This Second National Communication (SNC) follows the same themes with the exception of coastal erosion and land loss which have been addressed in the remaining sections on water resources, agriculture, ecology and geomorphology. Final evaluation of the adaptation measures has been ranked through a multi criteria analysis (MCA) tool.

The MCA comprises a set of indexes, used to evaluate the identified adaptation measures and to rank these. This has been done for each section separately as well as combined for all sectors together.

For the vulnerability assessment critical issues were emphasized in each section. Water resources in Suriname are mainly used for agriculture (in particular for the rice cultivation), energy generation (hydropower) and consumption (potable water). Emphasis is placed on urban areas which are susceptible to flooding as a result of the cumulative impacts of abundant rainfall, poor drainage, and rising sea and river water levels. Additional attention is

paid to excessive rainfall in the Interior which caused severe flooding in 2006 and 2008. Emphasis in the agricultural sector is placed on food security and food safety. Possibilities to increase the production and export of agricultural goods are evaluated as potential adaptation measures. The coastal and geomorphology section focuses on changes of the coastline in relation to the sea level rise and climate change. The assessment is conducted on the basis of ad-hoc studies, experiences gained in this field, and the expert judgment of consultants. The emphasis in the human health section is placed on monitoring dengue and malaria occurrences. Finally, the focus in the socio-economic analysis is primarily placed on existing vulnerabilities among certain groups in society such as women in the Interior and farming communities.

3.2 BASELINE CLIMATE CONDITIONS

Suriname is located on the north eastern part of South America, just north of the Amazon delta, between 2 - 6 degrees northern latitude and 54 - 58 degrees western longitude, with a climate characterized as tropical wet and hot, which is generally controlled by the bi-annual passage of the Inter ï Tropical Convergence Zone (ITCZ); once during the period December to February (known as the short wet season), and the second time, during the months of May ï mid August (long wet season). The periods in between are the short dry season (February to the end of April) and the long dry season (middle of August to the beginning of December). According to the Köppen classification, Suriname has three climate types, namely monsoon climate, tropical rainforest climate and a humid and dry climate.

Another major condition determining the countryôs climate encompasses the surface conditions, such as the abundance of rivers and swamps and the presence of well-developed vegetation cover that produces large amounts of water vapor, which together with the local convection and orographic lifting along the hills and mountainous regions, also contribute to the relatively high precipitation in the country[15].

[15]Urritia R.O. 2008. Assessment of the 21st century climate change projections in tropical South America and the tropical Andes, Master Thesis.

In general climatic conditions have remained almost the same throughout the year for decades[16]; the variation of annual temperature is only 2-3 degrees Celsius. At the same time there is an insignificant change in rainfall as well, when excluding the extremely dry and wet years. This leads to the conclusion that the climate of Suriname is relatively stable. An example of an exceptionally wet year is 2006, when due to large amounts of rainfall significant areas along the upstream of rivers were inundated. However, it was also noted that such an event seems to re-occur every 25-75 years[17].

The current climate is best described according the following parameters:

A. Temperature

In the coastal zone of Suriname, temperature observations over the past 47 years, have shown an increase of approximately 0.016 degrees per year on average (Meteorological station Cultuurtuin). In the Hinterland, on the contrary, no significant trends in temperature change have been observed (Meteorological station Zanderij). Nonetheless, it should be noted that the temperature observations in the coastal zone as well as in the Interior may be affected by local conditions; in the coastal zone, due to the increasing urbanization and in the Interior because of a particular type of land cover, such as those observed in the savanna areas.

B. Precipitation

One of the principal parameters of climatology is rainfall. For Suriname this is essential since the distribution of the four seasons is based upon rainfall.

[16]Amatali M.A. 2011a. Technical Paper Present Profile. Sector Water Resources. Technical document "Project Enabling activities for the preparation of Suriname's Second National Communication to the UNFCCC". Ministry of Labour, Technological Development and Environment.
[17] Brinke, W. and Botterweg, J. (2006), ñOverstromingen Suriname 2006: Oorzaken, herhalingskansen en preventiemaatregelenò.

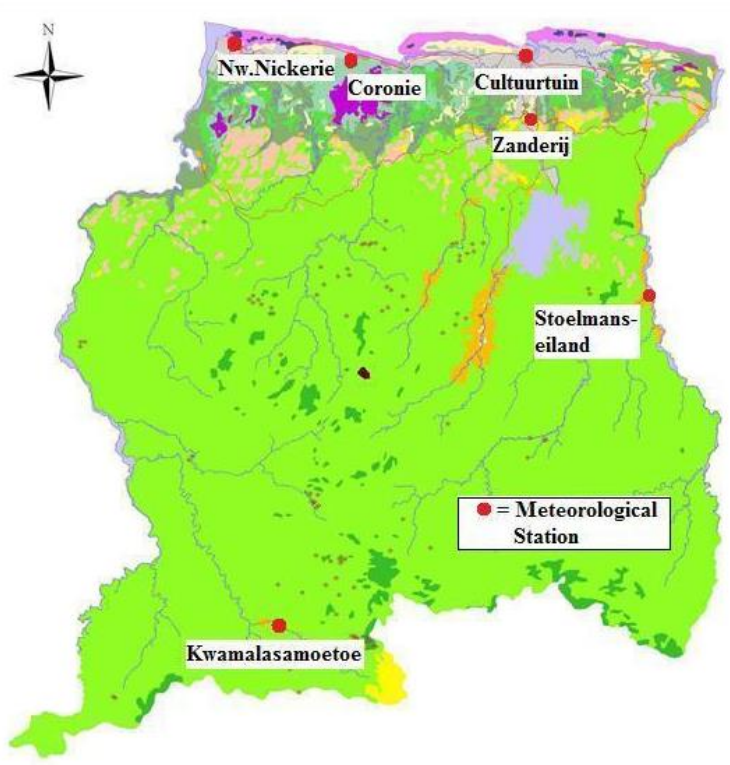

Figure 3.1 Location of meteorological stations
Source: Amatali, 2011a; Technical Paper Present Profile. Sector Water Resources

Data on precipitation was available for 6 meteorological stations, namely Cultuurtuin (Paramaribo), Zanderij, Coronie, Nieuw Nickerie, Stoelmanseiland and Kwamalasamutu. Due to incomplete data, rainfall trend analyses could not be performed for all datasets. Trend analyses of those located in the young coastal zone show no significant negative trend over the approximately past 100 years (see Appendix III: figures 3c, 3e, 3g). At the same stations, however, the trends are found to be slightly positive over the period 1971-2008 (see Appendix III: figures 3d, 3f, 3h). At this moment, thereôs no clear explanation for such a change in the rainfall trend.

Rainfall trends at stations located in the Hinterland are shown in the figures 3i throughï 3n in the annex. Compared to those located in the coastal zone, these stations show a slight decrease in the rainfall trend in the Hinterland over the period 1971-2008, except for station Kwamalasamutu, which shows a positive trend.

Based on the available data it can be stated that the highest amount of rainfall (about 3,000mm/yr) is observed in the center and the lowest in the northwestern part of the country (less than 1,750mm). In Paramaribo and Wanica the rainfall varies within a wide range from 1,400mm in the north to 2,100mm in the south. To the south of this zone, except for the central part of the country, rainfall varies from 2,000 ï 2,350mm on average.

C. Wind

The wind is generally weak: having annual averages of about 1.3-1.6 on the scale of Beaufort (or 1-5m/s). The daily wind speed variation is higher and can reach up to 3-4 Beaufort (3-8m/s). High winds in Suriname correspond with the occurrence of local gales, called ñsibibusiò, reaching wind speeds of up to 20-30m/s near the end of the rainy seasons.

D. Extreme weather conditions

Extreme weather conditions often occur when these coincide with the El Niño and the La Niña events. A positive trend has been presumed between the extremely dry conditions in Suriname and the strong El Niño events on the one hand, whilst on the other, extremely wet conditions with strong La Niña events. Extreme weather conditions are also observed during the 'sibibusi' events, when wind speeds of up to 30m/s (over the 100km/hour, or 67mph, or 58knots) are observed, comparable with stormy conditions and accompanied by significant damages if occurring in urban areas. Up till now it is unclear how the global climatic circulations affect extreme weather patterns in Suriname. Moreover, according to predictions, the Walker current is weakening[18]and may drop 1% in force by the end of 2100. This will impact the hydrological cycle and hence rainfall and other climatological conditions.

No clear description can be given of the current climate due to a lack of data and poor observation networks. Events such as occurrences of 'sibibusis' and strong alternations in rainfall are not consistently observed and hence no analyses can be produced.

[18]Urritia R.O. 2008. Assessment of the 21st century climate change projections in tropical South America and the tropical Andes, Master Thesis.

3.3 EXPECTED CLIMATE CHANGE AND SEA LEVEL RISE PROJECTIONS

Climate change scenarios

For the Vulnerability and Adaptation Assessment within the First National Communication the following assumptions were made:

- A sea level rise of 1m;
- Rainfall decrease of 10%;
- Temperature increase (unknown value);
- Possible changes in wind speed;

IPCC has developed a set of scenarios to describe how the future may develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships[19]. The expected future climate of Suriname and sea level rise has been described according to the A2 and B2 IPCC scenarios. Elements of both of these scenarios have been used since one specific scenario is difficult to apply to the national circumstances of Suriname. Taking the specific characteristics of the country, its location and the climate into consideration, none of these scenarios fits perfectly. The selected IPCC scenario is further supplemented with country specific data, particularly, with regard to the expected rise of the average temperature in Suriname, the sea level rise and the possible change in the total rainfall. Other data such as occurrences of extreme events, variations in the amounts of seasonal rain, including periods between dry and wet seasons are also considered in the selected scenarios.

According to these scenarios the economic growth will vary from low to intermediate. Suriname has a number of natural resources that could be utilized to contribute to intermediate economic growth. However, after depletion of these natural resources, a drop in the economic growth is expected. Technological change in the scenarios A2 and B2 is fragmented and relatively slow paced, undoubtedly depending on the level of the countryôs education level. Suriname is currently investing in the improvement of education at various

[19] UNFCCC. 2010. Handbook on Vulnerability and Adaptation Assessment. Consultative Group of Experts (CGE) on National Communications from parties not included in ANNEX I to the Convention. *UNDP*, **3,** 1-16

levels so that more Surinamese people can get a qualitative higher education and become more involved in the various sectors of the country's economy.

In the context of these scenarios, taking into consideration the intermediate economic growth, it is to be expected that the Surinamese population will undergo some growth as well. In this context the typical diversity will be largely maintained and this will remain deflected in the entire social, cultural, and political structure of Suriname. Nonetheless, simultaneous cultural integration will continue to take place. Surinameôs membership to both the Caribbean Common Market (CARICOM) and to the UNASUR (the Union of South American Nations) demonstrates her continuing efforts and openness to the process of regional integration.

These efforts are in line with the selected scenarios. According to scenarios A2 and B2, the ambient temperature is expected to have risen approximately 2-3 degrees Celsius by the end of this century. Changes in severity and frequency of weather extremes could therefore have great immediate impacts on many sectors in Suriname.

Projections resulting from these scenarios also reveal that the sea level is expected to have risen in the range of 20ï 51cm by the end of this century. The main factors contributing to the sea level rise are expansion of sea water and melting/sliding of land-based ice sheets and glaciers. However, there are many uncertainties regarding: carbon cycle feedbacks, ice flow processes, the amount of heat uptake by the oceans and recently observed ice discharge rates. Since these factors are insufficiently understood, their contributions to sea level rise are often times neglected[20]. Researchers such as Rahmstorf, Horton, Rohling, Köppen, Pferfer, and Sidall[21,22,23,24,25], have shown that when some of these uncertainties are taken into account,

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[20]Nicholls, R.J., P.P. Wong, V.R. Burkett, J.O. Codignotto, J.E. Hay, R.F. McLean, S. Ragoonaden and C.D. Woodroffe, 2007: Coastal systems and low-lying areas. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 315-356.

[21]Siddall et al. 2009. Constraints on future sea-level rise from past sea-level change. Nature geosciences 2009.

[22]Pfeffer et al. 2008. Kinematic Constraints on Glacier Contributions to 21st-Century Sea-Level Rise. *Science* **321**, 1340 (2008);

[23] Rohling et al. 2007. High rates of sea-level rise during the last interglacial period

[24] Kopp et al. 2009.Probabilistic assessment of sea level during the last interglacial stage. Vol 462| 17 December 2009| doi:10.1038/nature08686

[25] Horton et al. 2008. Sea level rise projections for current generation CGCMs based on the semi-empirical method. GEOPHYSICAL RESEARCH LETTERS, VOL. 35, L02715, doi:10.1029/2007GL032486, 2008

higher maximum sea level rise projections are found, ranging from 59cm (IPCC projection) to 190cm (Rahmstorf). An average of various sea level projections reported by these five studies, exceeds the +100cm SLR level. Further analyses of these studies reveal that the lowest value among the maximum projected sea level rise is +80cm[8]. The highest value among the researchers has been found by Vermeer & Rahmstorf[26]; it equals +180cm. According to Simpson et al[27] these high projection values are based on the ongoing complex processes and the vulnerability of the Greenland and West Antarctic ice sheets; this should result in a continuation of sea level rise regardless of the predicted changes in global temperature. According to the same studies, the SLR in the Caribbean shall be more pronounced than in some other regions.

For Suriname, a 1m sea level rise projection has been adopted based on:

- Analysis of 5 major projections of sea level rise;
- Exclusion of the IPCC projection (AR4) on sea level rise, because of new evidence indicating higher predictions;
- Lack of reliable data on sea level rise in Suriname;

In addition, local factors such as storm surge and subsidence should also be considered as important contributors to SLR.

In conclusion, the expected climate change scenario used for the vulnerability assessment in Suriname could be described as follows:

- Temperature rise between 2-3 degrees Celsius;
- Rainfall decrease of 10%;
- Increase of weather extremes, including wind;
- A sea level rise of 1m;

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[26]Vermeer M and Rahmstorf S. 2009. Global sea level linked to global temperature. Proceedings of the National Academy of Sciences, 106(51), 21527i 21532

[27]Simpson, M.C.,Scott, D., Harrison, M., Silver, N., O'Keeffe, E., Sim, R., Harrison, S., Taylor, M., Lizcano, G., Rutty, M., Stager, H., Oldham, J., Wilson, M., New, M., Clarke, J., Day, O.J., Fields, N., Georges, J., Waithe, R., McSharry, P.1 (2010). Quantification and Magnitude of Losses and Damages Resulting from the Impacts of Climate Change: Modelling the Transformational Impacts and Costs of Sea Level Rise in the Caribbean (Summary Document), United Nations Development Programme (UNDP), Barbados, West Indies.

– All projections are made for 2100;

3.4 VULNERABILITY ASSESSMENT

A vulnerability assessment has been conducted, based on the impacts of climate change on water resources, agriculture, ecology & geomorphology, socio-economy and health.

3.4.1 WATER RESOURCES

Rainfall is the only source of water in Suriname. The many rivers originating in the Hinterland, groundwater aquifers and swamps found in the coastal area are all fed by rainfall, with annual averages varying from 1750mm p.a. in the north to about 3000mm p.a. in the center of the country.

3.4.1.1 RIVERS

With the exception of the Suriname River, the seven main rivers (Table 3.1) with their numerous tributaries, discharge excessive rainfall from the mainland directly into the Atlantic Ocean. The discharge of the Suriname River is regulated by the Afobakka hydropower dam.

Table 3.1Average discharge characteristics of the rivers in Suriname

No.	Main river	Area of the basin in Km^2	Discharge in m^3/s	Specific discharge ($l/s/km^2$)
1	Marowijne	68,700	1,780	25.9
2	Commewijne	6,600	120	18.2
3	Suriname	16,500	426	25.8
4	Saramacca	9,000	225	25.0
5	Coppename	21,700	500	23.0
6	Nickerie	10,100	178	17.6
7	Corantijn	67,600	1,570	23.2

Variations in freshwater discharge are encountered due to alternations in rainfall and hence in availability of freshwater resources. During the rainy seasons freshwater is abundantly available, while during the dry seasons, this resource may become temporarily limited. This freshwater resource may further experience pressure when drought coincides with a strong El

Niño event. During a strong La Niña event abundant rainfall is expected, which, if accompanied with other conditions, such as, high soil moister content, limited storage for water under relatively continuing rainfall, may result in inundation.

Changes in rainfall in the upper basins of the Surinamese rivers are followed by saltwater intrusion in their lower courses since these parts of the rivers are controlled by the hydrological regime of the Atlantic Ocean. Consequently, a decrease of the upstream flow promotes seawater intrusion, while an increase in river discharge pushes back the salt limit close to the estuarine zone of the river. **Error! Reference source not found.** illustrates the approximate location of the current saltwater wedge.

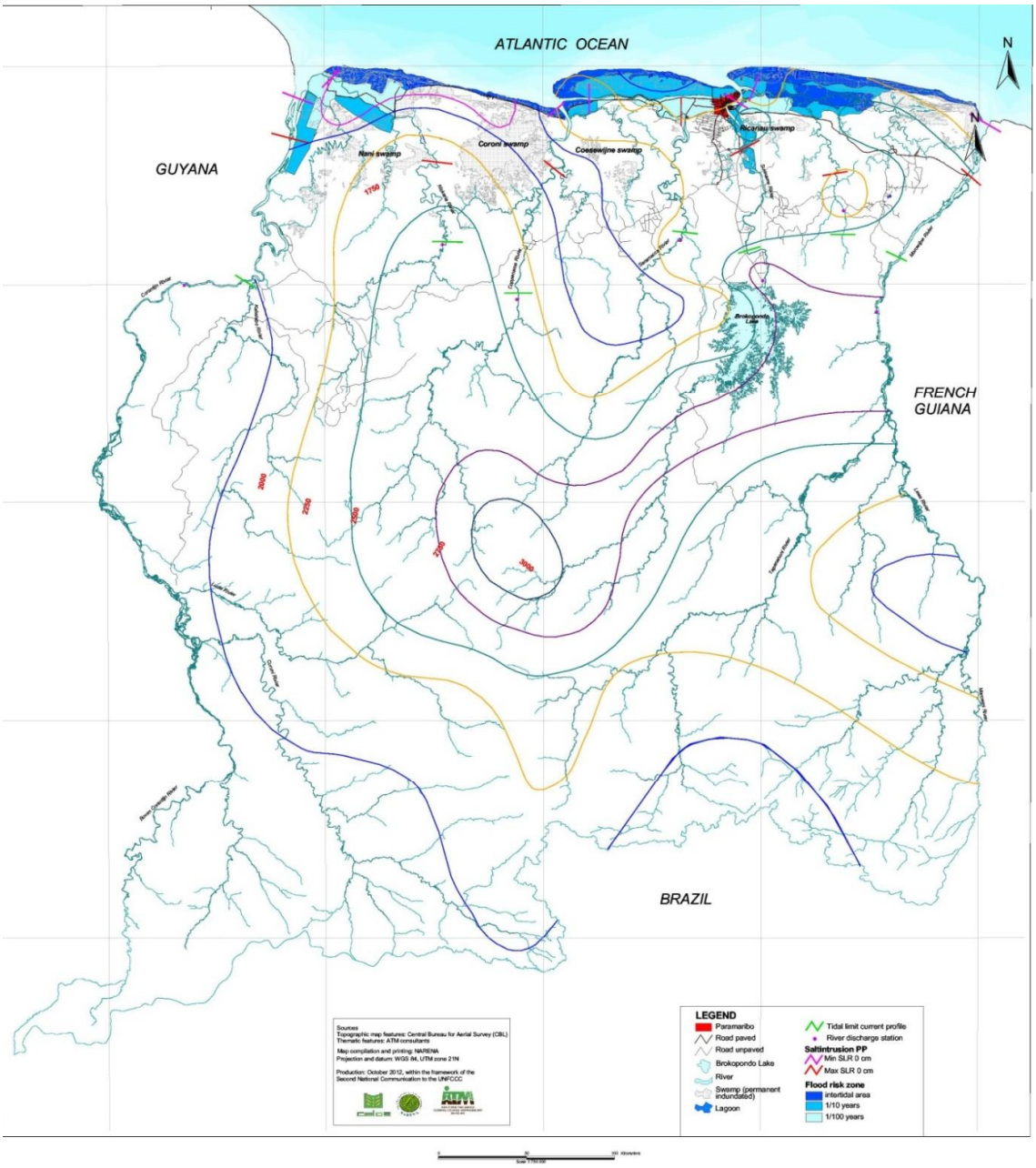


Figure 3.2 Hydrology of Suriname

In the northwestern part of Suriname, where wetland rice is cultivated, large volumes of freshwater per unit of time and area are required. This freshwater is obtained from local water resources such as freshwater swamps and rivers found in these areas. In case of deep penetration of the salt wedge in the rivers, due to low freshwater discharge and low water

levels in the neighboring swamps, pumps have to be utilized to provide additional irrigation water. These pumps are located approximately 66km upstream of the rivers.

3.4.1.2 LAKES AND WETLANDS

Numerous wetlands and swamps are found in the coastal zone. The total area covered by these wetlands and swamps (excluding the man-made lake) is approximately 12,000km^2; one third of which is permanently inundated and the remaining area seasonally during rainy seasons.

A man-made hydropower lake, further referred to as the Brokopondo Lake, was established in the early 1960's and covered an area of about 1,600km^2. The main objective of the Lake was to generate electricity for the aluminum smelter at Paranam. Since the closure of the aluminum smelter in1996 a significant part of the hydro-electricity is being transported to Paramaribo. However, alternating water levels in the Brokopondo Lake due to alternating rainfall, results in inconsistent hydropower output.. Consequently, during periods of excessive rainfall generated power may exceed 120MW, whilst in periods of drought electricity generated at this power station may drop to 80MW. In this way, alternating rainfall exerts immediate impact on the country's economy. Freshwater from the Brokopondo Lake is discharged via the Suriname River into the sea, after being used for hydropower generation.

A significant freshwater input for the swamps and rivers bordering the Zanderij formation and the higher Old Coastal Plain in the south, particularly during the dry seasons, is formed by groundwater inflow. In the districts of Nickerie and Coronie, water retaining dams have been constructed to protect the agricultural land against flooding during the wet season. Furthermore the retained water is used for irrigation for rice cultivation in that area during the dry season and also for conserving mangrove wetlands at the coastline. There are four major freshwater swamps, namely from east to west: the Surnau, Coesewijne, Coronie and the Nani Swamp. The Nani swamp is intensively used for agricultural purposes. High water levels in the swamps promoted by intensive rainfall and water retaining dams, in combination with poor construction and maintenance, have often resulted in dam breach and inundation of the adjacent agricultural lands and urban areas.

3.4.1.3 GROUNDWATER AQUIFERS

Potable water is extracted from groundwater resources, which are found in the coastal area at depths varying from several tens to hundreds of meters. The Zanderij aquifer is the only outcropping aquifer and the only aquifer receiving modern recharge. Intensive use of deeper located aquifers has resulted in an annual water level decrease of about 0.5m. One of the present day problems is an increase in salinity of these freshwater aquifers; particularly in the northern part of the country. This is an indication of groundwater depletion. Increase in population and urbanization will further exacerbate these conditions. At present time, 93.5% of the population in Paramaribo has access to potable water, while this percentage is lower (75%) for the District Wanica, the second most populated area for Suriname. The water supply in the Hinterland is poor. The inhabitants of the Interior primarily use surface water from the rivers during dry seasons (periods with relatively less rainfall) and rainwater during the wet seasons (periods with relatively excessive rainfall) for their consumption.

3.4.1.4 IMPACTS ON THE WATER RESOURCES

Water resources in Suriname may experience stress as a result of climate change, since the combined effect of reduced annual rainfall, increased evapo-transpiration, and prolonged dry periods will exert additional pressure on the existing water resources of the country.

Reduced rainfall and hence reduced discharge will lead to saltwater intrusion in the rivers, creeks and streams discharging in the Atlantic Ocean (Figure 3.2 and **Error! Reference source not found.**2). Linear projection of this relationship with respect to one meter sea level rise reveals a displacement of the saltwater wedge with approximately 20km or more upstream, depending on the local conditions, such as the tidal effect of the Atlantic Ocean on the water system and the freshwater discharge from upstream. It is certain that under these conditions, water resources of all rivers and significant parts of the wetlands in the coastal zone will decline rapidly. Without proper adaptation measures, the saltwater intrusion will significantly impact and even jeopardize the agricultural sector while other sectors will be hit hard as well.

In addition, high water levels will promote changes in river morphology, estuarine zone, and the immediate lower courses of the rivers. River processes such as river bank erosion and deposition, changes of navigation channel, movement of bars and mud banks at the lower courses near the outfall of the rivers may develop an array of risks to the environment, including the present and future infrastructure along these rivers.

Wetlands may also become highly susceptible to drought and consequently to natural fires during prolonged dry periods. On the contrary, agricultural lands will experience increased threats from inundation due to dam failure and/or intensified wet seasons.

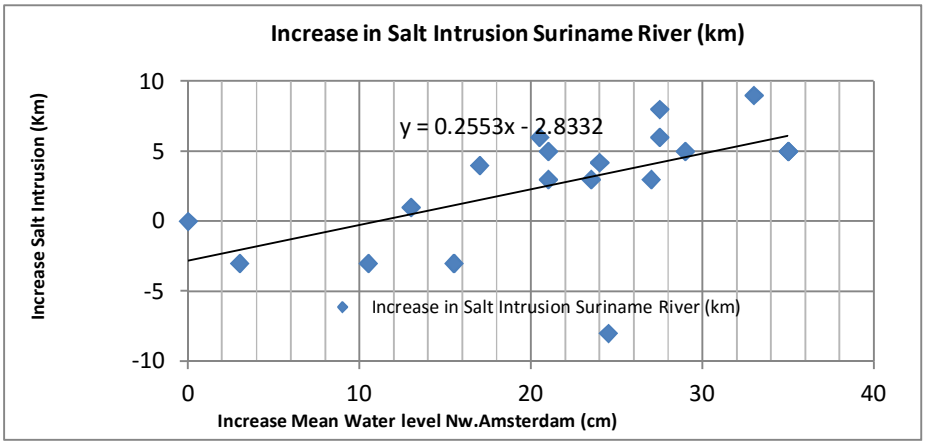


Figure 3.2 Illustration of the relation between the rates of salt intrusion and increased mean water level.

Source: Amatali, 2011b; Technical Paper Future Profile. Sector Water Resources

Salt water intrusion into the aquifers will also increase since the extraction of groundwater sources will continue; the sea level will keep rising and the recharge rates into the Zanderij aquifer will possibly decrease. Groundwater depletion will be enhanced by increased extraction of groundwater and pollution.

It should be noted that depletion of freshwater resources will further impact natural and manmade systems. For instance, sea water penetration in the coastal area will trigger a number of changes such as: decline of water quality, dislocation of freshwater fish species, higher water levels, or hyper-salination in case of stagnant water. Also industries are increasingly using freshwater resources for production purposes (water bottling and beverages, mining and agriculture), which add to the pressure on water resources. The

impacts on water resources in the Hinterland are two-fold: increased economic activities (e.g. wood logging, gold-mining) and increased climatic variations (e.g. temperature, rainfall).

3.4.2 AGRICULTURE

Agricultural activities are found in the Young as well as in the Old coastal areas and comprise the following subsectors: crop production (e.g. paddy, vegetables, and banana); animal production (beef cattle, sheep and goat, poultry, and pigs); fishery (including aquaculture); production of fruits, flowers and ornamentals. The last mentioned subsector (flowers and ornamentals) is a rather new sector with promising growing potential.

This sector is a key sector to the economy of the country, not only because of its contribution to the Gross Domestic Product (GDP), but also because of the high number of people involved in this sector. An overview of the percentage of laborers working in these subsectors can be found in Figure 3. below.

Approximately half of the laborers involved in the agricultural sector are engaged in animal production and fishery, whilst the other half is mainly active in crop production. Locally produced animal products do not fully meet the national demands. The remaining agricultural products are meant for local use and export. An overview of the average export values (in %) for the period 2004-2009 is presented in Figure 3..

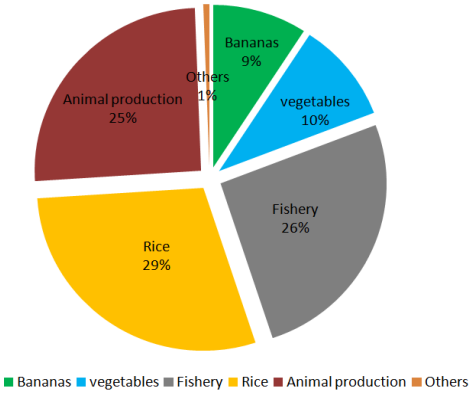


Figure 3.4 Laborers involved in agriculture (2009-2010)

Source: Tjien Fooh, 2011a; Vulnerability and Adaptation of the Agriculture sector in Suriname – Current profile.

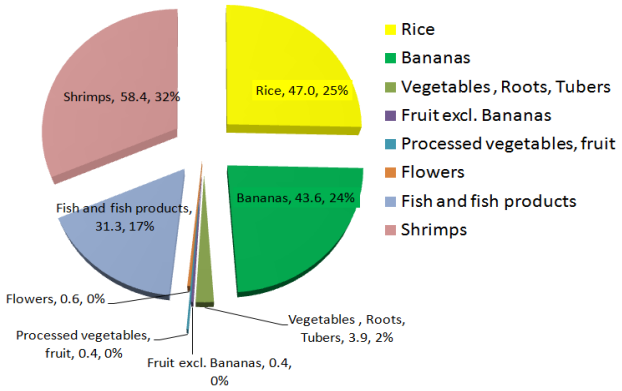


Figure 3.5 Export values (milj. SRD) and % of some agriculture products (2004-2009)

Source: Tjien Fooh, 2011a; Vulnerability and Adaptation of the Agriculture sector in Suriname – Current profile.

Significant decreases in the export values of shrimp have been observed during the recent years. Over the last decades the production in almost all sub-sectors has declined structurally, except for a few, amongst which the banana subsector. This subsector has shown a moderate growth which is primarily due to the intensive investments made recently, particularly in the irrigation and transport infrastructures.

Decrease of production in the agricultural sector is mainly due to two main factors: (1) socio-economic aspects (including a delayed maintenance of the infrastructure, population growth, shift of the production fields to newer locations, lack of new investments, and lack of innovation) and (2) climatic events (alternating rainfall intensities in time and space and high winds).

The main threats to agricultural production are:

- Reduction of agricultural land; a shift of the old production regions to newer locations is required under present socio-economic development, since these areas are now assigned to housing;
- Lack of appropriate irrigation and drainage facilities, which increases the vulnerability of this sector;

- Increase in prices of agricultural commodities. Although enough land and freshwater are available. Suriname is still largely dependent on imported agricultural products. This dependence increases the country's vulnerability in terms of food security.
- Food security and food provision in the Hinterland, in particular, for the Indigenous and Maroon villages, largely depends on the climatic conditions. According to Amatali[28] strong alternations in rainfall are expected in the future, and since agricultural practices in this area are climate based, these alternations may adversely affect their livelihood. It should be noted that irrigation infrastructure in the Hinterland is lacking, in contrast to the coastal zone where irrigation infrastructure exists. Therefore, an early or late start of the seasons is immediately noticed by these communities.

3.4.2.1 IMPACTS ON AGRICULTURE

Future projections pertaining to the agricultural sector based on the expected climate change and sea level rise scenario, as mentioned in chapter "Expected climate changes and sea level rise projections", are not optimistic. Although Suriname has enough land and freshwater, future agricultural development will be impacted negatively by climate change and SLR.

Moreover, according to Nijbroek (2011b), the projected mid-term population growth of about 44% by 2024 will exert a permanent pressure on the agricultural production. In addition, urbanization may also contribute to weaken the agricultural sector; people migrating from the rural areas and the Interior to the urban areas will no longer have the opportunity to produce their own staple crops and hence will depend on modern agriculture.

A significant number of threats may affect those crops which are heavily dependent on the availability of freshwater. Agricultural sub sectors that may be affected, involve:

A. **Rice production:** rice is the main staple food in Suriname and has the potential to grow when taking the available fertile land, global population growth and favorable world

[28]Amatali M.A. 2011b. Technical Paper Future Profile. Sector Water Resources. Technical document "project Enabling activities for the preparation of Suriname's Second National Communication to the UNFCCC". Ministry of Labour, Technological Development and Environment.

market prices into consideration. This sector would, however, be significantly threatened by seawater intrusion, unpredictable strong alternations in rainfall patterns and the combined effects of these two[29]. Rice production may be hampered by frequent occurrence of crop diseases and pest infestations in the coming years. Threats, originating from inland flooding and sea level rise, will become more evident and may hamper food security seriously. In addition, investments regarding maintenance of machines and equipment, infrastructure, and facilities in the rice sector are highly necessary.

B. **The banana sector** will also experience stress since it is located in the young coastal plain. However, serious investments and introduction of new technology, including those in the irrigation and drainage systems, have enhanced its resilience positively. The future of the banana sector is strongly dependent on world market prizes and the capacity of the banana company to compete under challenging circumstances.

C. **Vegetable crops:** By the end of 2024, about 25% of the vegetable production is expected to be produced under protective farming systems such as greenhouses and hydroponic systems. These modern systems can only be effective if accompanied by large-scale investments, including capacity building and awareness campaigns. Such developments are compelled by the climatologic and hydrological conditions. Farmers who produce in areas susceptible to flooding and siltation will no longer be able to produce their crops under the existing farming systems and have to move to other areas with lower risks or to adapt to the changed conditions. Under such circumstances the number of farmers involved in this sub sector is expected to decline while production will become more expensive.

D. **Fruit production** has the potential to grow rapidly in the coming years. Necessary conditions for growing perennial fruit, farming of exotic fruit species with high values of anti-oxidants such as açai (*Euterpe oleraceae*), which are less sensitive to extreme weather patterns, are present. Hence it is expected that the low number of specialized farmers in this subsector will grow when the necessary incentives become available.

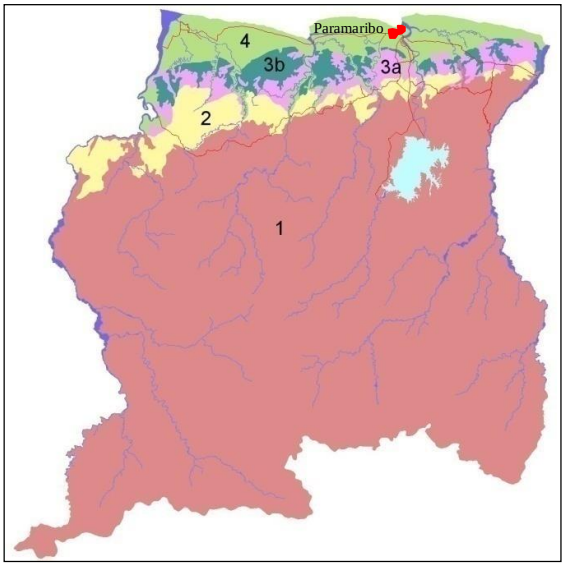
[29]Tjien Fooh R. 2011b. Vulnerability and Adaptation of the Agriculture sector in Suriname ï Future profile. Technical document "project Enabling activities for the preparation of Suriname's Second National Communication to the UNFCCC". Ministry of Labour, Technological Development and Environment

E. **Livestock production** is under pressure because of several factors such as the competitiveness with imported meat and meat products, physical constraints (rainfall, soil fertility and texture, temperature) and lack of the availability of good breeding stocks. Without strong support regarding necessary adaptation to new production conditions, improvement in livestock production will remain of great concern and local production markets will be further suppressed by necessary imports.

Development of the fisheries- and aquaculture sector are declining and expected to decline further in the near future. In this respect intensive research is required to understand this decline, whether this is due to the trawlers having negative impact on the breeding grounds of fish and shrimp near the coast and/or climate related processes and forces. The productivity, among other factors, is also dependent on sustainable fisheries management and on the recovery of the estuarine zone under conditions of climate change. In general, its vulnerability level is determined by the uncertain future climatic conditions combined with competitiveness and large investments.

3.4.3 ECOLOGY AND GEOMORPHOLOGY

As indicated in the previous chapter, large parts of Suriname's geomorphology belong, from a geomorphological point of view, to the Guiana Shield. This Shield is a sizable area that stretches, from north of the Amazon lowlands in south east Columbia through the Venezuelan Guyana and northern Brazil, to the Atlantic Coast of Guyana, Suriname, and French Guiana. The Guiana Shield formation is billions of years old, deeply weathered, and covered by rainforest. The topography of this Shield is hilly and mountainous. Therefore the geomorphology of Suriname's Hinterland is determined by the presence of this Shield. In the northern direction at the foot of this Shield, an area with terrestrial sediments has been formed and more northern to the coastal lowlands marine sediments are found stretching toward the Atlantic Ocean. In this respect four major geographical zones are distinguished in Suriname with their corresponding ecosystems (see Figure 3.6).



Legend

1. *Precambrian Guiana Shield area, popularly also known as the Interior Uplands, or the Hill and Mountain Land*
2. *Cover landscape; also known as Zanderij or Savanna Belt (Late Tertiary)*
3. *The Old Coastal Plain:*
   a. *Old Ridges and Sea clay Flats (Pleistocene)*
   b. *Old Coastal Plain: Old Swamps (Early Holocene)*
4. *Young Coastal Plain (Late Holocene)*

Figure 3.6 Outline of the major physiographic regions of Suriname

Source: Noordam, 2011; Ecology and Geomorphology

The Precambrian Guiana Shield area, also known as the Interior Upland, has elevations up to 750m and locally even higher, with the highest point at 1,230m. The rivers and creeks in the Interior uplands are, in general, characterized by the presence of rapids, except for those parts of the river basins where the valleys are filled with alluvium. In the lowland zone (up to 500 m) the dominant type of vegetation cover is the high dryland forest, also known as ñtropical mesophytic forestsò or ñtropical lowland forestsò. In zones with adverse soil conditions, savanna vegetation types can be found, comprising of high and low xerophytic forest patches among the tropical mesophytic and other types of forests in this area. Above the 500m MSL mountainous forests are found. Here species composition differs from the surrounding lowlands. The Tafelberg Mountain, at approximately 1,000 meter MSL, has different ecosystems, being an isolated plateau with very steep, often cliff-like slopes, very poor sandy soils and exposed sandstone. Along the rivers and creeks seasonally flooded forests occur in which marsh and swamp species may be found next to dryland species.

The Cover landscape, occurring at the foot of the Precambrian Guiana Shield and also known as Zanderij or Savanna Belt, is a gently rolling plateau landscape dipping to the north with elevations that are predominantly between 10-50m. On well-drained sandy to loamy soils that cover approximately 60% of the landscape, high dryland forest is found, while high

and low xerophytic forests and savannas occur on the bleached sandy soils. Species composition differs from the forests in the Interior Uplands and many forests in the Cover landscape are subject to selective logging.

The Old Coastal Plain, which is a discontinuous belt of erosion remnants of a former continuous coastal plain, is intersected by gullies and swamps filled with younger sediments during the Early Holocene. The landscape is undulating having elevations in the lower parts of 4-7m and 5-11m at the higher part of this plain. Poor drainage of this zone has led to the formation of extensive swamps or depressions in between the ridges and marsh flats, with swamp water levels increasing to 2m depth. In the deeper swamps (3-6m) extensive peat formations have been formed, with thickness of several meters. Swamps with such thick and often floating peat layers have open ombrogenous herbaceous swamp vegetation, such as the southern Nani Swamp, the central Coronie Swamp, and the swamp upstream of Buku Creek in the Cottica drainage basin. These swamps are poor in species and often covered with low herbaceous vegetation, dominated by a single species. On periodically flooded areas high marsh forest dominates, whilst on the old ridges high dryland forest is found.

The most northern land, known as the estuarine zone covers an area of about 2,000 km^2 and encompasses mangrove forests, lagoons and brackish herbaceous swamps as well as a strip with freshwater swamps directly south of it.

This estuarine zone is very dynamic, with its ever moving mud banks and beaches and the associated herewith erosion and accretion. On mudflats, when silted up during the presence of the mud bank to elevations above the mean high water level, often a mono-specific black mangrove or "Parwa" (*Avicennia germinans*) develops as an uninterrupted belt along the coast, which is uprooted during periods of erosion, subsequently partially thrown up on shore and partially transported westwards by the sea, where it drifts ashore elsewhere along the coast. Other reasons for the Parwa forests to die are drowning of the respiratory roots and changes in the salt content caused in general by ongoing "natural changes" and finally resulting in the formation of lagoons. Following the consecutive naturally induced processes including rainfall and changes in salinity and vegetation these lagoons may be finally transformed into fresh water herbaceous swamps where accumulation of possible peat formation will begin.

The presence of saline to brackish clay soils and waters, ranging from (hyper) saline to (nearly) fresh, are essential conditions for preserving life in the estuarine zone. For supporting these conditions a ñred lineò is marked on maps, approximately coinciding with the line of the ocean. In the south, along the brackish and muddy lower courses of the Surinamese rivers intertidal flats are found covered with red mangrove (*Rhizophora spp*.) forests characterized by their high prop roots.

Finally, **the Young Coastal Plain,** is characterized by flat and low-lying formations of heavy marine clays usually overlain by a peat layer, with elevations around 1m (± 0.5) above mean sea level and therefore very sensitive to inundation during rainy seasons, promoted by poor drainage conditions. The clay flats are locally interspersed by roughly east-west striking ridges, which form elongated, usually narrow bodies, often comprising sand, but locally also mixes with shells are found. These ridges may be found in elevations 1-3m above the surrounding clay flats and may be either occurring individually or in bundles varying in width between 10 and 400m.

Another feature of this coastal plain is the polder landscape, comprising of old plantation areas and recently established polders in the Young Coastal Plain. Water levels in these areas are controlled by dikes, canals, ditches, sluices and pumps, but are often seen inundated locally during heavy rainfall.

The eastern part of the Surinamese coast line, taking up to about 10% of the total Surinamese coast, is covered by sand beaches that provide suitable conditions for sea turtles to nest. The beaches of eastern Suriname are of international importance: not only as a nesting site for Green and Leatherback turtles, but also as the only place in the Atlantic where historically Olive ridley turtles nest in massive numbers. These beaches are prominent in eastern Suriname (Galibi/Babunsanti and Matapicaand Commewijne/Braamspunt); however, they are subject to erosion and they "move" in a western direction under the influence of the Guyana current and the dominating north east trade winds. An exception is formed by the most eastern beaches which are more or less in a óteady stateô, as erosion is compensated by deposition of sand originating from the rivers east of this location (mainly those of French Guiana). Only when mudflats are formed in front of these beaches, they become a stable feature in the landscape, the so-called ñridgesò.

There are currently threats to the above described ecosystems, in particular those of the Young Coastal Plain that can be categorized in:

- Grass and peat fires;
- Land reclamation and clearing;
- Civil technical works (construction of large canals, dams and roads);
- Poaching and collecting of wild life;

Grass and peat fires: Grass fires are annual events that normally only occur in herbaceous swamps. The grass fire destroys only the vegetation, but normally not the peat layer. Peat fires, on the other hand, destroy high and low swamp forests and temporarily create open water areas that are soon covered with a newly established floating or rooting herbaceous vegetation. During such events the peat layers that take many years to establish are significantly damaged. The last documented peat fire is dated 1963/64[30]. However, vegetation fires on small scale in the swamps are reported annually, in particular during the long dry season. Up till now, all documented grass and peat fires are related to human activities.

Land reclamation and clearing: Since the 17th century, about 2,000 km^2 land of the Young Coastal Plain has been turned into plantations and polders. Originally, most of these areas were wetlands. In the cover landscape and the Interior uplands, land is used for shifting cultivation; the total area is unknown, but is presently not expanding significantly. In these same areas, land is currently being requested for large-scale oil palm and sugarcane cultivation and for cattle grazing which indicate that large tracts of forest will be cleared for these land-use activities. In the coastal zones, new areas are issued for agricultural purposes.

Civil Technical works (construction of large canals, dams and roads): These are observed at several locations in the coastal areas. Large civil technical works are inevitable during economic development. However, where these works have been constructed, considerable hydrological changes and changes in biodiversity, reaching across large areas can be observed. Examples from the past are the east-west road Burnside-Wageningen, water

[30]Noordam D. 2011. Ecology and Geomorphology. Technical document "project Enabling activities for the preparation of Suriname's Second National Communication to the UNFCCC". Ministry of Labour, Technological Development and Environment.

retaining and drainage diversion dam south of the Nickerie rice area, the Corantijn Canal, and the water retaining dam south of the Coronie rice polders.

Poaching and collecting of wild life seem to be a common practice in Suriname and some animal species have become locally rare or even extinct. Illegal collection of sea turtle eggs on beaches in Eastern Suriname is already affecting turtle populations. Further development of the network of polders, dams and roads will improve access to previously inaccessible areas, leading to an increase in illegal activities. In the Interior uplands, the construction of new roads provides access for people to hunt, fish, log, collect, and conduct shifting cultivation in previously inaccessible areas, affecting ecosystems over vast areas. See Table 1.1 and Figure 1. for ecosystems in Suriname.

3.4.3.1 IMPACTS ON ECOSYSTEMS AND COASTAL ZONES

Ecosystems have always responded to global climate change, but on different scales and at different rates of changes in climatologic circumstances. These responses may include shifts in the timing of biological events, in population and reproductive biology, and shifts of species in geographical zones, including extinction of certain species. Data at species level are lacking and hence emphasis will be put on the impact of climate change at a broader ecosystem level.

With respect to future climate change a number of changes are expected to happen in the estuarine zone. Although the sea level rise is the main driver of these changes, this single force cannot create large problems for the existing healthy mangrove-mud coasts. Therefore the ongoing alternation of accretion and erosion at these coasts will be maintained under the future conditions with possible increase in the erosion and deposition rate. Under these circumstances it is expected that the ecosystems will not change dramatically, although some shifts will occur, especially where hard constructions are found[31]. Depending on the strength of these structures the coastline will be fixed at the given location, however at high costs;

[31]Noordam D. 2011. Ecology and Geomorphology. Technical document "project Enabling activities for the preparation of Suriname's Second National Communication to the UNFCCC". Ministry of Labour, Technological Development and Environment.

lack of maintenance may, for example, lead to deterioration of the dam and eventually to dam breach with tremendous losses in the end. Other structures such as clay dams will only enhance erosion rather than deposition. At these locations and at those free of natural and man-made structures sea water penetration will occur in the estuarine zone exerting negligible impacts on wild life which will either move to higher grounds or adapt to the new conditions.

Along the lower courses of the rivers, the riverine mangroves will not be impacted by the increasing sea level, yet they may become extended to some kilometers further stream upwards with the movement of the salt wedge. Adjacent to the coastal mangrove forest a brackish zone may develop where, depending on the mangrove ï mud bank interaction and climatic conditions (including decreased rainfall and increased evapo-transpiration), hyper-saline conditions may develop. Under such conditions the number of species can reduce drastically.

Changes in the numbers of turtles to nest on beaches in eastern Suriname are linked with the geomorphologic changes which are, among others, dependent on the rate of the sea level rise and sediment balance. A negative balance will possibly erode the beaches thereby affecting the number of nesting turtles; however, a positive balance might increase its number in this part of Suriname.

The freshwater zone: This zone, if not interfered by human development, will have the least impact by future climate change, except when a dramatic rise of swamp water occurs. Under dramatic rise in water level severe impact will arise; freshwater zones are often covered by intense growth of vegetation and peat cover, affecting the flow from this zone negatively and hence promoting water levels to increase with the same rate as the sea level rise and that of the river. Increased swamp water levels have modifying impacts on vegetation of the low swamp forests and promote carbon sequestration through conservation of peat. It is estimated that on every 1.1 million hectares of swamp, approximately $5.5x10^8$ ton Carbon will be fixed. However, alternation of climatic conditions e.g. prolonged dry conditions, reduced rainfall, and increased evapo-transpiration will promote the susceptibility of peat to possible swamp fires. Therefore, possible future occurrences of large-scale peat fires would be dramatic in terms of CO_2 release. On the other hand, a dramatic rise in swamp water levels might damage the adjoining swamp woods and swamp forests, which subsequently would then be replaced

by other types of vegetation. The bordering high dry land forests would be replaced by the seasonally flooding marsh forests.

All land beyond the young coastal zone is for the largest part covered with high dryland forests, which with regard to the relative high soil moisture content are less sensitive to extensive degradation. Degradation only occurs when these fire-resistant native forests are converted into fire prone vegetation through repeated forest damage from drought, logging and/or fire. Such extensive forest degradation does not regularly occur in Suriname with the exception of a few, generally very small sites. Future climatic conditions combined with large scale developments such as road construction through the forest, shifting cultivation, logging, and possibly other socio-economic developments may increase the sensitivity of the forest for further degradation, but die-off in general is not expected. For certain areas, in particular southwest Suriname, such developments could lead to the ñecological tipping pointò. Therefore it is worthwhile to evaluate the risks of forest die-off for the Surinamese forests.

3.4.4 SOCIO-ECONOMY

3.4.4.1 POPULATION

The total population of Suriname in 2009 was approximately 524,143 with a sex ratio of 101.96, indicating that there are a marginally larger total number of males than females. The working age population (15-59) is 61.7% of the total, while the young (0-14) and elderly (60+) make up 28.8% and 9.3% respectively. The growth rate is 1.3%.

The Surinamese population is ethnically diverse and according to the 2004 census is composed of: 27.4%Hindustanis; 17.7% Creoles 14.7%Maroons; 14.6% Javanese; 12.5% Mixed; 3.7% Amerindian; 1.8% Chinese; and 0.6% Whites.

See Table 1.2 for information on the average socio-economic indicators over the period 2003 - 2008 for Suriname.

Table 3.2 reveals that only 56% of the working age population claims to be formally employed out of which male participation in the economy is higher than female.

Table 3.2: Economic participation data

Source: Nijbroek, 2011a; Assessment of the Socio-Economic Current Profile of the Republic Suriname

	Working age population (15-60) – 2004 census			Economically active (incl. jobseekers) – 2004 census			Participation ratios		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Paramaribo/ Wanica	105,634	107,005	**212,639**	74,551	47,869	**122,420**	70.6	44.7	**57.6**
Suriname	154,836	154,179	**309,015**	109,627	63,485	**173,112**	70.8	41.2	**56.0**

Free health care service in Suriname is enjoyed by approximately 34% of all households. These include households with an annual income less than the governmentôs formulated poverty line. Furthermore, the majority of households are headed by men, which is approximately double the number of female headed households. The only exception to these data is the Maroon communities where all households are effectively female headed.

The official number of employed and unemployed individuals in 2009 was 126,370 and 12,525, respectively. This creates an unemployment rate of 9%. It is believed that many people work in the informal sector which is not reflected in these numbers.

3.4.4.2 GOVERNMENT

Suriname has a constitutional democracy with a President who is both the chief of state and the head of the government. The 51 members of Parliament, the National Assembly, are elected for five years by popular vote. The President and Vice President are elected by the assembly by a two-thirds constitutional majority, or by common majority of votes in the United People's Assembly. The Vice President of the Republic also chairs the Council of Ministers consisting of 17 Ministers, representing an equal number of ministries appointed by the President. A State Advisory Council consisting of 14 members advises the President in the conduct of policies. Justice is exercised by an independent Court of Justice, of which the members are appointed for life by the President, in consultation with the National Assembly, the State Advisory Council, and the National Order of Private Attorneys.

There are 10 administrative districts in Suriname: Brokopondo, Commewijne, Coronie, Marowijne, Nickerie, Para, Paramaribo, Saramacca, Sipaliwini and Wanica.

Political control over the entire country is carried out centrally from Paramaribo. Out of the 17 existing ministries the most important ministries with respect to vulnerability and adaptation to climate change are:

- The Ministry of Physical Planning, Land and Forest Management (RGB);
- The Ministry of Natural Resources (NH);
- The Ministry of Agriculture, Animal Husbandry and Fisheries (LVV);
- The Ministry of Public Works (OW);
- The Ministry of Regional Development (RO);
- The Ministry of Planning and Development Cooperation (PLOS), which no longer exists, and whose tasks are partially fulfilled by the Ministry of Foreign Affairs (BUZA) and the ministry of Finance.
- The Ministry of Labour, Technological Development and Environment (ATM). This ministry is responsible for representing Suriname at international meetings and creating strategic alliances with countries that face similar climate change risks such as Suriname: (note 2016: this ministry no longer exists; its environmental tasks are fulfilled by the Coordination Unit within the Office of the President of the Republic of Suriname.
- Local representation is generally weak, partly because political representatives outside of Paramaribo lack political power. District council members are elected locally and are required to work with the District Commissioner (DC) in addressing issues of local concern. While the positions of the council members and that of the DC are paid, they have limited operating budget. An ongoing decentralization process (started in 2002) is supposed to provide an operating budget ï mainly for local projects regarding infrastructure - for the DC and council, but this has not been fully implemented.

Groups exposed to environmental risks tend to request assistance from the leadership of affiliated political parties, but this is only effective if the group is politically homogeneous. Vulnerable groups can also request assistance from someone in government with a high

public profile, usually a minister, the speaker of the house, or even the president. This is usually done through the media, which is not the most effective form of participation. Local council members are therefore marginalized, people have little political representation, and adaptation measures will be increasingly autonomous at the household or community level. Participation in planned national adaptation will continue to be minimal if local governance is not changed.

Economy: Surinameôs economy is, due to many reasons, not a well-diversified economy. It used to depend heavily on mining, but is currently less dependent on that particular sector. When compared to other sectors, the mining industry is not a large employer any more. The economy of the country can be characterized as beyond transitional, with a large tertiary sector, but not yet developed. There is relatively too much income inequality compared with the EU (0.36) or the USA (0.46), with a Gini Coefficient of 0.5467, but compared to Brazil (0.57) or Colombia (0.58), Suriname is doing better(0 = total equality, 1 = inequality). Notwithstanding this, Suriname has some distinct economic advantages. Among these advantages are: an effective tax income stream from personal income, imports and consumption which covers annually around 80% of budget expenses, furthermore, a small, but professional banking and insurance sector, energy independence from oil production and export, as well as hydropower. Income from exports of oil, bauxite, gold and agricultural products (e.g. rice and bananas) and fisheries, with ample land and freshwater reserves for expansion will also contribute to these economic advantages.

What Suriname lacks in terms of capitalizing on its natural advantages listed above is capacity and capital. The government planning is limited to 5 year cycles, and given its importance the development of the private sector requires an in-depth strategy. Foreign Direct Investment (FDI) is required to develop strategic long term projects as Suriname does not have the internal capital resources (banking system and government) to underpin investment. The capacity required to get the best deal for Suriname does not exist and there is a resistance to employing agents. Furthermore, Parliament does not have the capacity to pass an investment law to give oversight to executives in implementing FDI deals. Inferior foreign language skills, English but also regionally important Spanish and Portuguese, add to the problems of acquiring effective investment. In the short term despite poor economic

governance and the global recession of 2007-2009, the economy, however, continues to expand.

Table 3.3:Baseline economic data

Sectors	Percentage (%)
GDP growth ï mean 2000 to 2009	4.52
Per capita income growth (SRD) - % change 2000 to 2009	716
Export growth (SRD) - % change 2004 to 2008	215
Import growth (SRD) - % change 2004 to 2008	176
Monetary reserves (USD) - % change 2004 to 2008	353
Monetary reserves import coverage (months) - % change 2004 to 2008	63
Debit interest rate ï mean 2004 to 2008	15.1
Average annual inflation ï mean 2004 to 2008	10.52
Foreign debt (USD) - % change 2004 to 2008	-17
Total debt % GDP2000 ï 73.9% é .. 2010 (Q3) ï 23. 4%	

Source: Nijbroek, 2011a; Assessment of the Socio-Economic Current Profile of the Republic Suriname

Trade and hospitality, agriculture and fisheries, and construction are important sectors in terms of private sector livelihoods. These sectors provide 37,638 formal jobs in total, with 11,552 (31%) being available in agriculture and fisheries, a far greater share of the formal employment market than the relative sectoral share of GDP (7%). The latter is also very likely to be impacted by climate change. Very important to note is the 20% share of the informal sector in the economy; this has very important consequences for socio-economic vulnerability and is evidence of strong coping capability in Surinamese society.

Table 3.4 below shows the relative share of formal GDP of each sector and formal employment in that sector:

Table 3.4: Share of formal GDP of each sector and formal employment

Sector	% GDP	Number of formal jobs
Trade, Restaurants & Hotels	19.71	16,260
Financial Institutions & Commercial Services	17.40	3,151
Industry & Manufacturing	11.70	7,173
Transport, Storage & Communication	11.38	2,152
Mining	7.82	3,040
Agriculture, Forestry and Fisheries	7.48	11,552
Utilities (Gas, Water, Electricity)	6.10	1,798
Construction	5.98	9,826
Government and public sector	5.74	26,637
Education (public teachers)	4.49	13,427
Social and Community Services	1.62	3,956
Health	0.57	Unknown
Total	**99.99**	**98,972**

Source: Nijbroek, 2011a; Assessment of the Socio-Economic Current Profile of the Republic Suriname

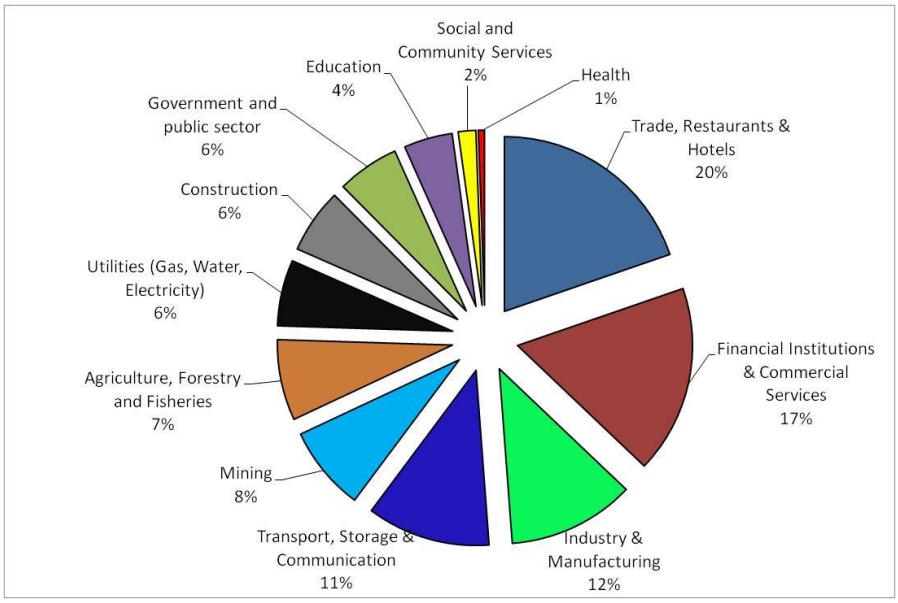


Figure 3.7: Relative share of formal GDP of each sector and formal employment in that sector

Source: Nijbroek, 2011a; Assessment of the Socio-Economic Current Profile of the Republic Suriname

The Figure 3.8 below represents the average disposable income as a percentage of household budgets in four important regions.

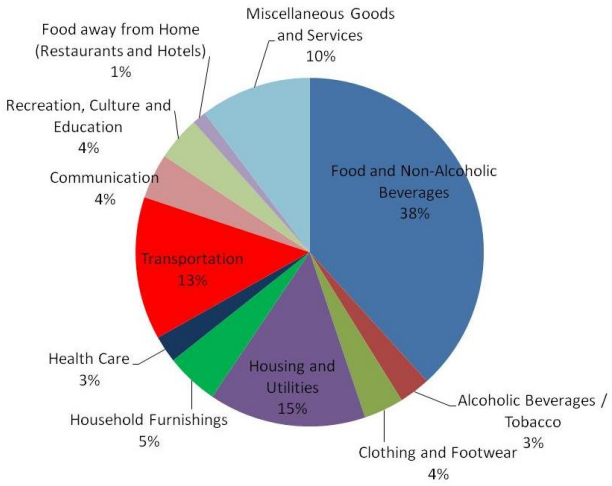


Figure 3.8: Average household monthly consumption expenditures as a percentage for Paramaribo, Wanica, Nickerie, Coronie, Saramacca, and Commewijne. Source: Nijbroek, 2011a; Assessment of the Socio-Economic Current Profile of the Republic Suriname

The four largest average household expenditures are: Food and non-Alcoholic Beverages (38%), Housing and Utilities (15%), Transportation (13%), and Miscellaneous Goods and Services (10%). These four groups account for 76% of the household budget. Changes in one of the items will go at the expense of other groups. The present state is one whereby the monthly income is fairly constant whilst the expense rises. Such developments will negatively affect the adaptive capacity of these people.

Land-use: The total area of Suriname is 16,327,000 hectares of which 61,000 ha are in production; which is less than 0.5% of the territorial land (Figure 12). The largest part of the land in production is found in the fertile young coastal zone. Data on spatial distribution and land ownership is lacking. In the Hinterland, the Interior Upland, Maroon and Indigenous communities are responsible for shifting cultivation on an estimated land surface of about 247,000 hectares, based on a 15 year rotation of 16,500 hectares. Agriculture in this part of the country is mainly subsistence agriculture; cultivated and processed mainly by the female head of the household after the forest is cleared by males.

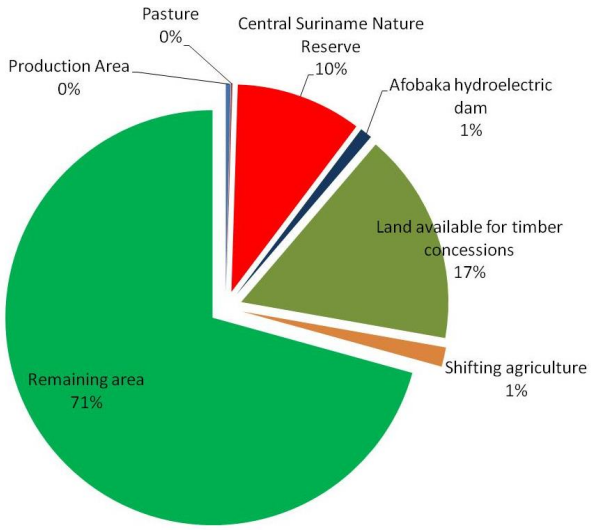


Figure 3.9: Graph showing land-use in Suriname.
Source: Nijbroek, 2011a; Assessment of the Socio-Economic Current Profile of the Republic Suriname

Figure 3.9 also reveals that more than 90% of the land area in Suriname is green and largely covered by forests. In this respect and taking into account the low historical deforestation rate, Suriname is identified as a HFLD (High Forest Cover, Low Deforestation) country. However, there are a number of threats undermining this position in keeping the country green at this level. One of these threats is the lack of land-use planning in Suriname. Necessary legislations to put in place have been discussed, but have never been implemented. This deficiency will only amplify the impacts of climate change with respect to changing rainfall patterns and sea level rise. This holds true in particular for the coastal area. Specifically for this part of the country an Integrated Coastal Zone Management (ICZM) Plan was also completed in 2010 but its implementation has not yet started.

3.4.4.3 TRANSPORTATION

In the coastal area roads are mainly used for transportation; Figure 3.10 reveals that the number of cars for passengers is rapidly increasing. In the Interior, road, land and air are used for transportation. There is an extensive network of rivers and airfields, but a poorly developed road system in the Interior. The majority of the people in the Interior use river transportation to get access to the Hinterland. During the last decade, economic growth has

improved national transportation in general, but not the transportation system in the Hinterland.

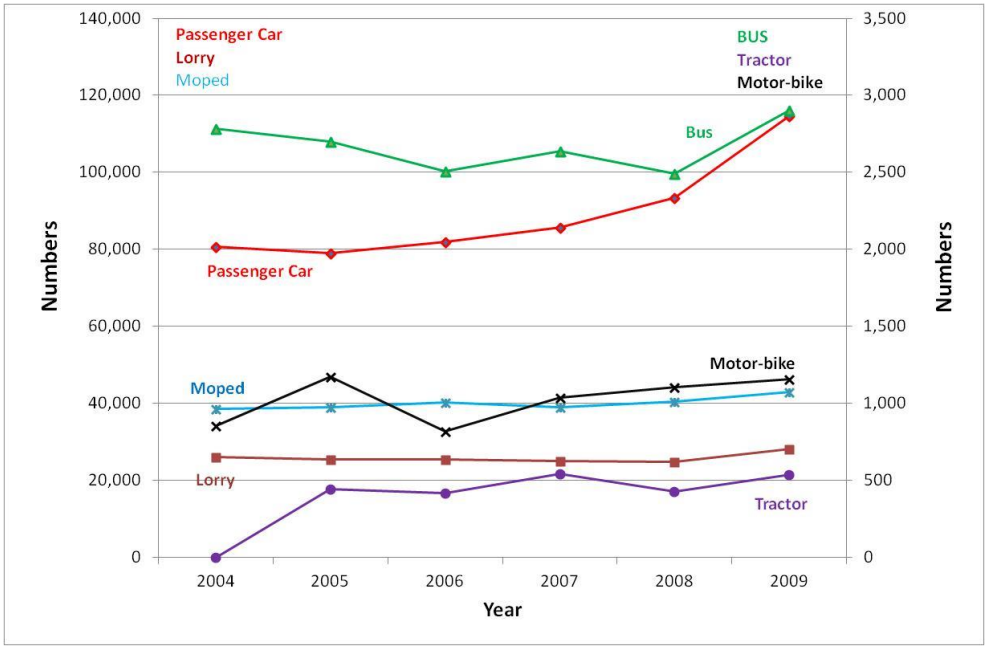


Figure 3.3: Number of registered motor vehicles on public roads, 2004-2009
Source: Nijbroek, 2011a; Assessment of the Socio-Economic Current Profile of the Republic Suriname

The Nickerie River port is in the western part of the country where rice and banana production is concentrated. The largest port, however, is Paramaribo with import ï export ratios of 75% and 27%. Concerning freight transportation, the port in Paramaribo has grown significantly, while for Nickerie it has declined and for Paranam it has been steady since 1988.

3.4.4.4 ENERGY SUPPLY

The NV Energie Bedrijven Suriname (EBS) is the only legal supplier of energy in Suriname, particularly in the coastal zone and part of the Interior. Electricity is produced by the Afobaka hydropower plant and diesel generators. About 79% of the population has access to electricity supplied by EBS. In the Hinterland electricity provision is poor due to various reasons such as difficult accessibility, a poor fuel supply, and high transportation costs. The total number

of people affected by these poor conditions is approximately 30,000 or 15% of the population who do not have adequate access to electricity. Demand for electricity is growing with about 5.3% per year. Peak demand is projected to rise from 130MW/795GWh in 2007 to 354MW/2160GWh in 2023. For the next 15 years, the expected level of investment in new generation and network capacity is estimated to be in the order of 1 billion USD. Efforts are made to over bridge the gap, mainly through realization of renewable resources such as hydropower, bio-, solar-, and wind energy.

3.4.4.5 WASTE

Solid and liquid waste production grows as the economy grows. Since collection of solid waste does not cover all households in urban areas, many people choose to burn household waste or dispose of it into open spaces or rivers. Waste water from Paramaribo and other urban areas are released directly into the rivers while household water is directed to septic tanks in peopleôs backyards. All these continue, posing risks to human health and the environment.

3.4.4.6 IMPACT ON THE SOCIO-ECONOMY

In determining the future profile of Socio-economic sector, two key figures are expected to play a significant role: (1) demographic predictions and (2) energy demand.

Future demographic trends are given for the period 2024. Population projections for this period varies from a low of 559,324 to a high of 711,399; an increase of 13% or 44% respectively over 2004 census population (492,829).

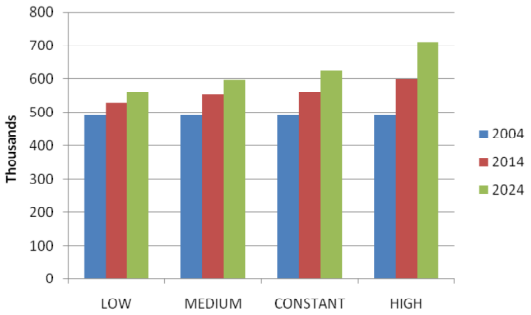


Figure 3.11 Total Population predictions for 2004, 2014 and 2024

Source: Nijbroek, 2011b; Assessment of the Socio-Economic Future Profile of the Republic of Suriname

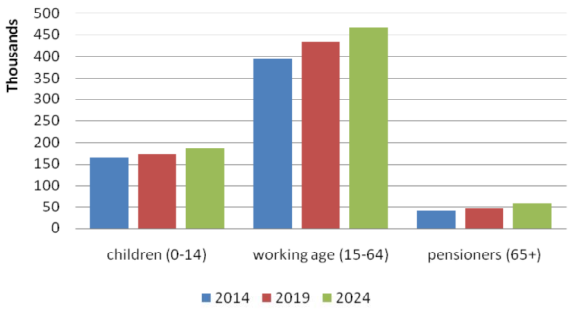


Figure 3.12 Future population predictions by age for 2004, 2014 and 2024

Source: Nijbroek, 2011b; Assessment of the Socio-Economic Future Profile of the Republic of Suriname.

Future population predictions indicate that the growing population will exert an increasing demand on the resources. The growth of school children by 12% and working age population by 19% over 2014 will urge for new jobs in teaching, building construction, health care and others, which have to be created and accommodated[32]. Also the number of pensioners will grow exerting extra pressure on the budgets. This population growth will largely take place in the urban areas, since urbanization of the small rural population remains small. Unexpected and unsustainable growth may occur among the immigrants from Brazil, China, lately also from the Netherlands. It should be noted that all urban centers in Suriname are located on the low-lying coastal zone. Unsustainable growth without proper planning and management of available resources will rapidly exhaust or deplete these resources and increase their vulnerability to extreme climatic and other conditions.

[32]Nijbroek R., S. Meaney 2011b. Assessment of the Socio-Economic Future Profile of the Republic Suriname.Technical document "project Enabling activities for the preparation of Suriname's Second National Communication to the UNFCCC". Ministry of Labour, Technological Development and Environment

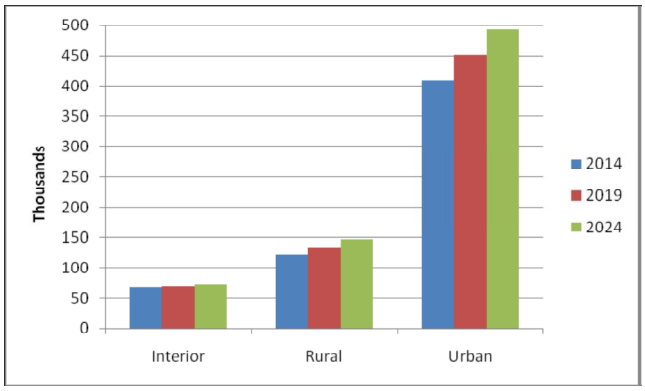


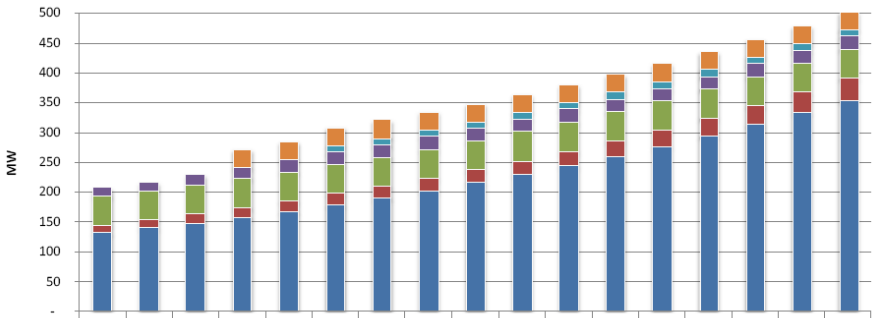
Figure 3.13: Population growth by area for 2014, 2019 and 2014 (source: ABS).[33]
Source: Nijbroek, 2011b; Assessment of the Socio-Economic Future Profile of the Republic of Suriname.

Energy demand at the domestic level is expected to grow by roughly 5%, which is the long run historical mean and is going to require investments of around $1 billion for the next 15 years (2008-2023). The peak demand in 2023 relative to 2007 will grow from 130MW to 354MW and will have to be supported by significant investments[17]. In this respect the following are worth mentioning:

- An energy availability of 12MW by the year 2012 is needed just for the expansion of the refinery Staatsolie Oil Company is planning to realize;
- Another 30MW is required for a number of new gold mining activities envisaged for the coming years in the Nassau Gebergte mountain area;

Figure 3. presents the overall forecast of the peak load in Suriname.

[33] In this regard land use planning is an important tool for mitigating the vulnerability, particularly when impacts of climate change, sea level rise, extreme events including rainfall and drought, and the currently unsustainable practice of constructing on low lying clay land around existing urban areas, are taken into consideration.



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total	206	216	229	271	284	308	321	334	349	364	380	397	416	436	457	479	503
Others				30	30	30	30	30	30	30	30	30	30	30	30	30	30
Refinery		-	-	-	-	12	12	12	12	12	12	12	12	12	12	12	12
Iamgold	13.5	14	17	19	21	21	21	21	21	21	21	21	21	21	21	21	21
Suralco	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49
Districts	14	14	15	16	17	18	20	21	22	24	25	27	29	30	32	34	37
EPAR	130	139	148	157	167	178	189	201	214	228	243	259	275	293	312	332	354

Figure 3.14: Overall forecast for peak load in Suriname (MW). Forecast for EBS are for the base case. Source: Nijbroek, 2011b; Assessment of the Socio-Economic Future Profile of the Republic of Suriname.

3.4.5 TOURISM

Suriname was one of the first countries in the Americas to develop nature tourism in the early 1970s, when the country became famous for its bird watching tourism (Inter-American Development Bank 2005). Nevertheless its contribution to the global tourism industry has been marginal up to now (Texel 2005).

In the past decade tourism has become more important for Suriname, earning foreign exchange and providing labour opportunities. The total number of visitors to Suriname increased from 138,043 in 2004 to 150,695 in 2009. The World Travel and Tourism Council[34] reported the following key facts on the Tourism Industry in Suriname:

[34] Travel and Tourism, Economic Impact Suriname 2012, www.wttc.org

Table 3.5: An overview of the contribution of travel and tourism in Suriname

Source: Travel and Tourism, Economic Impact Suriname 2012, www.wttc.org

Travel & tourism	2011	2012	2012-2022	2022 and onwards
Direct contribution	SRD 207.6m	- 2.1% of GDP	+ 3.2% of GDP	SRD 277.3m
Total contribution	SRD 514.7m	- 0.9% of GDP	+ 3.4% of GDP	SRD 711.3m
Employment	SRD 3,000	+ 1.6% of GDP	0% of GDP	+ 1.4% of total employment
Visitor exports generated	SRD 247.9m	- 3.8% of GDP	+ 2.4% of GDP	SRD 302.8m
Investment	SRD104.2m	+ 3.9% of GDP	+ 4.1% of GDP	SRD 161.1m

Suriname is endowed with an abundance of rainforest, freshwater and a tremendous diversity of cultures living in the Hinterland offering opportunities for nature based tourism. Tourism that is promoted in Suriname is entirely dependent on the integrity of the environment of the country. On the other hand, tourism can have a negative effect on the environment, namely on the crowded coastal zone and the Interior where the Indigenous and Maroon communities live. In addition, tourism can cause an increase in waste, emissions from transport, and water and energy consumption (ABS, 2010). Settlements of the Maroons and the Indigenous tribes are found along the upper streams of the rivers. Access into the rainforest of the Hinterland is provided mainly by these rivers.

Another important source for tourism in Suriname includes the vast number of nature reserves, multi-use- management areas (MUMAs), and one Nature Park. These form a great opportunity for bird watchers and admirers of various other species, such as turtles, dolphins, and other wildlife. Hence, Surinameôs biodiversity supports its tourism sector through rainforest treks, wildlife and bird watching, adventurous river tours with the opportunity to see endangered river dolphins and community-based tourism in Amerindian and Maroon villages.

Suriname is considered a Small Island Developing State (SIDS), because of its low-lying coast, its coastal communities and its open vulnerable economy. The WTO, in its paper of

2009[35] summarizes the effect of climate variability on tourism destinations and operators in the following way:

- Climate defines the length and quality of tourism seasons (e.g. winter sports) in different regions. Some tourism destinations are climate dependent; since climate is the principal resource upon which the tourism industry is based (e.g. many tropical small island developing states);
- Climate directly affects various facets of tourism operations (e.g. water supply and quality, heating-cooling costs, snowmaking requirements, irrigation needs, pest management, evacuations and temporary closures) that affect profitability;
- Moreover, a wide range of environmental resources that are critical attractions for tourism in many destinations are sensitive to climate variability, such as wildlife and biodiversity, water levels and quality among others;
- Climate also influences environmental conditions that can deter tourists, including infectious diseases, wildfires, algal blooms, insect or waterborne pests (e.g. jellyfish), and extreme events such as hurricanes, floods or heat waves;
- Climate is also a crucial determinant for tourists in their decision-making plans. Seasonal climate fluctuations at tourism destinations and at major outbound markets are key drivers of tourism demand at global and regional scales. Weather is an intrinsic component of the travel experience and also influences tourist spending and holiday satisfaction;

The tourism and travel sectors are characterized by considerable diversity and therefore extensive differences in the nature of climate sensitivities and adaptive capacities of tourism and travel operators and destinations. According to the WTO paper, ñthe implications of climate change for any tourism business or destination will also partially depend on the impacts on its competitors, with a negative impact in one part of the tourism system constituting an opportunity elsewhere. Assessments by different groups of international experts have consistently identified developing nations in the Caribbean, Small Island Developing States (SIDS), Southeast Asia, and Africa as the most at risk tourism

[35] From Davos to Copenhagen and Beyond: Advancing Tourismôs Response to Climate Change, 2009, pg5.

destinations. The main arguments supporting this outlook are the high exposure level of the multiple climate change impacts on the key tourism products, the distance to major markets (long haul travel greater than five hours) and consequent exposure to increasingly stringent emissions policy on aviation, lower overall adaptive capacity, limited domestic markets and a high economic dependency on international tourism and travel.

3.4.5.1 IMPACTS ON THE TOURISM SECTOR

The tourism sector in Suriname is only a small contributor to GDP, but is one of the fewest sectors that have achieved continuous growth in the past decade[36]. The tourism sector is also an important source of revenue for Maroon and Amerindian communities who host visitors in their villages and sell crafts. However, these groups also have peculiar characteristics that make them vulnerable to climate change, such as the high dependence on the natural resources to survive under the remote conditions, level of vulnerability to prolonged drought and flooding. A strong eco-tourism focus indicates that the industry is vulnerable to any changes in climate.

Projected changes in temperature and precipitation reveal a corresponding change in the vegetated areas, displacement and/or loss of habitats followed by (adverse) changes of plant and animal species. Forest and bush fires, among others, promoted by strong reduced moisture levels, will have profound negative impacts on Surinameôs biodiversity, rural communities and the eco-tourism sector.[37]In addition, the inhabitants of the Hinterland, and consequently the tourism sector, are exposed to flooding and extreme droughts, since both extremes affect the accessibility of the Hinterland negatively.

A one meter sea level rise by the end of this century will damage or change the existing ecosystems, primarily in the coastal zone, resulting in degradation of nature reserves, habitats of wildlife and the overall biodiversity. Tourism activities in the coastal area, which mainly encompass bird, dolphin and turtle watching, will be severely impacted.

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[36] CARIBSAVE Climate Change Risk Profile for Suriname, March 2012
[37]CARIBSAVE Climate Change Risk Profile for Suriname, March 2012

At regional level, the CARIBSAVE Climate Change Risk Atlas (CCRA) explored recent and future climate change scenarios using a number of combined observations and climate model projections. Despite the limitations that exist with regards to climate modelling, information retrieved from this Atlas provide very useful indications of the most likely changes in climate characteristics and their impacts on the socio-economic sectors. According to these findings adverse climate change impacts are being experienced by all sectors, particularly on housing, agriculture and transportation. Additionally the international climate policy combined with rising energy prices threatens the tourism industry as international travel is likely to become increasingly expensive.

3.4.6 HUMAN HEALTH

The major component of mortality in Suriname is caused by non-communicable diseases with roughly 29% of all deaths being cardiovascular in nature; malignancies and external causes account each for 11% and diabetes mellitus for 5% of all deaths[38].Figure 3. presents the 10 most prominent causes of mortality in Suriname.

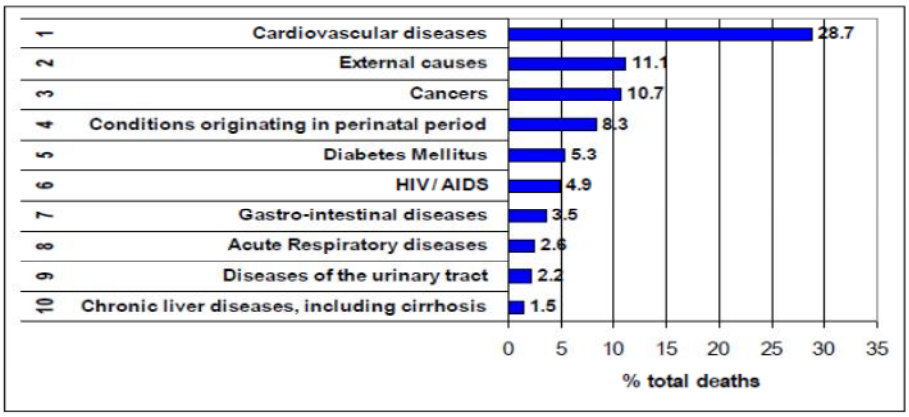

Figure 3.15: Leading causes of death as a percentage of all deaths in Suriname, 2000 – 2008.
Source: Huisden, 2011a; Report on the "Current Health Profile", Suriname 2011

[38]Huisden M. 2011. Report on the "Current Health Profile", Suriname 2011.Technical document "project Enabling activities for the preparation of Suriname's Second National Communication to the UNFCCC". Ministry of Labour, Technological Development and Environment.

The communicable diseases are characterized by respiratory infections and few vector borne diseases. Regarding the vector borne diseases, all 4 types of the dengue virus have been confirmed in the coastal plains while the occurrence of malaria is currently negligible in the coastal areas and well under control in the Interior; there are a few areas, however, where Malaria has been endemic in the past (Figure 3.4).

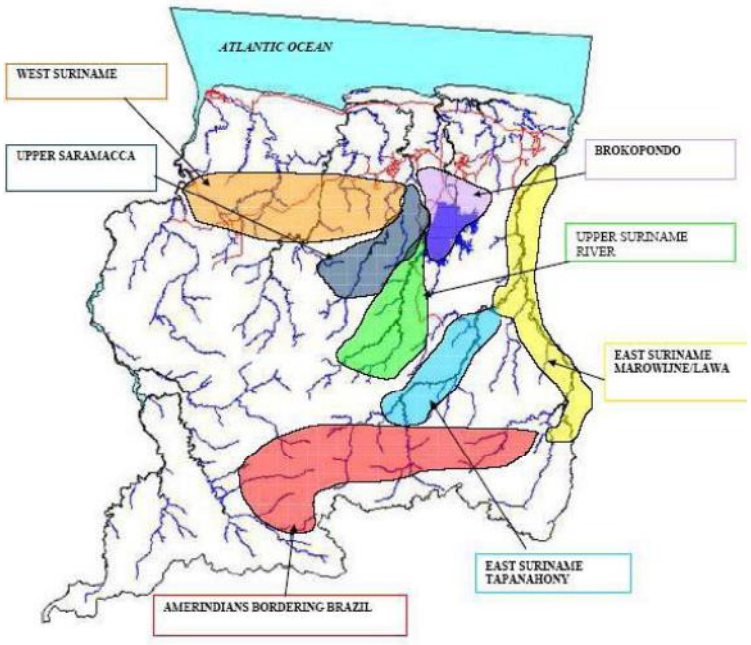

Figure 3.46: Endemic areas of Malaria in Suriname
Source: Huisden, 2011a; Report on the "Current Health Profile", Suriname 2011

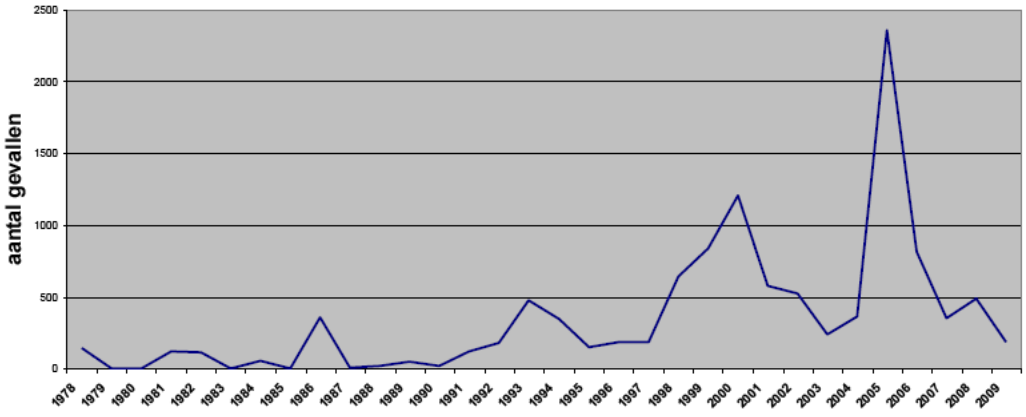

Figure 3.17 Graph showing the course of dengue in Suriname from 1978 -2009.
Source: Huisden, 2011a; Report on the "Current Health Profile", Suriname 2011

Figure 3.17 reveals an increasing trend in the number of dengue cases since 1980. As described under the section water resources, impacts of global climate change associate in Suriname with an increased alternation in rainfall characteristics, e.g. the amount of rainfall during one rainfall event, length of the duration between the rainfall events and increased rainfall intensity. The number of dengue casualties drops under extreme conditions, which often coincide with a strong El Niño (extreme dryer than normal) or La Niña (extreme wetter than normal) event. Analyses of the ENSO and dengue occurrences in Suriname reveal:

- an increase of dengue occurrences with alternating ENSO events, except for the strong events, since climatic conditions are unfavorable for dengue mosquito's to develop;
- strong El Niño associates with extreme temperatures and less rainfall and hence drought, whilst the La Niña events, associate with frequent and abundant rainfall and hence resulting in water to flow over large areas.

Both extremes reduce the growth of dengue causalities in Suriname. However, further monitoring and investigation is required to better understand this possible correlation.

Figure 3.18 is another example of how rainfall relates with dengue occurrences in Suriname. During the first quarter of the year, when rainfall is not consistent and the length of the duration between the rainfalls allows water to stand for days in pools, depressions, open pits and thrown wastes, such as cups, tires and bottles, etc., dengue occurrence increases. With more consistent rainfall, as seen in the wet months, water starts flowing and dengue occurrence decreases. The time frame of February to April, characterized by alternating rainfall, promotes conditions for Dengue to develop.

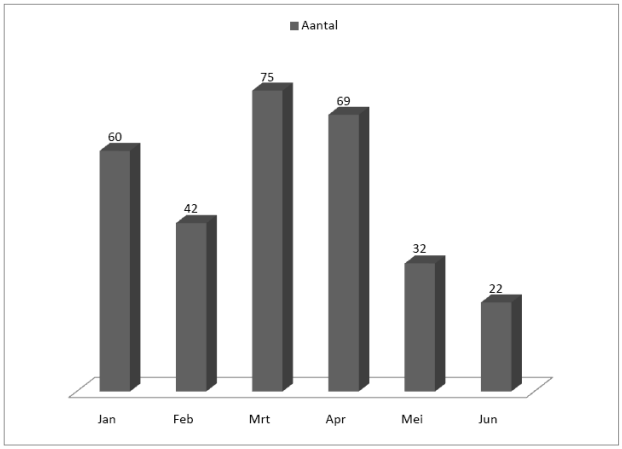

Figure 3.18 Dengue occurrences at 29 medical centers in 2006
Source: Huisden, 2011a; Report on the "Current Health Profile", Suriname 2011

Malaria occurrences also seem to be affected by strong alternations in weather and climatic patterns. During periods of abundant rain fall, creek, river and swamp waters often flow, mitigating Malaria occurrences by disrupting the completion of the life cycle of the Malaria vector, the *Anopheles darlingi*. On the contrary, under prolonged dry conditions, stagnant and standing water occurs in the creeks, swamps, and rivers, sustaining good conditions for the Malaria vector to develop.

With respect to Lymphatic Filariasis, Suriname has reached the stage for certification regarding its successful elimination. Eligibility for such certification is based on its low occurrence rate of less than 1/100,000. On the other hand there is an increase in tuberculosis cases in combination with HIV/AIDS co-infection observed; HIV/AIDS affects the immune system, which makes patients more susceptible to infectious diseases such as tuberculosis. During environmental changes, infectious microorganisms may thrive, leading to an increase in the conditions caused by them. Particularly conditions affecting the respiratory system may be more prevalent during particular climatologic situations. In addition, acute and chronic diarrhea, mal-nutrition, respiratory illness, dermatological and eye conditions are also of particular concern.

3.4.6.1 THE CURRENT HEALTH CARE INFRASTRUCTURE OF SURINAME:

The Ministry of Health with its three core institutions, namely the Ministry of Health's Central Office, The inspectorate (Office of Health Inspection) and The Bureau of Public Health, is the ultimate responsible institution for the health care system in Suriname. Due to the uneven distribution of the population, health care services are more readily available in the coastal area. These services are operated by the Regional Health Services (stg. RGD) and the ñBureau of Public Healthò (BOG). BOG is the most important institution regarding health promotion in Suriname; it plays an important role in public health policy design and offers a great variety of services including those of the Central Laboratory Services, Division of Epidemiology and the Environmental Inspection Agency.

The RGD consists of 43 general clinical centers including 8 large health centers located in the coastal area of Suriname, reaching from East to West and divided over 8 divisions or districts. The medical staff at the 43 clinics consists of a total of 63 medical doctors and 200 nurse practitioners, including 12 midwives, 24 diabetes nurses, 10 HIV counselors, 19 laboratory technicians, 2 pharmacists, 39 pharmacist's assistants and11 ambulances.

In the less densely populated areas of the Hinterland, medical services are being offered through the ñStichting Medische Zending (Primary Health Care Suriname)ò (MZ). The MZ was formed as an initiative of several religious organizations in Suriname and consists of 56 public health centers operational in various areas of the Interior of Suriname; the area has been divided into 6 general regions and 9 specific areas, each with their own health centers. All health centers are staffed by trained health assistants, microscopists and clinical aids responsible for daily availability of the health care services that are being supervised and guided by regional clinical supervisors and regional managers (general practitioners).

These services generally include consultations, diagnosis, vaccination and health education.

Suriname has seven (7) relatively large hospitals, which are all situated in Paramaribo except for two of which one in Albina, in the east of Suriname and the other in Nieuw Nickerie in

the west of the country. A total of 1,500 beds are available (3.0 beds per every 1,000 inhabitants) while the occupancy rate is about 85% and the average stay is 8 days[39].

3.4.6.2 MONITORING DISEASES OF CONCERN

Based on natural disasters that occurred in 2006 and 2008, causing populated areas in the Interior to flood for several weeks at a time, a disease monitoring system was introduced by MZ and BOG. This monitoring system includes among others, the hospital surveillance system, the telecommunication surveillance system and reporting services. All data are processed and reported to the division of Epidemiology, Director of BOG, Ministry of Health, PAHO and CAREC. The division of Epidemiology publishes these data in a yearly report and disseminates this publication to relevant data collecting organizations.

The system further keeps records of malaria cases and several key medical conditions for two age groups, namely below and over 5 years of age. The aforementioned medical conditions include amongst others fever and respiratory symptoms caused by upper or lower airway infections, various types of diarrhea and gastro enteritis.

During the flood of 2006 this system was put into practice in the affected areas. Data of this area showed an increase in airway infections among the Indigenous populations. These observations were consistent with the report of the Ministry of Health (2005-2007). In addition, there was also an increase in diarrhea cases among all inhabitants of these areas.

According to RGD data, however, the total number of patients with airway infections in 2006 and 2007 was respectively 25,266 and 25,685, which is approximately 3,000 cases more than in 2005. According to the same source, dermatological infections were increased with 1,500 from 2005 up to 2006.

During the time of the flood an increase in skin infections and cases of dengue fever has also been observed, but has not been further studied.

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[39]Huisden M. 2011a. Report on the "Current Health Profile", Suriname 2011.Technical document "project Enabling activities for the preparation of Suriname's Second National Communication to the UNFCCC". Ministry of Labour, Technological Development and Environment

Since 2001 there has been an overall and steady decline in malaria cases treated in one of the larger hospitals in Paramaribo, St. Vincentius Ziekenhuis. However, after the floods of 2006 this number, although moderate, has been doubled in 2008 and 2009 (Figure 10). One possible explanation is that increase in pools of standing water in the Hinterland has led to higher number of malaria causalities. Transmission of infectious disease agents is affected by environmental and climate factors. Disease vectors that spend their life cycle outside the human body and pathogens that are carried by insects are exposed to ambient weather. These vectors often display seasonal patterns in which the role of precipitation and temperature is significant.

3.4.6.3 IMPACTS ON HUMAN HEALTH

Human health in Suriname is vulnerable to the effects of climate change, such as increased temperature, alternating rainfalls leading to excessive stagnant water, floods, and droughts, and rising seawater levels causing flooding and intrusion of saltwater land inwards. These effects, occurring either separately or in combination, have impacts on:

- population concentrations located in the low coastal area;
- population concentrations located in isolated and remote areas in the Hinterlands;
- members of the population with low socio-economic income, many of whom lack insurance, and
- members of the population who are in poor health, infants, and the elderly.

Temperature and Health

Rise in temperature will affect health in various ways:

- Expansion of existing microorganisms and development of new microorganisms including pathogens, disease vectors, and diseases that will potentially thrive and cause a significant threat.
- Development of new pathogens as a result of conditions more hospitable to mutant species. This will significantly challenge the countryôs disease control ability.

- Increase in mortalities due to high temperatures, particularly during heat waves, will affect especially the elderly and those with a specific cardiovascular, cerebrovascular and respiratory disease.

Precipitation and Health

Change in precipitation will impact Human Health in the following way:

- Increase of vector diseases, such as malaria in the Interior and dengue in the coastal area;
- Increase in upper (nasal area and throat) and lower (respiratory tract and lungs) respiratory illness, as well as increasing the incidence of diarrhea and the risk of cholera outbreak;

Standing water gives rise to vector diseases, such as malaria. It can also increase the risk of contamination of drinking water reservoirs, potentially leading to a rapid increase of outbreaks.

In addition, flooding may also increase the mobilization of toxic chemicals and dangerous heavy metals and pesticides from manmade storage or stable environmental pools existing in natural reservoirs that may be disturbed when excessive water penetrates and causes leaching; potentially contaminating agricultural land, aquaculture and natural fishing waters and drinking water reservoirs.

On the other hand, periods with less rainfall can help control mosquito- and other insect-transmitted diseases such as malaria, filaria, dengue, leishmaniasis, and yellow fever. Extended drought will take its toll on the fresh water supply due to a decrease in aquifer replenishment, which can lead to less clean drinking water. Swamps and wetlands may also be affected by these droughts, which may consequently impact the availability of fresh water fish. Thus an important source of protein in the diet of many Surinamese people may diminish.

An increased risk of forest and other natural fires may affect air quality, causing occasional but severe respiratory illness in nearby populations. The combination of the abovementioned factors could also lead to an increase in the occurrence of gastrointestinal diseases, diarrhea and skin disorders.

Sea level rise and Health

A rise in seawater level is projected to be 1 meter at the coast of Suriname by the year 2100. This will have significant impact on the health infrastructure of Suriname since most of its inhabitants live in the low coastal plains. In some rivers, specifically the ones without sufficiently buffering rapids, the tidal limit will keep pace with the rising sea water level and hence will be moved further inland by the year 2100. Saltwater intrusion, linked with the displacement of the tidal limit, will impact negatively on the potential agricultural grounds and food production areas found along the river banks. This is also true for the freshwater fish, a potential protein source, which, due to changed water quality, will become less available to local populations. Degradation of water quality in the lower courses of the rivers and creeks will also have impacts on crop and animal production which, combined, could lead to increased incidence of malnutrition and decreased disease immunity among local populations, yielding an overall decline in health.

3.5 ADAPTATION ASSESSMENT

3.5.1 DESCRIPTION MULTI CRITERIA ANALYSIS

Adaptation responses in this communication are presented as follows:

First as an integral response for all sectors and the country in general, and second, adaptation responses for each sectors discretely. The following methodology has been applied for the formulation of the adaptation measures:

- At sectoral level the expert(s) assigned for this study has (have) identified adaptation measures based on their own expertise and expert judgment;
- At country level adaptation measures are identified using the Multi-Criteria-Analysis (MCA), during a two-day lasting brainstorming process by the total group of experts;

The multiple criteria that were assessed during the MCA were based on different impacts, sectors and regions. The list of impacts included 44 potential issues which were grouped in three categories: sea level rise, extreme weather conditions and temperature rise. These

impacts were given a score from -5 to 5 (where negative numbers indicate positive impacts) for urban, rural and nature geography under three sectors: economy, health and ecology. The sectors were weighted to indicate their relative importance. The corresponding sectors were then recalculated, where economy received the highest weight factor, followed by health and ecology. The last step of the exercise was to select the most critical issues based on the MCA to be addressed and ranked to determine appropriate adaptation responses.

The six most important issues are:

1. Breaching of dams and dikes / damage to water defense infrastructure;
2. Increase in number of flooding;
3. Decrease of fresh water availability;
4. Decrease of draining potential of urban areas;
5. Decrease of productive land;
6. Increase of ñsibibusiò (heavy rain events with bursts of strong localized rotating wind);

3.5.2 WATER RESOURCES

3.5.2.1 PROPOSED ADAPTATION MEASURES

Based on the abovementioned, it appears that water resources in the coastal area as well as in the Hinterland are ranked as vulnerable to highly vulnerable.

To mitigate its vulnerability, appropriate adaptation measures are identified, which, depending on site specific characteristics, need to be adapted and/or harmonized with additional components. At the implementation level, these measures should also be adapted according to the different needs and urgencies.

1. The general adaptation measures include:
   - Formulation of necessary legislation to protect water resources in general and to promote its sustainable use;
   - Formulation of necessary legislation on water quality standards and waste water discharge;

- Establishment of necessary institutional organization for the enhancement of water management, among others (water boards and authority);
- Establishment of physical infrastructure such as waste water treatment plants;
- Performing in-depth studies, including water balance studies, and the establishment of a required observation network and monitoring system;
- Implementation of the Integrated Coastal Zone Management plan;

2. The specific adaptation measures include:

   - Increase of the efficiency in drinking water supply and in water use in general. For the rural areas, increase in efficiency regarding irrigation practices through technical improvements of infrastructure, capacity building, training and awareness rising;
   - Decrease in the demand and increase of the capacity of available fresh water resources through technological improvements;
   - Encourage use of alternative fresh water resources such as the utilization of rainwater and surface water;
   - Carry out monitoring and in depth studies to enhance water management and sustainable use of water resources;
   - Upgrade of infrastructures for water supply, irrigation, drainage and flood protection;

3.5.3 GEOMORPHOLOGY AND ECOLOGY

Based on the abovementioned, it appears that section geomorphology and ecology over the entire country has in general a low vulnerability, except for those locations where the coastline is exposed to the violence of the sea. At these locations immediate adaptation measures are required.

3.5.3.1 PROPOSED ADAPTATION MEASURES FOR THE COASTAL ZONE

Based on the aforementioned vulnerability assessment appropriate adaptation measures are identified and categorized into two groups: (1) general and (2) specific measures.

The general measures are:

- Implementation of legal, administrative and organizational structures for effective land-use planning and management, and spatial planning;
- Inclusion of Environmental Impact assessments for long-term projects;

The following measures are identified for the coastline:

- Implementation of the structures and regulations required for a proper management and control of the existing MUMAs is needed; particularly for the mangrove stretches Well-managed MUMAs offer sufficient resilience to protect the coast in the long term. Exceptions are parts of Nickerie, Coronie, and the Paramaribo-Wanica coastline;
- Proper maintenance and frequent inspections of coastal stretches with dikes and dams;
- Engineering measures to increase the sedimentation rates along severely encroached coastal stretches to support mangrove growth;
- Policy and regulatory measures for the prohibition of, for example, further sand and shell mining activities and issuance of land in the estuarine zone.

For the estuaries the following measures are identified:

- Full protection of inhabited estuaries, such as Paramaribo, Wanica, Nickerie and Coronie;
- Establishment of new and reinforcement of all existing river defences;
- Promotion of studies/research with regard to the dynamics of the rivers;
- Prohibition and/or discouragement of further human developments along vulnerable sections of estuaries and rivers;

3.5.3.2 PROPOSED ADAPTATION MEASURES FOR THE ECOSYSTEMS

For the coastal plain the following measures are identified:

- A full coastal plain strategy including protection of all mangroves, implementation of existing and proposed MUMAs, stopping of the issuance of permits for building and other developments, withdrawal of unused and abandoned land in this zone, provision of incentives to protect the still existing mangroves, and implementation of a monitoring system;
- Implementation of conservation strategies to protect marine turtles in the light of climate change;

3.5.4 AGRICULTURE

3.5.4.1 PROPOSED ADAPTATION MEASURES FOR THE AGRICULTURE SECTOR

Regarding this sector, it appears that agriculture is ranked as vulnerable to highly vulnerable. Based on the aforementioned vulnerability assessment, appropriate adaptation measures are identified and categorized into two groups: (1) general and (2) specific measures.

The general proposed adaptation measures regard:

- Development and implementation of appropriate research programs, capacity building, and training required for animal husbandry (e.g. water buffaloes), crops (the introduction of new varieties including salt tolerant rice and upland rice varieties, integrated pest management) and fisheries (enhancement of competitiveness).

Specific measures for the agricultural subsectors are:

Rice

- The construction of dikes in the areas which lay in the lower parts of the land;
- Increase in the availability of freshwater for rice irrigation through establishment of necessary infrastructures;

- Agro-ecological research programs focussed on integrated pest management and disease control;
- Establishment of an insurance fund to compensate farmers who suffer from the effects of unexpected weather influences on crop production;
- Research focussed on crop rotation. During the dry season crops that are drought tolerant can be grown in areas where availability of irrigation water is a constraint during the long dry season;

Banana

- Planting of hedgerows of trees to protect against strong winds;

Fruits and vegetables:

- Change farming systems (greenhouses and hydroponics) to cope with alternating climate change conditions;
- Improve drainage systems to guarantee efficient production and quality products;
- crop diversification to guarantee food security under alternating climate conditions;

Livestock (poultry, dairy production, sheep, goats and pigs)

- Rehabilitation of abandoned farms to guarantee food security (shift of cattle from vulnerable coastal areas to higher grounds);
- Measures to prevent further decline in the number of productive animals (ban on the slaughtering of female animals and import of beef cattle for a certain period);

Aquaculture and fisheries

- Measures to enhance sustainable aquaculture and fisheries management:
- Protection of fishing breeding grounds (salt pans, mangrove vegetation, coastal wetlands);
- Establish funds for fishermen to promote aquaculture;

3.5.5 SOCIO-ECONOMY

Regarding this sector, it appears that Suriname's socio-economy is vulnerable to very vulnerable.

3.5.5.1 PROPOSED ADAPTATION MEASURES FOR SOCIO-ECONOMY

Based on the aforementioned vulnerability assessment, adaptation measures identified for this sector are categorized into two groups: (1) general and (2) specific measures.

The general measures are divided under three categories: infrastructure/settlement, transport and energy[40].

Infrastructure/settlement

Improvement of the resilience of the infrastructure/settlement in the coastal zone to sea level rise through the following measures:

- Determination of minimum set of conditions that reduce the vulnerability of key assets to flooding associated with sea level rise, for instance mangrove protection or prohibition of coastal sand and shell ridge removal;
- Realization of land use planning in the coastal zone: a single land use authority that considers vulnerability, land availability and position, land suitability to industrial, agricultural or human settlement purposes;
- Establishment of flexible and appropriate land tenure systems that allow for long term decision making on the part of land owners, tenants or users;
- Realization of spatial planning and zoning by a central authority to encourage appropriate urban growth;

[40]Nijbroek R., S. Meaney 2011c. Assessment of the Socio-Economic Vulnerability and adaptation for the Republic Suriname. Technical document "project Enabling activities for the preparation of Suriname's Second National Communication to the UNFCCC". Ministry of Labour, Technological Development and Environment

- Development of feasible insurance schemes that provide protection to both business and personal property and encourage adherence to minimum standards and building codes, through exclusion if the building or residence is not climate resistance;;
- Formulation of building codes that incorporate new appropriate and affordable technologies to improve resilience of physical infrastructure to climate change as well as encouraging mitigation through improved energy efficiency;

For the Interior it is recommended to use a community based adaptation approach with the following elements:

- Enhancement of the adaptive capacity of the Interior communities under extreme climatic conditions and incorporate climate change considerations into tribal and community decision making;
- Conduction of appropriate research programs into community and tribal land tenure systems and the effect that recognition of formal land rights would have on adaptive capacity;
- Incorporation of gender issues and political decision making in communities into adaptation measures to avoid elite agenda capture;

Transport

- Realignment and or relocation of the transport infrastructure located in the vulnerable coastal zone. Transport policy needs to consider future climate change scenarios in design;
- Construction of appropriate and hydrological correct transport routes in the coastal zone. Present transportation routes are currently built along sand dunes and shell ridges in the coastal area; this may hamper the hydrological process essential for the preservation of the natural systems such as mangrove swamps along the coastline. It is therefore recommended that more research is undertaken to protect both the natural systems and the infrastructure that relies on that natural protection. Modifications to the road network may be required to improve the role of natural protection.

Transport with regard to the Interior

- Incorporation of the Interior transportation into national transport planning, since this is not the case to date. It is recommended to incorporate this in decision making and to thereby take into consideration the impacts of climate change;
- Adaptation of boat transportation, particularly during the extreme and prolonged dry periods. Boat transport will experience difficulties under increasing climate alternations and therefore adaptation of boat transportation for lower water levels is highly recommended. Supplementary maintenance of the navigational channels of the most used rivers has to be studied and improved where possible;
- Advancing of necessary investments in research regarding alternative and improved transport solutions for the Interior, given the projected difficulties in future river navigation.

Energy

The measures with regards to Energy in the coastal zone are:

- Removing all subsidies and encouraging greater energy efficiency by domestic users;
- Encouraging greater energy efficiency through improved technologies and building designs;
- Application of measures to improve the situation in the Interior are listed below:
- Incorporation of the Interior into the national energy policy rather than being seen as a special side issue; provision of electricity can provide security in situations of food shortages and provide important storage of perishable agricultural goods;
- Application of appropriate technologies that take advantage of local natural resources and that provide sustainable energy solutions;
- Implementation of renewable energy projects such as mini and micro hydropower stations and solar energy accommodations where these are possible and feasible.

3.5.6 TOURISM

As stated in the WTO paper, ñthe impacts of climate change on the tourism sector will steadily intensify", particularly under higher emission scenarios. Global climate change will redistribute climate resources for tourism geographically and seasonally, whilst posing risk to the ecosystems and hence to the nature and the intensity of climate change impacts, which will differ for the tourism destinations around the world. The most vulnerable regions are found amongst the developing countries, with poor adaptive capacity and a number of challenges for their tourist destinations and host communities to survive. Moreover, climate change impacts on the tourism sector could influence other economic sectors, such as agriculture and local business networks supplying tourism. Conversely, the tourism sector must also be cognizant of the implications of climate change adaptation in other economic sectors, which could have significant impacts on tourism.

According to the same paper there will undoubtedly be costs associated with climate change adaptation. These costs cannot be abided solely by those having less ability to take actions to cope with the complications of the adverse impacts of climate change (e.g. LDCs, SIDS and local tourism SMMEs). -However, due to dynamic nature, the capacity of the tourism sector to adapt to climate change is thought to be relatively high and hence encompasses opportunities to reduce the vulnerability of this sector.

3.5.6.1 PROPOSED ADAPTATION MEASURES FOR TOURISM

- Improvement of the appropriate infrastructures, such as those related to transportation and accessibility arising during the heavy rainfall events, and development of the road network, which need to be seriously considered;
- Establishment of a roadside drainage system to deter water pooling and stagnation; and fortification of riverbanks especially in areas where the road runs immediately parallel to the river;
- Fortification of riverbanks especially in areas where the road runs immediately parallel to the river or where communities have built along riversides;
- Conserve, protect and monitor ecotourism;

- Enhancement of the adaptive capacity of the communities in the Interior, especially those Maroon and Amerindian communities heavily dependent on tourism
- Incorporation of climate change considerations into tribal and community decision making;
- Capacity building and awareness raising regarding conservation of biodiversity
- Establishment of response system in case of flooding;
- Establish appropriate insurance schemes for loss and damage due to extreme flooding;

3.5.7 HUMAN HEALTH

The steady increase in ambient temperature, sea level rise, and alternating precipitation are expected to affect human health in Suriname directly and indirectly. Overall, impacts are expected to be challenging to the general health of the Surinamese people and hence the wellbeing of the population of Suriname is threatened by climate change driven events. The overall vulnerability based on the aforementioned vulnerability assessment is ranked as high. In order to minimize its vulnerability, a number of adaptation measures have been identified.

3.5.7.1 PROPOSED ADAPTATION MEASURES FOR HUMAN HEALTH

The recommended adaptation measures are:

- Research on the following topics:
  - Management of weather-driven pests,
  - Implementation of weather-resistant crop varieties,
  - Relocation of agricultural production activities to less weather-vulnerable areas
  - Assignment of a group of local biomedical researchers to follow international research on newly emerging pathogens relevant to Suriname's future. This group should regularly advise the Ministry of Health on preventative and other public health measures such as new vaccination protocols, new antibiotics and health related precautions;

Urban Planning

- In planning discussions, inclusion of the differentiation between various conditions based on their location and vulnerability to climate change (Hinterlands vs. coastal plains);
- Inclusion of climate change vulnerability as an important factor in Suriname's urban planning and steering of population dynamics;
- In special planning of Suriname, reservation and expansion of agricultural activities away from vulnerable coastal zones;
- Gradually but steadily dislocation of infrastructure such as government buildings, housing facilities, hospitals and medical centers, industry and factories away from the flood-sensitive coastal zone onto higher less vulnerable areas in Suriname;

Public health policy

- Enabling insurance coverage for extreme weather conditions;
- Establishment of a disaster relief funds;
- Designation of institution(s) responsible for testing water quality after a natural disaster: governmental agency, disaster relief organization, or water supply companies;
- Expansion and better equipment of the existing NCCR infrastructure;
- Construction of fresh water and drinking water storage mechanisms for use in times of drought: artificial, controlled ground reservoirs, water towers, or bottled water reserves in strategic locations of the country;
- Construction of an emergency network of agricultural irrigation pipes and pumps, connected to reliable water sources such as nearby larger fresh water rivers or controlled reservoirs;
- Fortification of the Nation's current medical support staff as well as its medical infrastructure;
- Establishment of medical centers near potential risk zones and hospitals in less vulnerable areas;

Public health education

- Enhanced preparation for awareness rising regarding standard operating procedures in case of emergency before a natural disaster hits Suriname (emergency response plan);
- Raising public awareness through campaigns about the dangers of prolonged and unprotected exposure to the increasingly intense sunlight. Encourage Surinamers to wear protective clothing and sunglasses, choose shaded areas, and use sun-block lotions.

Disaster response

- Provision of clear instructions to victims on how to handle potentially contaminated water sources to prevent illness. Also provision of psychological guidance and physical relief measures to victims.

An overview of the proposed adaptation measures for the corresponding vulnerable sectors, as presented here above, is summarized in Table 3.6 here below.

Table 3.6: Comprehensive overview of the vulnerable sectors, the expected impacts, and proposed adaptation options [41,42, 43,44,45,]

Vulnerable sector	Expected impacts	Proposed adaptation measures
Water resources	Decrease of fresh water availability in aquifers and surface water bodies.	– Increase the capacity of the existing water resources through technological improvements and institutional strengthening – Encourage the use of alternative fresh water resources such as the utilization of rainwater and surface water when possible – Increase efficient water use through water management and recycling – Increase public awareness on the need for water conservation – Import freshwater from the Southern region of the country where freshwater is available
	Saltwater intrusion in rivers and aquifers	– Enhance management, monitoring and research – Set up appropriate structures to prevent saltwater intrusion in rivers – Enhance recharge capacity of aquifers

[41]Amatali M.A. 2011c. Technical Paper Vulnerability Assessment and Adaptation. Sector Water Resources. Technical document "project Enabling activities for the preparation of Suriname's Second National Communication to the UNFCCC". Ministry of Labour, Technological Development and Environment.
[42]Huisden M. 2011b. Report on the "Future Health Profile", Suriname 2011.Technical document "project Enabling activities for the preparation of Suriname's Second National Communication to the UNFCCC". Ministry of Labour, Technological Development and Environment.
[43]Noordam D. 2011. Ecology and Geomorphology. Technical document "project Enabling activities for the preparation of Suriname's Second National Communication to the UNFCCC". Ministry of Labour, Technological Development and Environment.
[44]Nijbroek R., S. Meaney 2011c. Assessment of the Socio-Economic Vulnerability and adaptation for the Republic Suriname.Technical document "project Enabling activities for the preparation of Suriname's Second National Communication to the UNFCCC". Ministry of Labour, Technological Development and Environment.
[45]Tjien Fooh R. 2011b. Vulnerability and Adaptation of the Agriculture sector in Suriname ï Future profile.Technical document "project Enabling activities for the preparation of Suriname's Second National Communication to the UNFCCC". Ministry of Labour, Technological Development and Environment

	Increased frequency of flooding and drought	– Upgrade, modernize and expand existing climatologic observation networks – Set up new water-boards and activate existing ones, and set up a water authority – Update existing draft water-law and approval by the Parliament and implementation by the G – Enhance collaboration of authorities and relevant institutions – Adapt to changing conditions – Enhance capacity in utilizing present and future water resources
	Pollution of surface water resources	– Improve wastewater and drainage infrastructure – Protect available water resources against pollution through the establishment, implementation enforcement of rules and regulations
Coastal Zone	Coastal retreat	– Incorporate engineering measures to increase the sedimentation rates along severely encroach coastal stretches – Conservation, protection and expansion of mangrove forests – Enhance monitoring of the coastline
	Damages to coastal infrastructure	– Stop the issuance of land in the estuarine zone – Use of sea protection and mud bank nourishment techniques
Ecosystems	The development of hyper-saline conditions in areas along the coast	– Research, monitoring and mapping of species vulnerable to climate change impacts – Provide incentives to protect the existing mangroves
	Decrease in turtle-nesting sites	– Implementation of conservation strategies to protect marine turtles

	Alteration in vegetation due to dramatic rise in swamp water levels	– Implementation of existing and proposed MUMAs – Implementation of a monitoring system
	Increased sensitivity of the forests due to drought, logging and/or fire	– Enhance management of forest resources – Incorporate measures into the national disaster plan with regard to forest fires
Agriculture	Reduced productivity	– Develop and implement appropriate research programs, capacity building sessions and trainin – Technological improvements in cultivation methods – Implementation of cultivation methods that prevent soil loss, such as the ñno tillò method – Re-cultivate abandoned agricultural land
	Damage to crops due to possible strong winds, extreme rainfall, severe drought and/or sea level rise	– Establishment of an insurance fund to compensate farmers who suffer from the effects of unexpected weather influences on crop production – The establishment and/or maintenance of efficient irrigation and drainage systems – Planting of hedgerow trees to protect crops from strong winds – Establish early warning systems
	Changes in crop growing seasons	– Change farming systems and/or construct greenhouses – Expansion and use of alternative crop varieties – Introduction of new varieties
	Siltation of fertile land due to sea level rise	– The construction of dikes in low lying areas
	Reduced productivity of farm animals	– Introduction/improvement of climate control systems in livestock farming

		– Adapt pasture lands to changing climate conditions
Socio-economy	Increase pressure on natural resources	– Realization of spatial planning and zoning by a central authority to encourage appropriate urb growth
	Damage to structures such as houses, water defense structures etc	– Modification of building regulations to changing climate conditions – Development of feasible insurance schemes that provide protection to both business and pers property, as well as encourage adherence to minimum standards and building codes
	Increased energy demand	– Implementation of renewable energy projects – Encourage energy efficiency
Tourism	Reduced revenue due to decreased tourist arrivals	– Conserve, protect and monitor ecotourism
	Dependence of Maroon and Amerindian communities on tourism	– Enhancement of the adaptive capacity of the communities in the Interior – Incorporation of climate change considerations into tribal and community decision making
	Degradation and/or loss of biodiversity	– Capacity building and awareness raising regarding conservation of biodiversity
	Loss and damage due to extreme flooding	– Fortification of riverbanks – Establishment of response system – Establish appropriate insurance schemes
Human health	Increased incidence of parasitic and infectious diseases	– Research on newly emerging pathogens – Training of health experts

		– Improvement and adaptation of health care systems to climate change risks – Public education
	Increased mortality under extremely high temperatures	– Enhance awareness on the dangers of e.g. prolonged and unprotected exposure to the sun – Ensure water availability to all groups and sectors
	Increased risk of damage from extreme weather events	– Establishment and enhancement of an early flood warning and monitoring system – Improved urban planning – Establish insurance coverage for damages due to extreme weather conditions
	Possible increase of vector diseases such as malaria in the Interior and dengue in the Coastal Zone	– Establish medical centers near potential risk zones and hospitals in less vulnerable areas – Increase awareness on the use of preventative measures
	Increase of diarrhea and risk of cholera outbreaks due to the use of contaminated water	– Designate (an) institution(s) responsible for testing water quality, especially after natural disa – Construct fresh water storage mechanisms for use in times of drought

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4 MITIGATION MEASURES

4.1 INTRODUCTION

Suriname has signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC). By doing so, Suriname acknowledges its role in the battle against climate change while striving for sustainable development.

As a developing country Suriname has no emission reduction obligations under the UNFCCC but can contribute to mitigation on a voluntary basis. In the past the Government has implemented several activities to mitigate greenhouse gas (GHG) emissions, such as provision of CFLs to households for free (this was a once-only initiative), improvement of the electricity distribution network, resulting in decreased leakages of electricity and installation of solar panels in Kwamalasemutu, a remote village in the most southern part of Suriname. The Ministry of Labour, Technological Development and Environment (ATM) had signed an agreement with UNEP/RISØ for capacity building regarding formulation and implementation of Clean Development Mechanism (CDM) projects. A Designated National Authority was established but to date no CDM projects have been approved in Suriname.

The UNFCCC urges developing countries to consider climate change on their road to national development. An important commitment under the UNFCCC is conducting a GHG mitigation assessment which is an analysis of the country member's programs and measures geared toward the reduction of CO_2 emissions.

This report presents the GHG mitigation assessment of Suriname. It provides the results of the evaluation of mitigation options in the energy sector and non-energy sector in Suriname. The mitigation assessment covers a forecast of GHG emissions for the period 2008 to 2025 and examines abatement potentials for that period.

The assessment is done by analyzing how Suriname's energy and non-energy sectors might evolve between now and 2025 under two different scenarios: a **baseline** scenario that assumes the continuation of historical trends, policies and a corresponding rise in GHG emissions, and a **mitigation** scenario that evaluates the results of mitigation options.

The scenarios are constructed carefully since considerable economic and social change is to be expected over the next decade according to the planned activities of the Government of Suriname. Some of the plans of the Government are to be considered as mitigation options. Strategies and projects of the Government of Suriname, whether already approved and adopted or not, resulting in a reduction of GHG emissions, are considered as part of the mitigation scenario.

This report should not be read as an exclusive endorsement of this particular pathway. While it shows that decrease of GHG emissions is possible together with economic development, it might equally be achieved through other pathways, some of which may well be socially, economically and technologically preferable to those identified here.

Whatever pathway is chosen, one point is absolutely clear: it will not happen spontaneously. It will require major and brave political leadership and a major mobilization of effort.

4.2 METHODOLOGY

The mitigation assessment has been done by a team of specialists covering energy, agricultural, forestry and economic expertise, called the Mitigation Team. The year 2008 was chosen as the base year since required data was available from the GHG Inventory which was carried out for this particular year. The required data for the projection of the activities that produce GHG emissions were collected from sources identified through a literature review phase. Data sources include Ministries, mining companies such as Staatsolie, Suralco and IAMGOLD, the General Bureau of Statistics (ABS), and several other institutions and key persons.

Mitigation options were selected by the Mitigation Team for key categories based on results of the GHG Inventory. These options were screened using six screening criteria and scoring points. Finally, 9 mitigation options were formulated for further scenario analysis.

The calculation of GHG emissions for the base year (2008) and the forecast for the following years up to 2025 were based on the 1996 IPCC guidelines.

The mitigation scenarios were compiled and elaborated on as a low emission pathway for Surinameôs development.

4.3 STRUCTURE OF GHG EMISSIONS ACCORDING TO GHG INVENTORY

Figure 4.1 presents the breakdown of the total emissions by economic sector in Gg CO_2eq derived from numbers from the GHG Inventory.

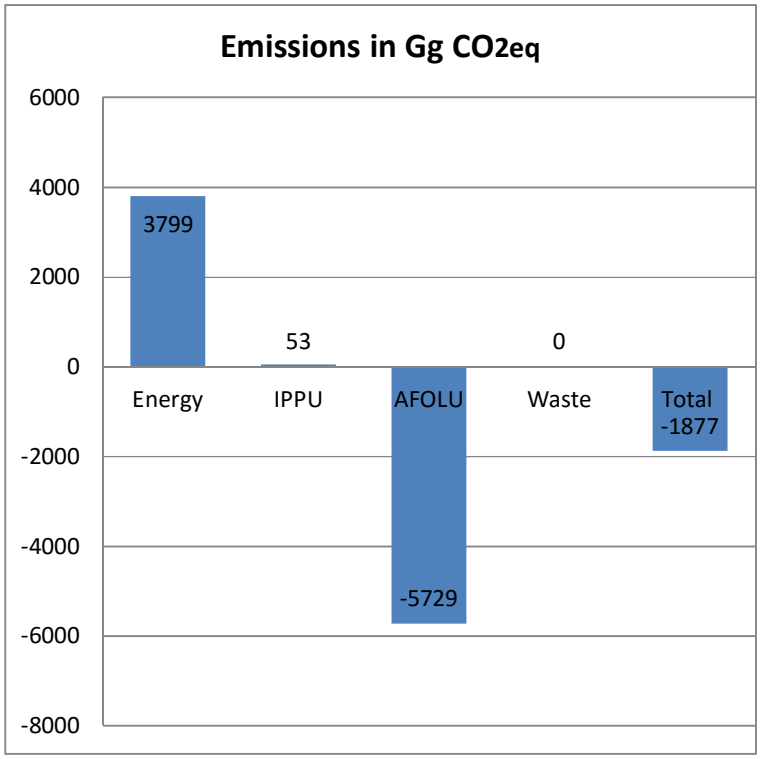

Figure 4.1: GHG emissions by economic sector

Source: Becker et al, 2012

The uncertainty analysis for 2008 data indicated that values are within the 7 - 17% range.

Domestic emissions from energy sources in 2008 were 3,799 Gg CO_2eq. International bunker fuels were not included in the national emission totals as stipulated by IPCC guidelines (Becker et al., 2012).

According to the calculated data of the GHG Inventory 2008 the energy sector is the major GHG emitter in Suriname: the emissions amount to approximately 60% of all GHG emissions.

The major emitter within this sector is *Manufacturing Industries and Construction*: 2,922 Gg CO_2eq or 77% of total GHG emissions within the energy sector. The second most important

emission source within the energy sector is transport: about 623 Gg CO_2eq or 16% of total GHG emissions within the energy sector. Emissions from electricity generation are around 3% of total GHG emissions.

4.4 MACRO-ECONOMIC SITUATION OF SURINAME

Lack of reliable detailed data makes it difficult to perform the kind of analysis needed to project long-term economic growth and energy demand. Trends based on historical data provide limited information about Surinameôs future as Surinameôs economy is at the crossroad of a dramatic change. The current Government envisages national development based on a different approach than historically envisaged and endeavored.

The general development of the economy in 2011 ï 2015 (and perhaps onwards) will be based on a new industrial system focused on resource saving technologies. The Government endeavors a booming small and medium business sector in forestry, agriculture and tourism. The related growing energy demand will be provided by conventional energy generation but also increasing usage of renewable resources which were not considered as feasible alternatives for electricity generation in the past, such as wood waste, rice husk and bagasse. Even options for increased hydropower generation are being worked out, such as capacity expansion of the Afobakka dam and a second hydropower facility in the eastern part of the country (Grankriki)[46].

In order to calculate scenarios, projections in socio-demographic status, Gross Domestic Product (GDP) growth and export, the main indicators of the development of Suriname for the period 2011 ï 2025, have been estimated and are presented below.

The population growth is a central factor in estimating future GHG emissions, since it eventually leads to increased energy and food demand by various sectors, increased production, and an increase in kilometres travelled. Surinameôs population grew steady at an average rate of 1.2% yearly from 2005 ï 2009. The long-term projection predicts 7% growth average per interval of four (4) years until 2028 (ABS 2010).This translates to a cumulative

[46] More information on development strategy of the Government can be found in the Development Plan 2012-2016. This Plan, however, was not available during the reporting period.

increase from 492,829 in 2004 to approximately 760,877 in 2028, which is the equivalent of 54% growth. In Figure 4.2 the population projection is presented.

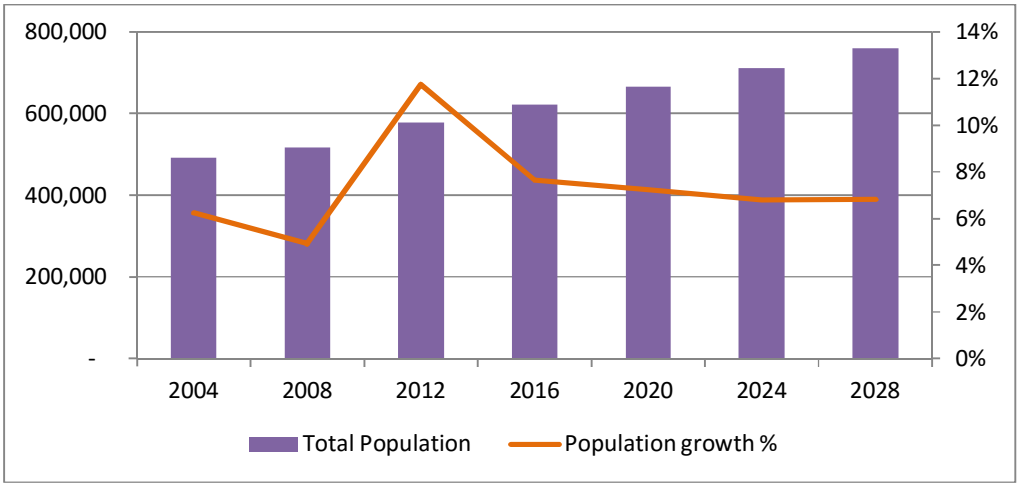

Figure 4.2: Population growth 1995 - 2028

Source: General Bureau of Statistics Suriname, 2010. Population projection 2004 – 2024, volume 2

Development of GDP at market prices in real terms formally and informally from 2005-2010 can be classified as positive. The average growth rate of the economy on an annual basis was 4.2% over this period. The expectation is that the economy of Suriname will grow steady by 4.4% on average from 2011 to 2025.

Figure 4.3 describes the course of the real growth of GDP for the period 2005-2025. The contributions to the GDP as of 2010 are as follow: primary sector 16%, secondary sector 28%, tertiary sector 38% and the informal sector 18%. The future GDP structure can be characterized by the following main tendencies:

Increases of shares are expected in the primary, secondary and tertiary sectors, while it is expected that the informal sector will decrease in future (2011-2025).

It is expected that the primary sector will grow significantly during the period 2015-2025. Suriname wants to become a major player in the agriculture sector, mainly providing the CARICOM market with products. Also the mining sector will be developed significantly in future years. There are plans to develop the energy sector faster in the near future. Due to

economic development, the demand of energy will grow; therefore Suriname needs to invest in this sector.

Suriname intends to develop the tertiary sector in future; the financial services, communication and tourism sector are the main areas to be developed.

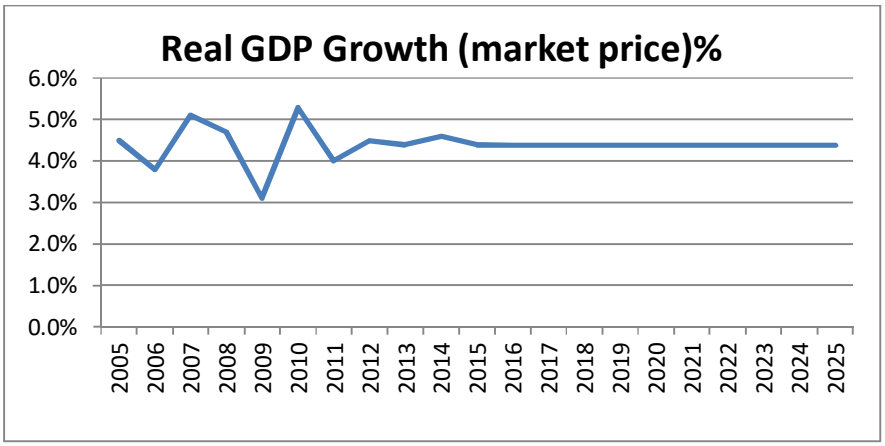

Figure 4.3: Real GDP development (%) 2005 - 2025

Source: Stichting Planbureau Suriname Year Plan 2011 – March 2011

Figure 4.4 provides an overview of the contribution of the sectors to the GDP and the development of these sectors during the period 2005-2010.

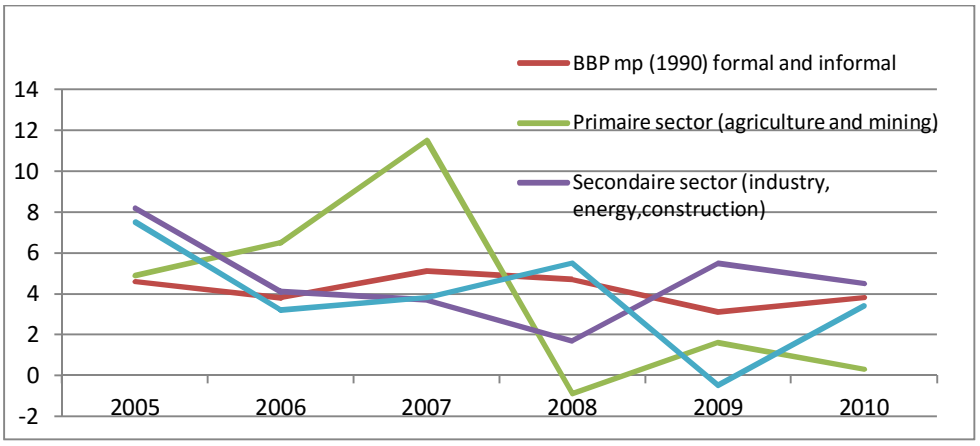

Figure 4.4: GDP growth (%) by sector 2005 - 2010

Source: Stichting Planbureau Suriname Year Plan 2011 – March 2011

Total exports and imports showed an upward trend and statistics show that since 2004 the trade balance is positive on a transaction basis. The increase in exports and the trade surplus is attributable to the mining industry (mainly gold, alumina and oil).

Imports on a cash basis have increased by 57% in 2009 compared to 2005 and decreased by about 11% compared to 2008. Exports rose 76% in 2009 compared to 2005 and decreased by 16.5% compared to 2008.

In 2005, the current account balance showed a deficit of around 242 million. The following years, however, showed a positive balance. The current account balance was around positive USD 182 million in 2006. In Figure 4.5the development of the current account is shown.

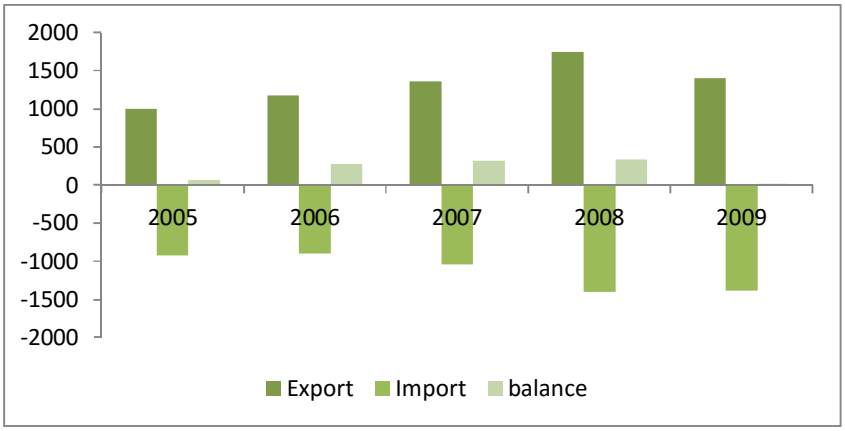

Figure 4.5: Current account balance (USD M) 2005 - 2009
Source: Stichting Planbureau Suriname Year Plan 2011 – March 2011

One of the key features of the economy of Suriname is a very large share of mining (oil, gold, and bauxite) in the overall economy.

The greatest shares of employment in 2008, apart from the Government and the hotel & catering industry, were from the agriculture and the forestry sector (12%), while the mining sector shares of employment in 2008 were about 3%.

Formal employment in the private sector had a very moderate growth of around 1.2% on average in the period 2005-2009. The construction sector grew the fastest of all sectors with ca.4% on average over this period. The rest of the sectors hovered around 1% on average.

The Census of 2004 of General Bureau of Statistics (ABS) shows that about 42% of workers are in the informal sector.

Based on the projected economic growth it is assumed that the employment will increase with 32% by 2025, from 93,255 in 2005 to 123,202 employees in 2025, Figure 4.6. The intention of the Government is to double the employment of the agriculture sector and the mining sector.

Furthermore, the service sector (financial services, tourism, ICT) will be developed according to plans of both the Government and the private sector.

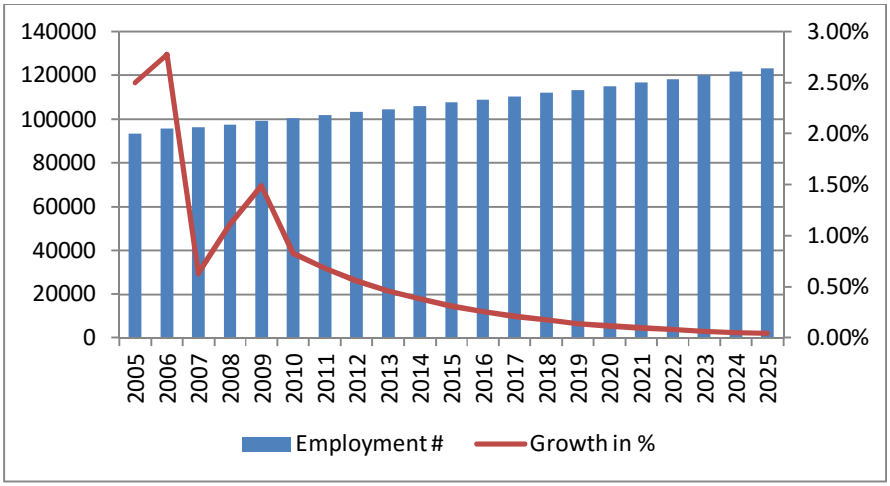

Figure 4.6: Employment forecast

Source: Stichting Planbureau SurinameYear Plan 2011 – March 2011

The results obtained from the analysis in terms of GDP growth and structure, employment and population growth serve to evaluate final energy demand projections. According to this approach the energy demand depends on economic activities and social needs. Energy demand will be influenced by socioeconomic development patterns (economic growth, lifestyle, society behaviour), expected technology mix in all sectors of economy and energy price growth.

4.5 SCREENING OF MITIGATION OPTIONS

For targeted mitigation it is most important to recognize the highest emitters within the main categories. According to the GHG Inventory the top ten emitters for the year 2008 are the sector subcategories as presented in Table 4.1 in descending order.

Table 4.1: Top ten emitters 2008 in Gg CO2eq

Sector subcategories and codes used by IPCC	Specific category	Emissions
AFOLU-3B6b Forest land	Forest Land converted to Other Land	1,740
Energy-1A2m Manuf. Industries & Construction	Non-specified Industry	1,456
Energy-1A2f Manuf. Industries & Construction	Non-Metallic Minerals	1,253
Energy-1A3b Transport	Cars	599
AFOLU-3C7 Rice cultivation	Rice cultivations	475
Energy-1A2i Manuf. Industries & Construction	Mining (excluding fuels) and Quarrying	210
Energy-1A1a Energy Industries	Electricity Generation	121
AFOLU-3C1 Emissions from biomass burning	Biomass burning in croplands	94
AFOLU-3B3a Grassland	Grassland Remaining Grassland	77
AFOLU-3A1	Enteric Fermentation	72

Source: Becker et al, 2012

It is within these sector subcategories that mitigation actions will have the most impact, with regards to reducing GHG emissions.

The Mitigation Team considered a total of 29 GHG mitigation options in the following sectors:

- Energy supply
- Transport
- Industry
- Agriculture
- Forestry

Part of these GHG mitigation options were formulated in collaboration with national stakeholders during the kick off workshop of the Second National Communication (SNC). The options are not a comprehensive list of mitigation options but are considered by the Mitigation Team as the most promising options, given the circumstances in Suriname. The mitigation options considered were related to national development policies, policy goals with regards to the environment and other national circumstances such as population density and availability of natural resources.

A qualitative screening was performed which enabled a rough assessment of the GHG mitigation options ahead of performing a more detailed mitigation scenario analysis.

The Mitigation Team formulated screening criteria and assigned scores regarding the importance of the criteria. The total scores of the screening criteria are listed in Table 4.2.

Table 4.2: Screening criteria

No.	Screening criteria	Total score
1	Potential for large reducing impact on GHG	14
2	Consistency with national development goals (incl. environmental goals)	14
3	Data availability	11
4	Feasibility (technical, social, economic)	13
5	Direct & indirect economic impact (on GDP, employment, trade)	9
6	Institutional considerations	6

The criteria Potential for large reducing impact on GHG and consistency with national development goals were both awarded the highest score.

The criterion Data availability refers to accessibility of specific data and appropriateness for Surinamese conditions. The criterion *Feasibility* included cost-effectiveness (capital and operating costs, opportunity costs and incremental costs) and replicability (adaptable to different geographical, socio- economic, cultural, legal and regulatory settings). The criterion *Direct & indirect economic impact* included macro-economic considerations such as implications for long-term development, foreign exchange and trade, other economic benefits or drawbacks.

The criterion *Institutional considerations* encompasses institutional capacity needed for data collection, monitoring, and enforcement.

The mitigation options were rated (low/medium/high) on each of the criteria. The Team decided to use the following scoring system:

- Low = 1x total score of the criterion
- Medium = 2x total score of the criterion
- High = 3x total score of the criterion

Per sector, the options with the highest scores were selected for a more in-depth analysis during the mitigation assessment.

The final result is a listing of 9 mitigation options.

Table 4.3 and 4.4 present the scoring results of mitigation options with the highest scores.

Table 4.3: Screening of mitigation option for sector Energy Supply, Transport and Industry

Criteria	Solar power	Hydro power	Wind power	Biomass	DPollution device
Potential for large reducing impact on GHG	H	H	H	H	H
Consistency with national development goals	H	H	H	H	H
Data availability	H	H	M	H	H
Feasibility **Technical** **Economical**	 H M	 H M	 H M	 H M	 H H
Direct & indirect economic impact	H	H	H	H	M
Institutional considerations	M	M	M	M	L
Total score	**221**	**207**	**210**	**221**	**231**

Preliminary estimation of the GHG mitigation potential was based on avoided fuel use for electricity generation.

The development and intensification of the traditional branches of the energy sector, namely the expansion of hydropower capacity (large scale and small scale) and the use of solar and wind power have high scores. For the transport sector, new technologies score high.

All options score high for *Consistency with national development goals*. From the viewpoint of *Direct and indirect economic impact*, one can note that the considered options will not affect the employment of the population. In terms of *Feasibility,* application of Pollution devices scores high.

From the viewpoint of highest support, hydropower is the most attractive, because this is one of the common methods for energy generation in Suriname. Also, this is the most technologically and economically developed option in Suriname.

In addition, nuclear power, efficiency in electricity generation and distribution, hybrid vehicles, intensification of public transport, and combined heat and power were considered. These options score relatively high on most of the criteria but lack of data, with the exception of nuclear power, made calculations extremely difficult. These mitigation options were therefore not considered in further calculations. Nevertheless, they could be considered in future mitigation strategies. Further elaboration on nuclear power was excluded, despite indications of large deposits of uranium in Suriname. Concerns about safety of nuclear generation and the ability to safely dispose of and store nuclear waste were the reasons for exclusion.

Given the fact that rice cultivation is a large contributor to GHG emissions it was apparent that mitigation in the rice production sector would make a difference; more so for unused agricultural lands. Both options scored high for *Consistency with national development goals.*

For agriculture, other options such as improved nitrogen fertilizer application techniques, agro-forestry pilots and no tillage pilots were considered but did not score high.

Within the forestry sector options of utilization of wood waste as bio-fuel and restoring mangrove forestation had the highest scores. They scored medium to high for *Consistency with national development* and *Direct and indirect economic impact*, since they do not contribute directly to an economic sector. But using wood waste as bio-fuel will lead to less electricity generation with the use of hydrocarbons and mangrove restoration will have positive effects on fisheries and natural defense of the coastline against sea level rise.

Table 4.4: Screening of mitigation options for Agriculture and Forestry sector

Criteria	Improved rice cultivation techniques	Utilization unused agricultural land for energy crop farms	Utilization wood waste as biofuel	Mangrove reforestation
Potential for large reducing impact on GHG	H	H	H	M
Consistency with national development goals	H	H	M	H
Data availability	H	H	H	H
Feasibility **Technical** **Economical**	 M M	 H L	 H M	 M L
Direct & indirect economic impact	L	H	M	H
Institutional considerations	M	L	M	L
Total score	**190**	**214**	**198**	**200**

4.6 TECHNICAL DESCRIPTION OF THE SCENARIOS

This chapter provides a technical description of the baseline and mitigation scenarios for Suriname, starting with a description of the main data and assumptions underlying the GHG projections in the energy and non-energy sectors.

The baseline scenario represents a future in which there are no policies or programs designed to encourage or require actions that reduce GHG emissions or enhance carbon sinks.

The baseline scenario examines how Surinameôs energy system might evolve if policies continue largely unchanged. The projections are extrapolated to 2025 using standard assumptions about population and economic growths, and shifts in economic structure.

The baseline is built upon historical energy statistics published by ABS, which have been extrapolated into the future based on a variety of information sources: historical trends,

reports such as the KEMA report (KEMA, 2008) and expert judgment. Information from these sources has been further augmented and adjusted to include projections for GHG emissions from non-energy GHG sources and sinks (forestry, land use change and agriculture).

The mitigation scenario examines the mitigation potentials of the most important future sources and sinks sectors. In the mitigation scenario a conservative approach was taken, examining only technical options that are already commercially available, while taking into account the availability of natural resources and the existing scientific and technical studies.

Potentially major options such as hydrogen fuel cells and nuclear energy, which appear to be many decades away from the Surinamese market, were excluded, while options such as solar and wind energy are included, but only in the later years of the scenario.

It is necessary to state that a mitigation scenario is not a fixed roadmap but rather evolving in time. Inevitably there will be changes in policies and advances in technology by 2025.

Ideally the cost of any mitigation option should be considered, but estimating costs in the future is very difficult. There are many uncertainties, including estimating fossil fuel prices and costs of technologies. Calculation of costs would be highly indicative. Estimations could give a skewed image and are therefore not elaborated on.

4.6.1 ENERGY SECTOR

4.6.1.1 ENERGY RESOURCES AND TECHNOLOGIES

This paragraph gives a brief impression of the national energy resources of Suriname.

Suriname is richly endowed with raw material and natural resources. The current energy demand is mostly covered by hydropower (approximately 53%); the remaining demand is covered by combustion of hydrocarbon fuels.

Hydro energy: Suriname has the potential for approximately 4000 MW hydro power (Plan Atlas Suriname, 1988). Considering accessibility of the Interior and the possibility for construction of dams, this potential was downsized to 2500 MW (Adama, 1983).

With this hydro-energy potential, the electricity demand of Suriname could be fulfilled abundantly.

Solar energy: Studies (Facet, 1980) estimated that approximately 1800 kWh / m^2 solar energy reach the Surinamese surface per year. This corresponds with approximately 7.3 x 10 GWh spread evenly over the countryôs surface. However, the transformation methods of solar energy to electricity through solar-panels, heliostats and photo-voltaic cells are still very expensive. Solar water heaters seem to be very successful (especially in cold countries).

Biomass: Just like solar energy, Suriname theoretically possesses a large potential of biomass, since more than 80% of the country is covered with forest. In 1980 the amount of biomass that was directly available for energy generation had an equivalent of approximately 98,635 TOE (Ton Oil Equivalent). This biomass amount was generated as waste product from agricultural plants and wood mills (Marienburg, Victoria, SML, Bruynzeel, etc.) among others. It is proven technology to produce biofuel from certain crops. Suriname has a lot of fertile soils to grow these crops.

Crude-oil: N.V. Staatsolie Maatschappij started the production of crude oil in 1980 at Tambaredjo in the district Saramacca. The Tambaredjo reservoir covers a surface of 35 km^2 and is estimated at 216 million barrels crude-oil with a recovery factor of 30%. Currently the production of crude-oil is at 16,000 barrels per day. There are strong indications that there are much larger oil reservoirs (more than 10 times the Tambaredjo reservoir) in the off-shore areas.

Peat: Peat is the only solid fossil fuel that appears in Suriname (Adama, 1983). Studies show that peat is present in the Corantijn area. It is estimated that 1.5 million m^3 (equal to 350,000 TOE) of peat can be found in this area.

Uranium: Findings of radiometric-, magnetic- and electromagnetic measurements done in the Tafelberg area in 1960 and 1966, by ñCanadian Aero Mineralò (a Canadian Mining Consultancy), in collaboration with the governmental department ñDienst Bodem- en

Luchtkartering[47]ò and the Canadian engineering company ñN. Tribe & Associates Ltdò, indicated that there is a high probability that this area possesses a large amount of uranium.

Uranium is used as a source for the generation of nuclear power. No further survey or exploration has been done after these activities.

Wind energy: The wind energy potential in Suriname is caused by the trade-winds that blow during the whole year with average velocities of approximately 5 m/s. However, there are locations (Galibi and Coronie) where the velocities can reach up to 10 to 15 m/s (Facet, 1980).

4.6.1.2 GHG PROJECTIONS

As mentioned earlier, the most significant contributor to GHG emissions in Suriname is the energy sector. The main focus in the mitigation analysis is therefore on this sector.

The energy sector is very broad, since it covers or fulfills the energy demand for all economic activities in the country (e.g. mining, agriculture, transport, industry, fishery, electricity for households, etc.).

With the projected increase of economic activities in Suriname, it is expected that this will go along with a higher demand for energy in order to carry out these activities. Assuming that the increased energy demand will most likely be fulfilled by hydrocarbon fuels, it can be expected that the countryôs contribution to the overall GHG emissions will also grow at an increased rate. Data from the 2011 GHG Inventory show that the countryôs GHG emission has already increased with 36% in 2009 compared to 2003, Table 4.5.

Table 4.5: CO2 emission from all fuels for the Energy sector (reference approach)

Year	2003	2005	2006	2007	2008	2009
Emission Gg CO_2eq	2,442	3,003	2,853	3,019	3,250	3,327

(Becker et al, 2012)

[47] Soil and Air Mapping Service

Surinameôs energy sector is described only by category 1A of the 2006 IPCC guidelines. The subsectors which play an important role are given in Table 4.6.

Table 4.6: Energy sector according to 2006 IPCC guidelines (sectoral approach)

1A. Fuel Combustion Activities
1A1 Energy Industries: Electricity and Heat production ï Electricity Generation
1A2 Manufacturing Industries and Construction: • Nonferrous metals (gold sector) • Nonmetallic mineral (bauxite sector, alumina production) • Construction and others
1A3 Transport: • Civil aviation • Road transportation • Water-borne navigation • Off-road transportation
1A4 Other sectors: Residential Stationary Off-road vehicles and other machinery Fishing (mobile combustion)

The applied growth figures for the energy sector are based on the combination of the following assumptions:

- Forecast calculations of Surinameôs GDP until 2025: the economy of Suriname will grow 4.4% per year on average between 2012 and 2025 (Apapoe, 2012).
- Average annual growth of 4.4% for the subsectors (including the informal gold sector) from 2008 to 2025 (Apapoe, 2012).
- Development of the transport sector goes parallel with the annual economic (GDP) growth of 4.4% based on the continuous use of hydrocarbon fuels.
- Energy demand projection is based on governmental expectations. The Ministry of Natural Resources has calculated that the electricity demand will grow up to 710 MW until 2020.
- Limited *additional* renewable energy contribution to the energy mix. This assumption is based on the history of renewable energy in Suriname where this contribution remained constant at around 53% of total energy mix.

- Limited *energy conservation and energy efficiency activities*. This is also based on the prevailing historical trend in Suriname. The reasons for a lack of energy efficiency programs promoted by the Government are unknown.
- Bauxite industry will remain the largest contributor to GHG emission, as it is expected that the Government will not obligate Suralco to take necessary measures to reduce GHG emissions. Suralco itself is mandated by Alcoa to reduce the GHG emissions of their combustion processes with 20% by 2020 against their 2005 baseline. Each Alcoa plant has to make its own local plan to reach this global Alcoa goal. However, Suralco could not provide elaborated plans regarding the roadmap to reach this goal and the application of mitigation options to reduce GHG emissions. Therefore input from the Suralco was not considered in the formulation of the baseline and mitigation scenarios.
- Taking the delays of their mining activities into account, it is unlikely that the Suralco plant will reach its maximum production level before 2015. It is expected that the Suralco alumina plant will gradually increase its production again from 3750 tpd in 2010 to its rated production capacity of 6200 tpd in 2015. This development is based on an average production growth of the 490 tpd annually (8% of the rated capacity). During the period 2015 to 2025 the growth is assumed to be 4.4% annually.

The baseline forecast for the Energy sector is presented in Figure 4.7. Calculations were made by using growth figures as input in an excel template derived from the LEAP-model. The results show the projected GHG emissions for each subsector.

In appendix A the calculated figures for baseline emissions regarding the *Energy sector* are given. According to the 2008 GHG Inventory the sum of the calculated emissions in the Energy Sector totals 3,799 Gg CO_2eq.

The baseline forecast shows an increase of GHG emissions from 3,799 Gg CO_2eq in 2008 to 8,470 Gg CO_2eq in 2025, an increase of 223%.

For the subsector *Electricity Generation* the final electricity demand projection for the baseline scenario shows a linear growth. As the demand for electricity increases, so does electricity generation. The results show that by 2025 the power energy demand will be 12

times greater compared to 2008. In the 2012 ï 2016 Development Plan of the Government it is calculated that the electricity demand will be 710 MW by the year 2020 (Ministry of Natural Resources, personal communication, 2011). Extrapolated to 2025, it is estimated that the energy demand may reach 862 MW. For the baseline scenario, the 80 MW of energy generated by hydro power is excluded.

Emissions from the subsector *Electricity Generation* will increase from 121 Gg CO_2eq in 2008 to 1,478 CO_2eq in 2025.Significant growth is expected in fossil fuel plants. Gradual efficiency improvements are assumed for fossil generation. However, no major shifts in feedstock fuels are assumed and no major new technologies are included.

The subsector *Manufacturing Industries and Construction* will increase from 2,922 Gg CO_2eq to 5,420Gg CO_2eq, a growth of approximately 85%.

The *Transport sector* is one of the major emitters of GHG in Suriname, responsible for 20% of total GHG emissions of the Energy sector in 2008. All forms of transport directly burn fossil fuels. The only public transportation systems are bus and boat transport. The increase in road traffic and distances traveled is expected to accelerate the use of fossil fuel in the transport sector, thereby contributing to increased overall GHG emissions.

The baseline forecast indicates that, given a continuation of historical trends, transportation emissions will grow from 623 Gg CO_2eq in 2008 to 1,295 Gg CO_2eq in 2025, a growth of 208%.

Emissions from the subsector *Other sectors* will increase from 133 Gg CO_2eq in 2008 to 277 Gg CO_2eq in 2025.

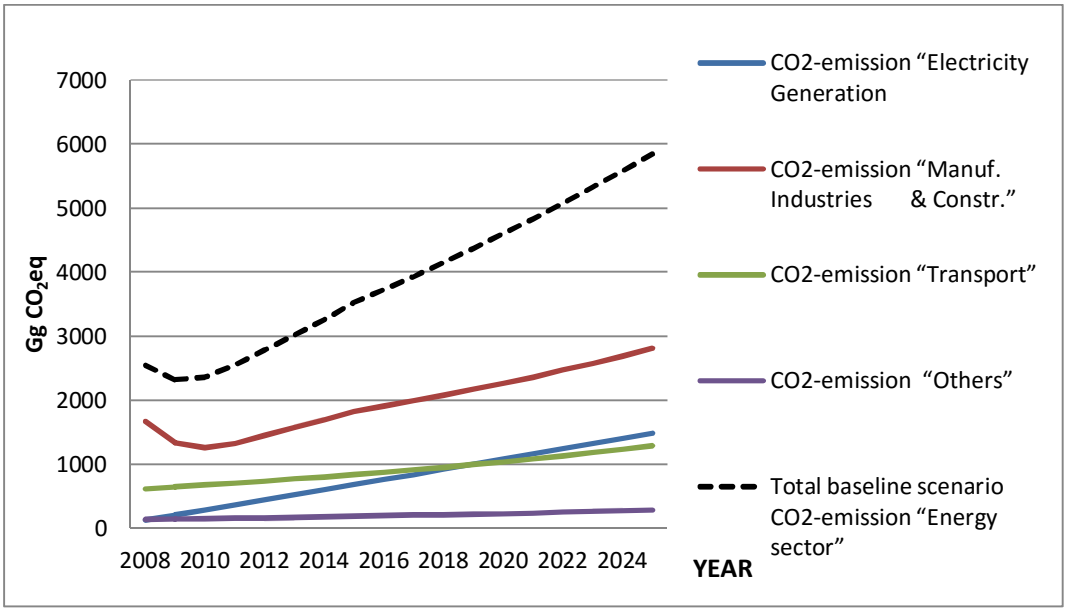

Figure 4.7: Baseline forecast Energy Sector

4.6.1.3 KEY MITIGATION OPTIONS FOR ENERGY SECTOR

Electricity generation

Suriname is endowed with several energy resources that could be considered to sufficiently fulfill its energy demand. Interest in the fields of renewable energy has increased considerably in the past years, encouraged by climate change concerns. Future projects in this field are considered as part of the mitigation scenario.

The mitigation scenario relies heavily on renewable sources for electricity generation, such as hydro, wind, solar and biomass.

Given the lack of climate requirements for substantial development of wind and solar energy, merely a small fraction of the estimated economic potential for wind and solar will be actually developed in the next decade (Adama, 1983).

For **hydropower** the mitigation scenario is based on the 2020 energy plan of the Ministry of Natural resources and consists of the projects listed in

Table 4.7.

Table 4.7: Expected hydropower projects

Hydropower projects	Year expected to be operational	Capacity
Grankriki hydropower plant[48]	2015/2016	15 MW
Tapa-Jai hydropower plant[49]	2018/2019	302 MW
Additional capacity at Afobakka dam	2020	116 MW
Micro hydropower plants[50]	2012/2014/2016/2020	1.2 MW

The West Suriname Hydro project is not considered for the baseline scenario.

However, if obstacles associated with this project (lack of finance, knowledge and capacity) could be ósolvedô, total electricity demand of the country will be fulfilled by more than 100%.

A very important phenomena with regard to the GHG emissions when applying this option, is the deforestation of ñlargeò forest areas for the construction of hydro-lakes, roads and transmission lines. The initial effect of the deforestation is the release of GHG emissions caused by deterioration of carbon sinks. The increase of the GHG emissions is reflected in the Figure 4.8 and Figure 4.9 as two peaks for the periods 2013-2014 and 2017-2018.

For **biomass** the mitigation scenario is described in Table 4.8.

Table 4.8: Expected biomass projects

Biomass projects	Year expected to be operational	Capacity
Power plant (electricity generation) based on the gasification of rice husk	2016	60 MW
Additional plant capacity for rice husk based on positive developments in the rice industries	2025	25 MW

[48] Grankriki project is located approx. 180 km southeast of Paramaribo, in the forest. Grankriki River flows into the Marowijne River, a border river with French Guyana. This will be a small scale hydropower project (15 MW)

[49] Tapa-Jai project is to divert water from Jai-kreek, a branch of the Tapanahony River, through the Marowijne-kreek, into the van Blommenstein hydro-lake, enabling the generation of 305 MW in the Jai-kreek and Marowijne-kreek and 116 MW additional at the Afobakka hydro-plant

[50] Small hydro-plants among others in Granolo sula (pilot project is now in construction (300 kW) while the university is currently doing research on micro water turbines to see how these can be applied in the countryôs Interior to generate electricity for (small) villages along the rivers.

Biomass projects	Year expected to be operational	Capacity
Wood has a caloric value of approximately 15 MJ/kg (equivalent to 4.3 kWh). Combustion installations that use wood as fuel, have a conversion efficiency of 30 %, meaning that currently approximately 4.5 MJ/kg energy output can be (equivalent to 1.29 kWh) produced with such combustion installations. Therefore wood waste produced in Suriname has a potential to replace 110,000 MWh in 2012 and 240,000 MWh in 2025.	20122025	12.5 MW27 MW

Other possibilities for renewable energy are described in Table 4.9.

Table 4.9: Other possible renewable energy projects

Other renewable energy projects	Year expected to be operational	Capacity
Solar energy: Although this energy source has a high potential for reducing GHG emissions, its use as substitute for the hydrocarbon fuels has not yet succeeded. However, application of solar collectors and solar-cells (photo-voltaic conversion) for electricity generation still has high expectations. A conservative prediction is that approximately 2 MW will be installed and operational by 2018. In 2025 the operational capacity is expected to be 5 MW.	2025	5 MW
Wind energy: Wind energy (for electricity generation) could successfully be supplied in locations with relatively high wind velocities. Large scale application still seems only possible in the distant future. A conservative prediction is that approximately 1 MW will be installed and operational by 2016 and by 2025 this will be approximately 3 MW.	2025	3 MW

These mitigation scenarios combined together resulted in an overall mitigation scenario for the subsector *Electricity Generation*, with regard to GHG emissions, which is reflected in Figure 4.8 and Figure 4.9. Since the contribution of solar and wind energy are considered to be negligible, these two options are not included in the final results of the mitigation assessment. The mitigation scenarios are a combination of a gradual transition away from

fossil fuel power plants, radical improvements in energy efficiency, and a dramatic shift toward various types of renewable energy.

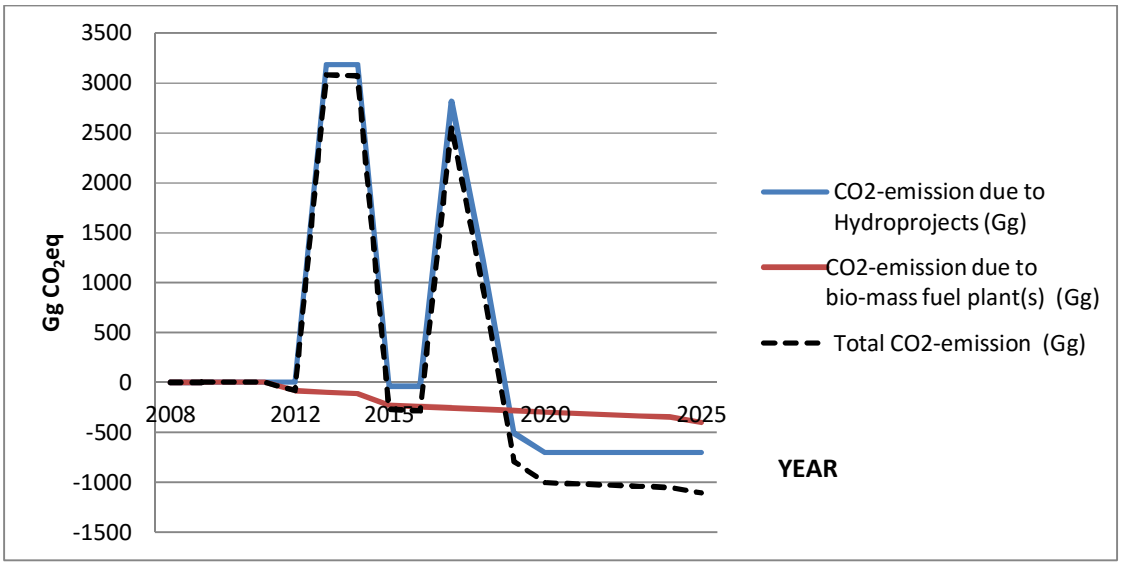

Figure 4.8: CO_2 eq reduction by mitigation options in Electricity Generation

Figure 4.9shows the baseline scenario versus the compiled mitigation scenario for the subsector *Electricity Generation.* The calculated results in Gg CO_2eq are presented in appendix IV.

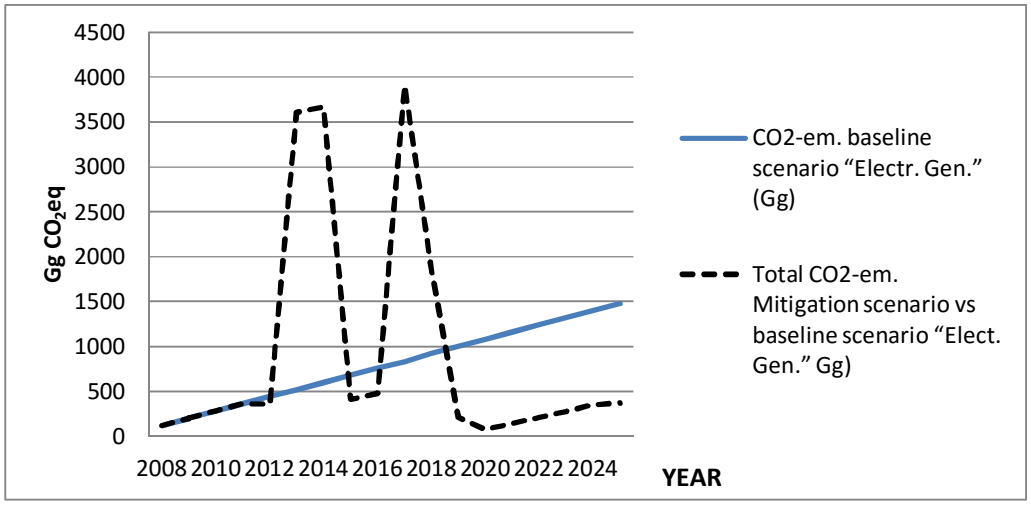

Figure 4.9: Baseline scenario vs. mitigation scenario for subsector Electricity Generation

Manufacturing Industries & Construction

Although the bauxite industry is the largest contributor to the countryôs overall GHG emissions, no detailed plans have been made or are known in this field, regarding the application of mitigation options. There are no national regulations to obligate Suralco to reduce the GHG emissions of their combustion processes. It is not expected that Suralco will start to reduce GHG emissions on its own, considering the huge related investments. Therefore no mitigation option is worked out for this industry. The mitigation scenario for the subsector *Manufacturing Industry & Construction* is therefore solely focused on the application of measures in other categories, such as the informal gold sector which is the 2nd largest consumer. The mitigation option which could be applied here, is the **use of bio-fuel in (mostly diesel) combustion machines for driving machineries**, thereby eliminating the need for hydrocarbon fuels. The results of implementing this measure will only become obvious after the bio-fuel plant of Staatsolie becomes operational in 2015. Based on this assumption, it is projected that this mitigation scenario will result in an annual GHG emission reduction of 7-8% from 2015 to 2025, Figure 4.10.

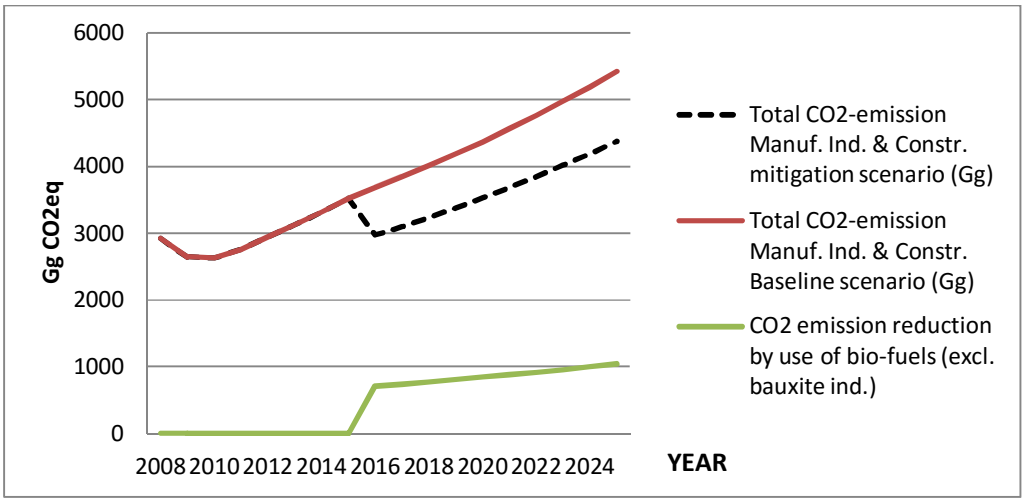

Figure 4.10: Baseline scenario vs. mitigation scenario subsector Manufacturing Industries & Construction

Transport Sector

The mitigation scenario for the *Transport sector* is focused on passenger transport, being the largest contributor within this subsector.

In order to start a transition towards a sustainable transport system resulting in lower GHG emissions, short term measures that enable the use of renewable energies in road transport are key (IEA-RETD RETRANS, 2010). For the short and medium term, use of bio-fuels and the *dPollution devices* are considered to be the most feasible means of achieving intermediate GHG reductions. A shift from road to public and non-motorized transportation will possibly be implemented after 2025.

In Table 4.10 the possible mitigation projects for the Transport sector are elaborated on.

Table 4.10: Possible transport projects

Projects in transport sector	Year expected to be operational
Use of biofuel: Staatsolie is preparing an ethanol production plant, with a capacity of 100 million liters/year. Since this energy resource looks very promising it is predicted that by the end of 2025 an additional bio-fuel plant will be built with a capacity of 50 million liters/year.	2014/2015 2025
Application of dPollution devices in combustion engines: It is estimated that the fuel consumption of the engine can be reduced by 12% with this device. Assuming that time is needed for the awareness of using this device in Suriname, the most optimistic expectation is that only by 2015 results will become noticeable.	2015

Based on the predictions described in Table 4.10 it is calculated that **use of bio-fuels** will annually replace 30% of the fuels consumed in the transport sector (diesel and gasoline) from 2015 to 2025.

The ***dPollution devices in combustion engines*** are already considered to be the next generation fuel saver and pollution remedy. The working principle of this device is that electric current, applied at a proprietary frequency and wavelength, cracks the longer chains of hydrocarbon molecules into shorter chains, lighter and more volatile molecules, which burn more readily and completely in the combustion chamber. This enables the engine to

consume less fuel (DPollution International Inc). It is estimated that the fuel consumption of the engine can be reduced by 12%. A cautious prediction is that this option could result in a 5% annual reduction of the total GHG emission until 2025.

The mitigation scenario illustrated in Figure 4.11 is a combination of the scenarios mentioned above for the *Transport sector,* regarding the GHG emission during 2008 to 2025.

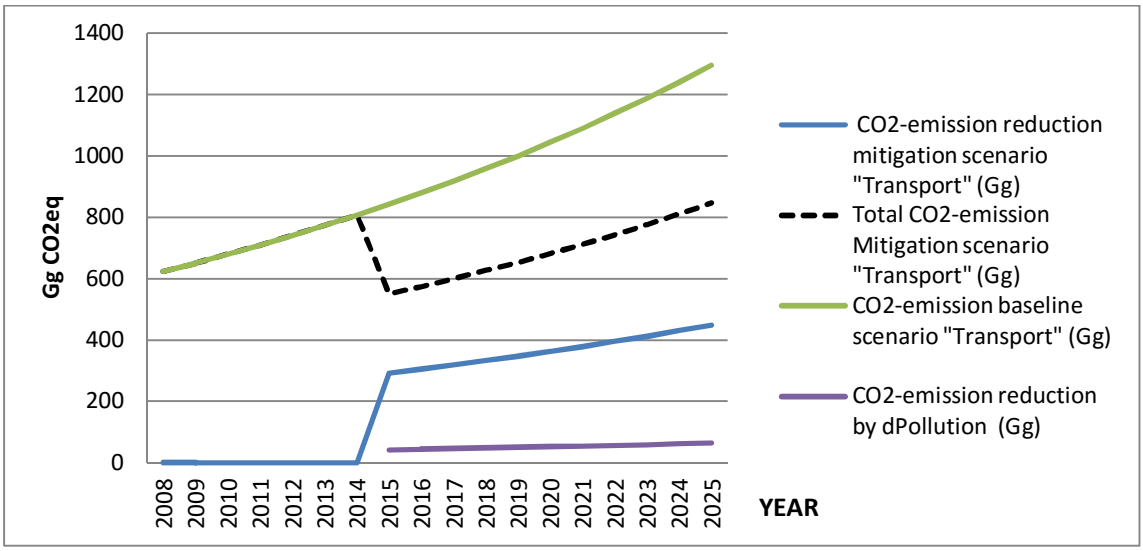

Figure 4.11: Baseline scenario vs. mitigation scenario subsector Transport

4.6.2 RESULTS GHG PROJECTIONS ENERGY SECTOR

The baseline scenario and mitigation scenario are compared with each other in Figure 4.12. Based on this comparison the following conclusions can be made:

If no mitigation measures are taken and the energy demand will be fulfilled by the continuous use of hydrocarbon fuels, the GHG emission will be more than doubled within the period 2008 to 2025; changing from 3,799 Gg CO_2eq in 2008 to 8,470 Gg CO_2eq in 2025.

According to the mitigation scenarios which include the implementation of aforementioned mitigation options, the total GHG emission is calculated to reach 5,870 Gg CO_2eq in 2025. The GHG emission in 2025 will thus be reduced by 31%.

4.6.3 NEGATIVE EFFECT OF HYDRO-ENERGY

The use of hydropower instead of fossil fuels can have obvious positive effects. Despite this, there is still a serious disadvantage to this mitigation option.

In general, the potential to generate hydro-power is dependent on height of water fall (the head) and flow velocities in the rivers. Although the flow velocities in Suriname are high, the height differences in the rivers are relatively small. Due to these conditions, fairly large areas will be needed to be deforested in order to build the hydro-lakes. In addition, roads and transmission lines have to be constructed, further contributing to deforestation.

It has been calculated that the establishment of the TapaJai hydro-power plant(s) will result in the total deforestation of an area larger than 247 km^2 (235 km^2 of inundated area and 12 km^2 of roads). The deforestation will ultimately lead to the release of CO_2 into the atmosphere and potentially even methane (CH_4) which was previously stored in biomass..

It would be ideal to use the available wood for the generation of electricity in a combustion installation, instead of just letting the wood decompose without using the caloric value of wood. Since there are no plans for the building of these combustion installations, it is assumed that this biomass will be transformed to CO_2 ñat onceò during the years in which the deforestation takes place. Consequently, during 2013-2014 and 2017-2018, an increase of CO_2 emissions is projected in the mitigation scenario.

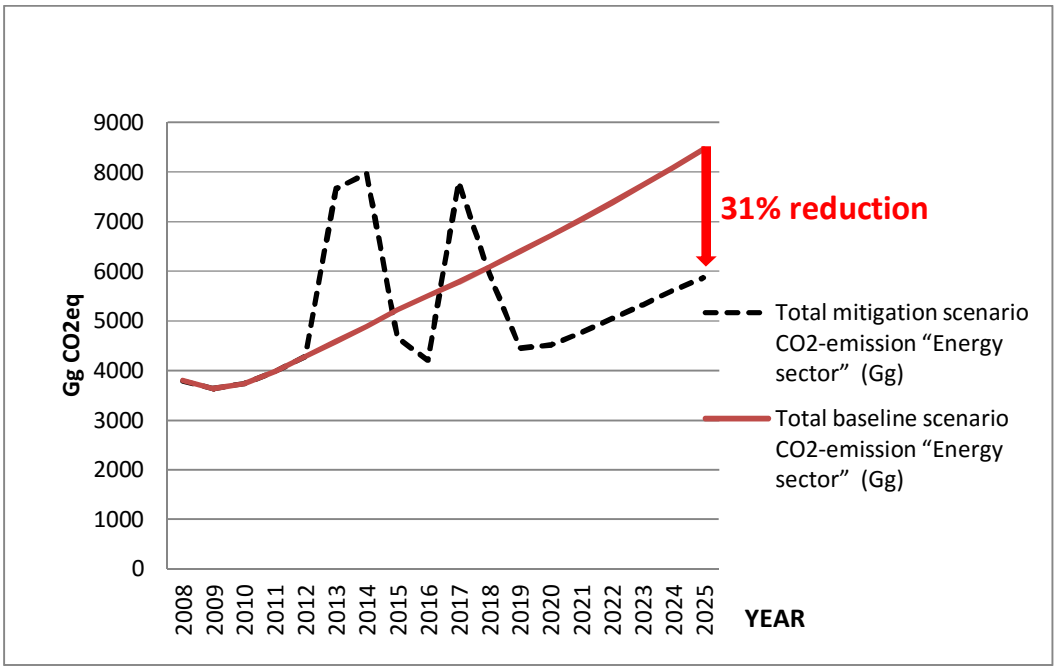

Figure 4.12: Compiled baseline vs. mitigation scenario Energy Sector

4.7 NON ENERGY SECTOR

The AFOLU sector is currently a sink for CO_2 emissions (it actively sequesters CO_2). The net removal (i.e. sequestration) of emissions from the atmosphere by AFOLU is primarily through the growth of trees, sequestration of carbon in wetlands, forest, agricultural and grassland soils.

More than 80% of Surinameôs territory is covered with forests and other hardly disturbed natural areas (e.g. swamps and savannas). Surinameôs deforestation rate has been limited to 3% of original forest lands (since 1650), on average less than 0.1% per year. Deforestation is caused by timber harvesting, creation of (relatively small) agricultural lands, mining areas (mainly bauxite, gold, granite and sand), creation or rehabilitation of roads and for housing (mainly in the urban areas in the coastal region).The GHG Inventory concluded that the main removal of forest in the time period 2000-2008 was induced by mining (gold and bauxite), and that carbon sequestration was induced by reforestation of mined out bauxite areas and changes in carbon content of grassland which was converted back into unproductive agricultural land.

The agriculture and forestry sectors are significant sources of the highly potent GHG CH_4 and nitrous oxide (N_2O). The most important source for GHG emissions in the *Non-energy sector* is agriculture.

4.7.1 GHG PROJECTIONS

The projections for scenarios rely on historical agriculture and forestry activity, and planned land use changes due to infrastructure and agriculture among others.

The applied growth figures for the *Non-energy sector* are based on the combination of the following assumptions:

- An average annual growth of 4.4% for the subsectors from 2008 to 2025 according to the socio-economic development;
- Several rates are derived from the GHG inventory, such as the deforestation rate because of informal gold mining and re-growth rates in sustainable managed forests;
- Several new roads are projected in the Interior, for which forests will be cut; The main new roads are:
    - Haul road from Paranam to Nassau (110 km long, 50 m wide), probably to be built in 2012 or 2013;
    - Road from Nickerie (Southdrain) to Apura, mainly along an existing path (60 km long, approx. 20 m wide); it is unclear when this road will be built;
    - Hardly any deforestation is expected from the upgrading of roads (e.g. the road from Paramaribo to Albina and from Brownsweg to Pokigron), although it might result in increased deforestation as a side-effect (e.g. agriculture and mining);
- Expansion of urban areas will correspond with population growth. It is assumed that expansion of urban areas will result in an additional deforestation to replace agricultural land that is converted to urban areas. These figures are presented in Table 4.11;
- At least 2,000 ha of agricultural land (mainly grassland) will be transferred to housing project;.

- The total land area used for sugarcane production by Staatsolie will be about 12,500 ha; Part of the land allocated for the project (5,000 ha) was previously used for rice production. The remaining acreage (7,500 ha), which was previously uncultivated, mainly consists of grass swamps and marsh forests. According to the planning the establishment of the sugarcane plantation will start in 2014;
- *Suriname Green Energy*[51] has planned to establish a large scale sugarcane plantation (30,000-35,000 ha) between the Corantijn River and Multi Purpose Corantijn Channel. The end product (ethanol) will be mainly destined for the foreign market as a bio-fuel;
- *China Zhong Heng Tai Investment Suriname*[52] has planned to re-cultivate the former Patamacca palm oil plantation, which is currently abandoned and overgrown with secondary vegetation. An area of 2,000ha will most likely be re-cultivated. No primary or old secondary forest will be cut. It is expected that this area will be cleared in 2011 and that the first palms will be planted in 2013. In the future this area might be expanded to the southern direction, into an area with primary forest;
- The company *Foods Fats and Fertilizers* (FFF)[53] has planned the re-cultivation of former palm oil plantations at Phedra, Victoria and other abandoned plantations (such as pine plantations). They have requested an area of 40,000 ha, but will likely obtain a total net area of slightly more than 35,000 ha. The palm oil plantations are currently abandoned and overgrown with secondary vegetation. The other areas are mainly a mixed forest type of plantation trees and secondary forest. It is likely that FFF will start its activities in 2012;
- The cultivation of palm oil will also result in carbon fixation in palm oil trees, which is estimated at an accumulated 75 tCO_2eq/ha after the first 15 years;
- The Government intends to increase rice cultivation up to 150,000 ha by 2020. This means that the land in use for rice production (about 27,000 ha in 2010 based on two

[51] Suriname Green Energy is a newly established private company in Suriname intending to produce ethanol from sugarcane

[52] China Zhong Heng Tai Investment Suriname is a Chinese investor intending to set up a palm oil plantation in Suriname.

[53] Foods Fats and Fertilizers is a palm oil company from India intending to set up a palm oil plantation in Suriname.

crops a year) must be tripled within 10 years. It is expected that this will expand in the Nani zwamp (an area of 30,000 ha, currently mainly swamp forest), and other forested areas and/or polderland not in production;

- The bananas production area is not expected to increase;
- The current area in the Interior which is being used for small-scale agriculture (mainly shifting cultivation) is estimated at a total of 150,000 ha and will remain more or less the same, although there is a slight tendency from shifting cultivation towards permanent agriculture;
- The national beef, sheep and goat livestock is expected to expand within 5-10 years. At least 10,000 ha of forest in the Interior will be used for the establishment of grassland;
- With regards to bauxite mining, Suralco[54] is planning mining activities at Nassau that might result in a deforestation of approximately 750 ha totally, to be cut in 2013 and in 2014;
- Deforestation rate caused by informal gold mining is estimated at 2,621 ha per year (current historic rate of 3,100 ha/yr minus historic deforestation of IAMGOLD), (Playfair, 2011) and it will remain the same, as the price for gold is expected to remain at a high level;
- With regards to gold mining, IAMGOLD[55]intends to clear an additional 813 ha in the coming period 2011-2015;
- Surgold[56] is planning a new gold mine in the Merian area, which will likely result in the deforestation of approximately 1,500 ha, starting in 2012/2013;
- With regards to oil drilling, Staatsolie (oil company of the state) is currently exploring on-shore and off-shore sites in many parts of the coast. It is not yet clear where and when exploitation sites will be established and how much forest will be cut and/or swamps will be drained;

[54]A subsidiary of ALCOA (from the USA) engaged in exploring and mining bauxite in Suriname.
[55] IAMGOLD is a Canadian mining and exploration company engaged in exploring and mining gold in Suriname.
[56] Surgold is a joint venture between Newmont and ALCOA (both from the USA) engaged in exploring and mining gold in Suriname.

- The *Foundation for Forest Management and Production Control* (SBB) will continue to promote sustainable forest practices and improvement of policy and regulations for sustainable forest management. Sustainability of the forestry sector will indeed increase, and GHG emissions will decrease because damage to the remaining forest will decrease. Although there is no information to indicate how much this decrease will be, it is expected to be relatively small;
- The turnover percentage in sawmills will increase with 1% point per year, starting with 30% in 2009 and eventually reaching a turnover of 46% in 2025;
- Timber harvesting remains at a rate of 12m^3/ha and a harvested forest will recover in 40 years, with 1 m^3/ha/yr;
- An average wood density of 0,65 kg/dm^3 is used;
- Finished wood products (construction, furniture, paper etc.) keep carbon sequestered for a longer period, although not infinite. Decay of finished products will be 25% per year.
- The effect on carbon emissions of forest and swamp protection will be zero because of leakage;
- Reforestation plantations accumulate 34 tCO_2 eq/ha/yr (IPCC default value)[57];
- A young plantation of mangrove forest will accumulate approximately 7tCO_2 eq/ha/yr (based on figures of Crooks et al., 2011)[58];
- It is expected that the amount of abandoned agricultural lands will be 0ha by 2020, as these areas are likely to be re-used for agricultural purposes or for urban expansion. Total forest re-growth on abandoned (agricultural) lands will be zero in 2025;
- The Ministry of Spatial Planning, Land and Forest Management (ROGB) and SBB intend to increase the timber production, which corresponds with the sectorôs goals; While the current production per year is approximately 200,000m^3, SBB expects that this will be 500,000$m^3$by 2019. If this timber is cut in a sustainable way, GHG emissions for the specific area will increase in the first years (decomposition of remnants of cut trees ï crowns, roots), but it will decrease in later years, because of an

[57] IPCC default value for tropical broadleaf plantations in South America: 20 (5-35) t dry biomass/ha.
[58] IPCC default value for similar plantations is not available. As it differs extremely from default values of other tropical rain forests, it is decided to use figures provided from other sources, namely Crooks et al., 2011.

increase in growth of trees in and around gaps created by forest exploitation. The average net carbon uptake over a period of 25 years will be somewhat similar as in undisturbed forest. ROGB will improve the management and governance of protected areas in the coming years, but it will not result in a change of the deforestation rate. Protecting forest and swamps might reduce emissions from that specific area, but will likely result in leakage within the country, meaning that activities will move from these areas to other locations that are not under protection;

- The mangrove afforestation along the coast near *Weg naar zee* area is projected in the baseline; other afforestation projects of serious extent are not (yet) planned;
- For the cultivation of herbaceous swamps, it is assumed that 75tCO_2eq/ha will be released;
- It is expected that no specific policies will be developed to protect natural areas with high carbon stocks.

Table 4.11: Expected population growth and expected urban expansion

	2008	2009	2010	2011	2012	2013
Population	517,052	524,143	542,022	559,902	577,781	588,816
Urban area (ha)	57,200	57,984	59,962	61,940	63,918	65,139

	2014	2015	2016	2017	2018	2019
Population	599,851	610,885	621,920	633,158	644,395	655,633
Urban area (ha)	66,360	67,581	68,801	70,044	71,288	72,531

	2020	2021	2022	2023	2024	2025
Population	666,870	678,214	689,559	700,903	712,247	723,591
Urban area (ha)	73,774	75,029	76,284	77,539	78,794	80,049

Source: Partly based on General Bureau of Statistics Suriname – Population projection October 2010)

4.7.1.1 GHG PROJECTIONS FOR AGRICULTURE

Agriculture is one of the important sectors of the Surinamese economy, accounting for 6.8% of GDP in 2009. Agriculture provides significant opportunities for growth, investment and jobs. Agriculture provides food for the nation and produces feed for livestock and bio-energy.

Rice cultivation was the most important source of methane emission and accounted for 26% of total GHG emission within the AFOLU sector in 2008. Most emissions from agriculture are released from fertilized fields, which generate emissions of N_2O. Livestock farming, which generates emissions of CH_4 associated with enteric fermentation and manure, also contributes to these emissions.

Land used for rice production in 2009 was about 54,000ha. The Government intends to increase this area to 150,000ha. This goal, however, will not be reached in 2025 but in 2028 (a delay of 3 years to reach target production) due to the fact that the infrastructure for stepwise expansion of the rice acreage will be ready in 2015 instead of in 2012. As a result, 150,000ha of rice can be produced in 2025 instead of 132,246ha. The baseline scenario, depicted in Figure 4.13, indicates that given a continuation of historical trends and planned activities, emissions due to agriculture will increase from 953 Gg CO_2eq in 2008 to 3,788 Gg CO_2eq in 2025, an increase of 4 times.

4.7.1.2 KEY MITIGATION OPTIONS FOR AGRICULTURE

One of the most important mitigation options in agriculture is the introduction **of farming systems and farming techniques for rice production** with a GHG reducing effect. Research on rice cultivation has shown that emissions mainly occur in the months of the year when the ground is fully waterlogged (FAO, 2010). Studies (Sass et al., 1992; Yagi et al., 1996) show that regular drainage may be the most efficient method to minimize emissions. The proposed mitigation option consists of single drainage of rice fields during the planting cycle. Scientists have found that this can lead to a 50% reduction of methane emissions (Sass et al., 1992; Yagi et al., 1996).Taking the costs for the supply of irrigation water and logistics into consideration this is preferred above frequent water drainage. At least two years will be needed before the implementation can start (start in 2014).

Another mitigation option is the **utilization of abandoned agricultural land for the production of energy crops.** The so called energy crops can reduce GHG emissions by removing carbon dioxide from the air as they grow and store carbon in the crop roots and soil as organic carbon (BIOGRACE). By establishing plantations for bio-fuel crops on abandoned land the need to cut down forests is minimized. In the Interior, abandoned degraded land previously used for shifting cultivation can be used for the production of bio-fuel crops.

The Wageningen Sugarcane Project (implemented by Staatsolie) encompasses sugarcane cultivation and ethanol processing and production. The total area used for sugarcane cultivation will be approximately 12,500 ha, of which roughly 5,000 ha has been previously used for rice cultivation but currently lies fallow. The remaining 7,500 ha is uncultivated and mainly consists of herbaceous swamps (80 %) with some marsh forests (20 %). Some (or maybe all) forests will be cut and swamps will be drained. Drainage is expected to lead to some decomposition of peat, although it is yet very unclear to what extent. Carbon emissions caused by forest clearings resulting from these projects are also calculated in the mitigation scenario.

The mitigation effect is further calculated for part of the sugarcane plantation which will be established on abandoned agricultural land. The total avoided emissions (carbon sequestration) of 1 ha of sugarcane used for bio-ethanol production are 13,830 kg CO_2eq. The total avoided emissions of 5,000 ha sugarcane is 69.15 MtCO_2.

In Figure 4.13 the baseline forecast versus total mitigation forecast is shown. During the period 2012 ï 2015 deforestation for sugarcane cultivation results in an initial increase of GHG emissions.

Other mitigation options such as expansion of no- or low-till practices which sequester carbon in agricultural soils are not elaborated on. Although the effects of such practices could be significant, there is uncertainty concerning the permanence of carbon sequestered in soil.

In appendix B the calculated emissions for the Agriculture sector are presented.

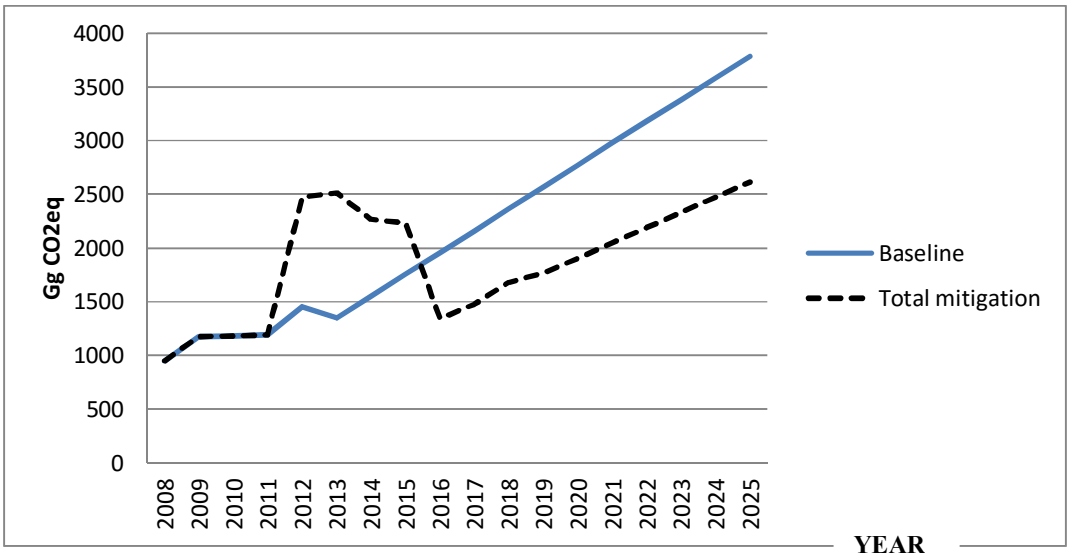

Figure 4.13: Baseline forecast vs. mitigation for Agriculture sector

4.7.1.3 GHG PROJECTIONS FOR FORESTRY SECTOR

The main changes in *carbon emissions* as a result of planned and expected developments can roughly be divided in four categories: deforestation for development (e.g. infrastructure), increased forest exploitation (forestry), wood processing, and forest and swamp protection.

The main changes in *carbon sequestration* as a result of planned and expected developments can roughly be divided in three categories: reforestation in mined out areas, afforestation of mangrove and natural forest re-growth on abandoned agricultural areas.

The baseline scenario calculations are summarized inFigure 4.14. If emissions are negative, more carbon is sequestered than emitted. Since little information is available on the carbon content of the different Surinamese forest types, the IPCC default value for tropical rainforest in South America is used in the calculations: mature forests contain 517 tCO_2eq/ha (IPCC, 2006)[59]. For secondary forest 2/3 of the IPCC default value (= 345 tCO_2eq/ha) is used.

[59] IPCC default value for tropical rain forest in South America: 0.30 (0.12-0.40) Gg dry biomass / ha; 47 % of biomass is carbon and 1 C = 3.67 CO_2 equivalent.

The calculated emissions for the Forestry sector in 2008 differs from the GHG Inventory. The calculations for the GHG Inventory are based on land use. For mitigation, GHG emissions related to wood logging and deteriorating wood waste are calculated on top of the numbers of the GHG Inventory. GHG emissions for 2008 result in 832 Gg CO_2eq.

The baseline projection shows that emissions in the forestry sector will decrease from 832 Gg CO_2eq in 2008 to -1,433 Gg CO_2eq (net sequestration) in 2025. However, large agricultural projects and a corresponding increased rate of deforestation can result in periodic high carbon emissions. Reforestation efforts with the aim of carbon sequestration will barely contribute to a decrease in net carbon emissions before 2025.

4.7.1.4 KEY MITIGATION OPTIONS FOR FORESTRY SECTOR

REDD+ opportunities

For the past years, the Government is investigating its possibilities and the opportunities to participate in a REDD+ scheme. REDD+ focuses on retaining sequestered carbon in forests, and might create promising opportunities for Suriname as a High Forest Cover, Low Deforestation (HFLD) country. Therefore, the Government has started several projects and activities to calculate the national carbon stocks: development of a forest cover map and distinguishing different types of vegetation. Based on this map, so-called carbon plots in which the total amount of carbon is measured are allocated. Based on both the forest cover map and the field results of the carbon plot a national carbon stock will be measured.

These results will give the opportunity to calculate (and allocate) where the highest carbon stocks might be found. Using these results in spatial planning tools will help the Government to plan development in areas with relatively low carbon stock, while avoiding areas with high carbon stock.

Specific mitigation options can be developed to move human activities from these high carbon stock areas to low carbon stock areas. Other mitigation options can be developed to promote the allocation of new development projects in low carbon stock areas, and protecting areas with high carbon stocks. Adequate spatial planning will be the crucial part of these mitigation options to avoid large emissions from deforestation.

As the abovementioned activities are still in measuring and calculation phase, there are no plans yet regarding spatial planning for REDD^{+}. This mitigation option is therefore not considered in the further calculations.

Measures considered in the *Non-energy sector* related to forestry, are **use of wood waste as bio-fuel and additional afforestation of mangrove.** Use of wood waste has already been incorporated as biofuel in the chapter for Energy sector.

Regarding the second mitigation option, coastal ecosystems such as mangroves, tidal marshes, and sea grasses remove carbon from the atmosphere and ocean, storing it in plants and depositing it in the sediment below them by natural processes. In addition to their role and value as a global carbon store, coastal ecosystems provide significant other benefits for climate change adaptation, local livelihoods, tourism and culture such as protection from storms and prevention of shoreline erosion, regulation of coastal water quality, habitat for important fish species and other important and vulnerable species (Crooks et al, 2011). International studies (Crooks et al., 2011; Gong and Wong, 1990) have calculated that the **additional afforestation of mangrove** may contribute to the sequestration of 1.5 to 2.5 ton C/ha/yr (which is 5.5 to 9.2 tCO2eq/ha/yr). For the Surinamese situation an average of 2.0 ton C/ha/yr is used, although this figure is very rough and still needs to be investigated for local conditions. There is no information available on potential sites for additional mangrove afforestation and success factors are not yet intensively investigated. The current mangrove afforestation project should be seen as a pilot to investigate the possibilities. Nevertheless some rough estimates for potential areas are given.

Table 4.12 shows a rough estimate of potential areas along the coast for mangrove afforestation. Although a large extent of the coastal area consists of mud, only growing mud banks create favorable conditions for mangrove afforestation. Assuming that mangrove afforestation can be done up to 300 m in sea on average, a total area of approximately 4,050 ha might be afforested. It is recommended that afforestation takes place in a North-Western direction with rows curving into the sea. This will support natural growth at the sheltered side.

Overall, approximately 75,000 ton C (275.25 Gg CO_2eq) will be sequestered by 2025 if a total of 4050ha is planted in the period 2012 to 2019, at a rate of approximately 200ha per year.

Table 4.12: Potential areas for mangrove afforestation

	Total length along the coast	**In %**	**Suitable for mangrove afforestation?**
Dikes, harbors, river-mouths	~ 40 km	~ 10 %	No / hardly
Ridges, sand / shelf beaches	~ 65 km	~ 20 %	No
Mud banks	~ 270 km	~ 70 %	Depends on the presence of growing mud banks: approximately 50 %. Note: but the mudbank must be stabilized as they move westward by a process of relocation of mud from their rear end to the front, which is a cyclical phenomenon and may take about 7 years for a mud bank to ómoveô. With mudbank ómovementô mangroves are uprooted.
Total	**~ 375 km**	**100 %**	**Approximately 35 % = 135 km**

Figure 4.14presents a projection of the baseline scenario against the mitigation scenario in the forestry sector. In appendix V the calculations for the baseline and mitigation are shown.

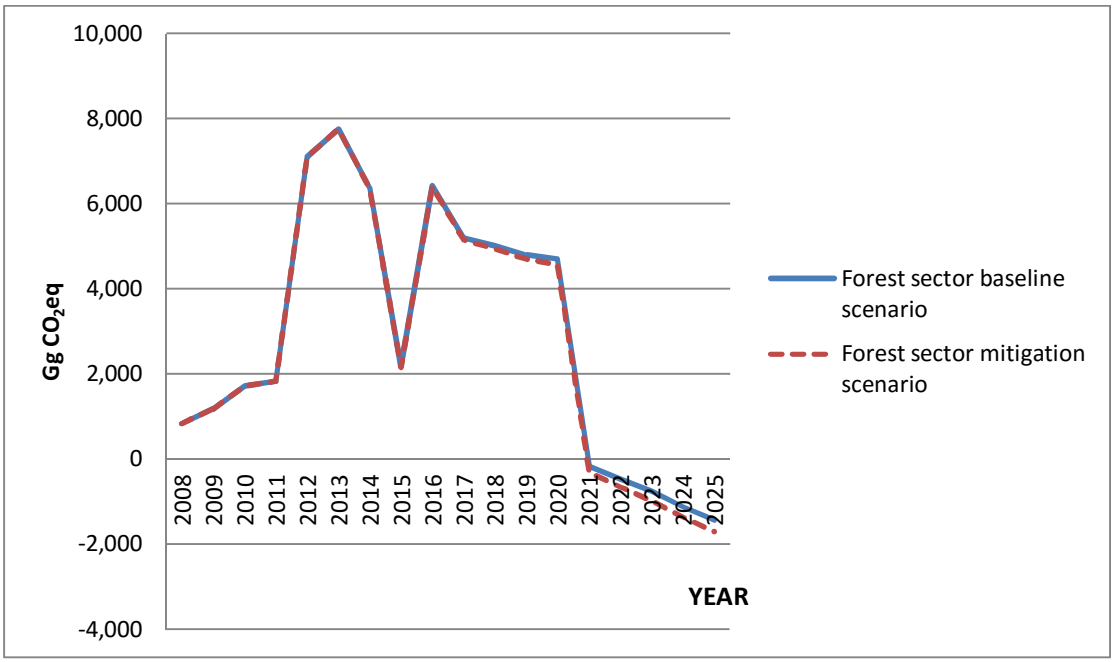

Figure 4.14: Total baseline vs. mitigation for Forestry sector

4.7.2 RESULTS GHG PROJECTIONS NON-ENERGY SECTOR

The baseline scenario and mitigation scenario for the Non-energy sector are compared with each other in Figure 4.15. Based on this comparison the following conclusions can be made:

If no mitigation measures are taken and planned activities in the Agriculture and Forestry sector will be continued, the GHG emission will increase from 1,785 Gg CO_2eq to 2,355 Gg CO_2eq from 2008 to 2025, mostly due to large agricultural projects.

Implementation of aforementioned mitigation options, however, will cause the GHG emissions to drop to 908Gg CO_2eq in 2025.

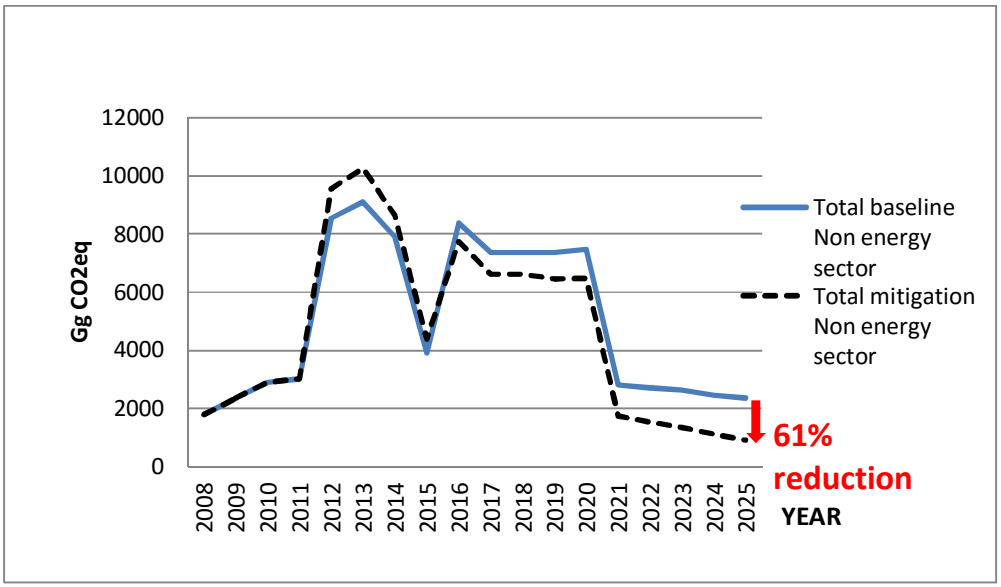

Figure 4.15: CO_2eq emission projection for baseline and mitigation scenario Non-energy sector

4.8 RESULTS

The comparison between emission levels for the baseline and mitigation scenarios of the sectors shows that the potential of CO_2 reduction differs considerably among different sectors.

Table 4.13 shows the contribution of different sectors to this overall reduction, with the largest decreases coming from the *Energy sector* (i.e. electricity generation and transportation).

Table 4.13: Contribution of different sectors to overall reduction

	Baseline in 2008 in Gg CO_2eq	Baseline forecast in 2025 in Gg CO_2eq	Mitigation forecast in 2025 in Gg CO_2eq	Net mitigation result in Gg CO_2eq
Energy sector	3,799	8,470	5,870	2,600
Agriculture sector	953	3,788	2,616	1,172
Forestry sector	832	-1,433	-1,708	275
Total	*5,584*	*10,825*	*6,778*	*4,047*

As shown in Table 4.13, in the year 2025, according to the baseline scenario, total expected emissions reach 10,825Gg CO_2eq, whereas potential abatement measures total 4,047Gg CO_2eq, resulting in a mitigation forecast of 6,778Gg CO_2eq.

According to the baseline scenario, an increase of 94% in GHG emission is expected from 2008 to 2025. In contrast, implementation of the surveyed mitigation measures will result in an increase of approximately 21% in GHG emissions by 2025 compared to 2008.

Table 4.14 summarizes the foreseen emissions until the year 2025. From the table it can be seen that without any mitigation action, emissions per capita are expected to grow with 38% during 2008 - 2025. With mitigation the expected reduction per capita is 13% in 2025 compared to 2008.

Table 4.14: Summary of GHG emissions

	Business as usual scenario 2008	Business as usual scenario 2010	Business as usual scenario 2015	Business as usual scenario 2020	Business as usual scenario 2025	Mitigation scenario 2025
Total emission CO_2 eq (Gg)	5,584	6,625	9,146	14,179	10,825	6,778
Population (x 1000)	517	542	611	667	724	724
Emissions per capita	10.80	12.22	14.97	21.26	**14.95**	**9.36**

As shown in Figure 4.16 the mitigation scenarios result in a huge decrease in GHG emissions. Overall GHG emissions decrease with 38% in 2025 versus their baseline value.

The periods 2012 ï 2015 and 2017 ï 2018, in which emissions from the mitigation scenarios are higher than emissions in the baseline, correspond with the periods in which deforestation takes place for hydropower generation and biofuel projects, causing deterioration of carbon sinks and temporarily resulting in an increase of GHG emissions.

Figure 4.16: Compilation of mitigation scenarios vs. compiled baseline scenario

4.9 BARRIERS AND CORRESPONDING POLICIES

This paragraph describes the barriers to mitigation measures that are selected and calculated in paragraph 4.6 and proposes policies to encourage mitigation measures. A barrier is any obstacle to reaching a potential that can be overcome by a policy, program or measure (IPCC).

Table 4.15 Barriers for energy sector

Barriers for energy sector	Description of the barrier	Encouraging measures
Lack of adequate financial support	Investors often obligate the receiving countries to fulfill certain requirements before being eligible for large loans. Banks and development agencies do not offer soft credit, or programs aimed specifically at energy technologies.	GoS demonstrates priorities by setting targets for renewable energy use in electricity production and negotiate for these targets. Make use of local expertise (or experts) with sufficient knowledge during negotiations. In cases where there is a lack of knowledge hire foreign consultants. For small scale: Ministry of Natural Resources and Energy (NH) encourages

Barriers for energy sector	Description of the barrier	Encouraging measures
		production of electricity from renewable energy sources, especially solar, wind, and biomass, mainly for following reasons: - Reduction of fossil fuel import - Reduction of air pollution - Promotion of modern technologies
Legal and regulatory framework Uncertainty with regard to tariffs for renewable energy	EBS is the only electricity provider. There is a dependency on the willingness of EBS to accept another player in the energy market. Energy supply is subsidized, without incentives for increasing efficiency or evaluation of energy costs.	Legislation should be developed / changed to support the use of renewable energy sources. GoS stimulates introduction of biofuel into the energy mix of Suriname by creating economic incentive measures for the sale of renewable energy to EBS and by creating related feed-in tariff and licensing arrangements for renewable energy generation.
Poor maintenance and operation practice	Renewable energy projects often fail because of poor maintenance.	Proper training programs for maintenance workers as well as operators conducted during the commissioning phase of the project, and yearly refreshment trainings. Training costs and maintenance costs should be calculated in yearly budget.
Slow adaptation rate	It often takes time before people are used to a new system. The adaptation problem often occurs during the implementation phase of the new technology.	Adequate support through (governmental) regulations and awareness campaigns.
Lack of data and capacity to develop sustainable renewable energy project	The lack of data on different aspects of renewable energy sources and lack of technical knowledge regarding the application of new systems often results in the slow implementation of these systems.	Encourage training of new professionals in this field through enrollment in technical schools and the University, focusing on the use of new technologies and research into new options.
Complexity of planning and implementation of public transportation projects, which		Impose a differential tax on vehicles based on a qualification of vehicle

Barriers for energy sector	Description of the barrier	Encouraging measures
require substantial land and financial resources		pollution Give preference to tenders for service vehicles in government agencies to fuel-efficient environment-friendly vehicles Grant economic incentives for promoting alternative fuels.
Absence of (or poor) environmental regulations for industrial companies with regard to their waste streams.	Since there are no or poor governmental environmental regulations on waste reduction and ï elimination, industrial companies are not obligated to reduce their waste streams (e.g. CO2-emission)	Establish a group of experts (lawyers, environment specialists and energy experts) to formulate these regulations for (political) ratification.

Table 4.16 Barriers for agriculture sector

Barriers for agriculture sector	Description of the barrier	Encouraging measures
Lack of awareness and reluctance of farmers to adopt the proposed measurements	Farmers are usually rather hesitant to adopt new measures, especially if they are not aware of disastrous effects of climate change on their crops.	Awareness program focused on the rice farmers. This program must be coordinated by the Ministry of ATM in collaboration with the Ministry of Agriculture.
Availability of knowhow for the implementation of mitigation measures	National research institutions lack access to information, and are not aware of technologies that suit local conditions.	The *National Rice Research Institution* in collaboration with the *ADEK University of Suriname* has to start with a pilot project focused on the effects of water drainage on crop development, rice yield and GHG emission.
Lack of capacity to implement the research activities	There is not enough capacity available to concentrate on substantial research.	Capacity building (train the trainers program) concerning agriculture and climate change (mitigation, adaptation) could be done through the ADEK University of Suriname.

Table 4.17 Barriers for forestry sector

Barriers for forestry sector	Description of the barrier	Encouraging measures

Barriers for forestry sector	Description of the barrier	Encouraging measures
Lack of technical capability	Lack of funding and technical capabilities limit generation of information required for planning and implementation of forestry mitigation projects. Capacity for monitoring carbon stocks has only just been addressed.	As local capacity is limited: attract foreign expertise and support regional (neighboring countries) cooperation and evaluation of forestry mitigation options.
Small and irregular availability of wood chips at single sawmills / wood processing companies	Smaller sawmills and wood factories do not have a continuous availability of large amounts of wood chips, which makes it less or not feasible to generate electricity from wood waste.	Logistical and infrastructural arrangements to support collection of wood waste and electricity generation concentrated at a limited number of electricity generating units.
Fire risks (safety)	Saw mills and wood processing factories are places with fire risk. Extra attention should be given to safety when placing a combustion installation at such a location.	Safety policies should be in place to prevent unsafe situations.
Reluctance of timber companies to re-use their wood waste	Wood waste is rarely seen as a resource for other products, and thus treated as waste and burned or dumped in the open air. A mind shift is needed.	Introduction of financial rewards for re-using wood waste for electricity generation, together with the introduction of financial penalties for burning wood waste in the open air. Such a penalty system will generate financial resources that can be used for the reward system and to promote and encourage the introduction of combustion installations, or even provide subsidies to import and/or install such installations.
Lack of financial resources for mangrove afforestation	Mangrove forests have a great economic value for local fishermen, as they provide coastal protection and are important fishing grounds for local fishermen. It is however unlikely that local fishermen are willing or even able to invest in planting mangrove forests for future financial benefits.	Aim for external financial sources. For example, explore the potential for a wetland NAMA, encompassing management of all relevant national wetland types. Funding for readiness activities and implementation of NAMAs for coastal ecosystem management could be accessed through multilateral and bilateral initiatives

Barriers for forestry sector	Description of the barrier	Encouraging measures
	Additional external financial sources should be found.	that are currently providing fast-start finance as well as the future Green Climate Fund.
Unclear land tenure or use rights for the newly created land	Local fishermen might only be interested in planting mangrove trees when land tenure or use rights for the newly created land are clearly defined, in which they can profit from their investments.	Land use rights should be clearly defined and controlled: who is permitted to use the resources from the new mangrove forests and to what extent is cutting trees permitted? Who will be responsible for control and how will control take place? Also, financial incentives, to increase forest area, to reduce deforestation and to maintain and manage forest, should be created.
Obstructed inflow of fresh water for mangrove afforestation	Mangrove forests need fresh water to survive and expand.	Extra diversion channels and/or outlets in the dike should be constructed to improve the diversion of fresh water along the coast. For other locations great attention should be given to the possibilities for improved inflow of fresh water.

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5 OTHER INFORMATION

5.1 INTRODUCTION

This section provides other information considered relevant to the achievement of the objectives and implementation of the Convention.

In the context of addressing climate change at the national level, this report includes information on activities that have been and currently are being implemented in Suriname[60] concerning the following:

- Steps taken to integrate climate change into relevant social, economic and environmental policies;
- Activities related to technology transfer;
- Climate Change research and systematic observations;
- Research to adapt to and mitigate climate change;
- Information on education, training and public awareness;
- Information on capacity-building at the national, regional and subregional levels;
- Efforts to promote information sharing (information and networking);

The information regarding the above mentioned subjects is obtained through desk research and interviews (Table 6.7). In this section only the main projects and programs concerning the subjects listed above are being discussed in the following sections.

[60]REPORTING ON CLIMATE CHANGE, user manual for the guidelines on national communications from non-Annex I Parties, UNFCCC, 2003

5.2 STEPS TAKEN TO INTEGRATE CLIMATE CHANGE

5.2.1 BACKGROUND

According to vulnerability analyses done under both national communications, climate change will have serious impacts mainly on the coastal zone of Suriname and its sectors. These impacts will affect particularly the coastal areas where most agricultural activities and over ninety per cent of the population are concentrated, compromising the livelihoods of communities in this area and food security of the country. In addition, floods might occur in the Interior due to climate change or poor water management.

The chapter Greenhouse Gas Inventory (GHG inventory) in the SNC concludes that Suriname is a net-sink country. **As a non-Annex country, Suriname has no immediate restrictions with regard to emission.** Therefore, plans and actions in Suriname are mainly focussing on adaptation and less on emission reduction, as climate change and sea level rise initially will negatively affect wildlife habitat, agriculture, fisheries and general environmental conditions (e.g. health)[61].

5.2.2 NATIONAL POLICY AND INSTITUTIONAL ORGANIZATION

During the preparation of the FNC, the environmental management structure consisted of the following three entities:

- The Ministry of Labour, Technological Development and Environment (ATM), responsible for the integration of environmental policy in the national development policy.
- The National Council for the Environment (NMR, an advisory body towards the Government. Their responsibility was to advise the Government in the preparation and the monitoring of environmental policy.

[61]Suriname National Capacity Self-Assessment-Thematic Assessment UNFCCC, August 22, 2008

– The National Institute for Environment and Development in Suriname (NIMOS) as the technical working arm of the Ministry of ATM.

At the end of 2004 a Climate Change Steering Committee was installed by the Minister of ATM. The committee was installed in order to oversee and give advice on issues regarding climate change in general and more specifically the execution of project related activities, with a balanced representation from the key government ministries, academic institutions and private sector representatives.

The Government Declaration for the period 2006-2011 emphasized that responsible management of environmental problems requires an efficient and effective approach. In this declaration the Government of Suriname (GoS) defined the overall goal of the national environmental policy as: protection, conservation, improvement and rehabilitation of environmental quality. During the period 2006-2011, the GoS has undertaken several initiatives like conducting plans and programs, to assess and respond to climate change adaptation challenges. The main plans and programs are being discussed in the following sections.

While progress has been made, particularly in biodiversity conservation, the GoS faces challenges in sustainable natural resources planning and management and the implementation of international conventions and treaties[62].

5.2.3 CURRENT SITUATION

After the elections in 2010, the environmental structure changed. The Climate Change Steering Committee is now disbanded, but the ministry of ATM still has the lead responsibility for the preparation of the coordination of Environmental policy in Suriname with NIMOS as its technical working arm (note: the ministry of ATM is disbanded as of May 2015). The main tasks of the ministry are the formulation of policies and legislative proposals and the coordination and monitoring of both national environmental policy and international

[62] Country Programme Document for the Republic of Suriname(2008 ï 2011), UNDP

agreements. ATM is thus responsible for the coordination of the activities of other line ministries regarding the use of natural resources, biodiversity conservation, health, and regional development[63].

Although the governmentôs development policy is based on an integrated approach towards economic, social and environmental sustainability, an integrated climate change policy is still missing. There are no laws that specifically address climate change issues and commitments to the UNFCCC. The institutional environmental framework is currently unable to adequately address problems regarding implementation in an efficient way and to reduce risks resulting from Climate Change in the future[64]. For example, there are no laws or regulations that support the protection of mangroves outside of established protected areas and establishment of protection forest); there is no zoning of coastal areas and there are few restrictions in place on coastal development. Also, restrictions on resource use are very limited and not well-enforced (e.g. dredging of sand/shell ridges).

Other challenges in addressing climate change issues are a lack of staff and knowledge within specialised ministries[65], political changes are frequent and so are case-by-case decisions without coherence. Existing institutions and agencies need to be strengthened and the co-operation between different institutions needs to be intensified and improved[66].

Despite the above mentioned constraints within the institutional framework and the lack of policies concerning climate change, Suriname aims to combat the effects of climate change through its Development Plan (OP 2012-2016). In the Development Plan, a clear need for adaptation measures in Surinameôs low lying coast is articulated as well as a need for a cross-sectoral Climate Compatible Development Strategy. The OP also identifies the need to prioritize integrated management of the coastal zone. A Climate Change Strategy , as well as

[63] The Caribsave Partnership, Climate Change Risk Profile for Suriname, 2012
[64] Source: several report e.g. NCAP, NCSA, UNDAF.
[65] The ministry of Physical Planning, Land and Forest Management Agriculture (with its foundation for Forest Management and Production Control (agency SBB)), the ministry of Natural Resources (ROGB, NH), the ministry of Agriculture, Animal Husbandry and Fisheries (LVV) and the ministry of Labour, Technological Development and Environment (ATM).
[66] NCSA, 2009

a National Climate Change Action Plan (NCCAP) are being prepared. Both focus on the expected impacts and vulnerabilities resulting from climate change. The NCCAP stresses the importance of integrated coastal zone management and spatial planning.

The OP states that the GoS has the intention to reorient her diplomatic strategy from the regular diplomacy to a development-oriented and economic diplomacy, through which more attention will be paid to issues such as poverty reduction, food security and safety, the protection of emerging businesses and industries and the effects of climate change.

As such the development diplomacy aims to achieve cooperation agreements with funders/ investors for the implementation of projects and programs, identify possibilities of education and training and transfer of knowledge, and to ensure expertise and technology.

Within the next five years the GoS will focus its policy on increasing its capabilities to carry out operational activities through training and education related to environment and development. Priority will also be given to conducting environmental related research and studies. Activities related to research activities and education and training are described in sections four and five.

In August 2011 the Climate Compatible Development Agency (CCDA) was established within the office of the President. With the aim to consolidate all governmental efforts on climate change mitigation and adaptation, and promote effective deployment of existing financing and technology transfer mechanisms.

At present, an *Environmental Framework Act* is being prepared. This Act will address amongst others regulation of pollution and waste management, obligate companies to perform an environmental impact assessment and promote the use of clean technologies. Legislation on reducing exhaust gases is already in place. The *Framework Act on Environment* has been prepared since 2001 and is still not yet approved. It is not possible to give a reliable time frame for the final approval of this Law, since it is subject to an ongoing political decision process.

5.3 ACTIVITIES RELATING TO TECHNOLOGY TRANSFER, TRAINING AND CAPACITY BUILDING

The transfer of technology, training and capacity building plays an important role in mitigating climate change and adapting to its impact. The Intergovernmental Panel on Climate Change (IPCC) defines the concept[67] of technology transfer as:

"….a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, non-governmental organizations (NGOs) and research/education institutions…

… the broad and inclusive term "transfer" encompasses diffusion of technologies and technology cooperation across and within countries. It covers technology transfer processes between developed countries, developing countries, and countries with economies in transition. It comprises the process of learning to understand, utilize and replicate the technology, including the capacity to choose and adapt to local conditions and integrate it with indigenous technologies."

Developing countries, like Suriname, can address the global climate change challenge with the transfer of technology. This can include know-how, goods and services, equipment, as well as organizational and managerial procedures. Access to innovative technologies is mostly possible through foreign financial mechanisms, e.g. grants or funds for technical feasibility studies or measuring equipment. The outcome of these studies and measurements can demonstrate the benefits of investing in environmental sound technologies.

The private sector (e.g. mining companies) can play an important role in direct technology transfer, because the ownership of the environmental sound technologies generally lies with the private sector rather than with governmental or multilateral organizations.

[67] Methodological and Technological Issues in Technology Transfer, IPCC 2000

Transfer of technology takes place with regard to the exploitation of the renewable resources, followed by upgrading of the existing energy infrastructure, including the sources of energy generation.

In Suriname the transfer of technology has been incorporated in several adaptation and mitigation projects and programs. Technology transfer plays a significant role in adaptation projects, through mangrove restoration, building climate resilient infrastructure and the use of high-tech solutions for data logging and *Early Warning Systems*. The technologies in mitigation projects are more focused on energy efficiency; renewable energy; emerging low-carbon and energy-generating technologies.

In the forestry sector the ôReduced Impact Logging (RIL) systemô established a decrease in emissions from timber exploitation. Reduced impact logging techniques also reduce damage to trees in the residual stand and the amount of land disturbed by machinery.

Economic and ecological benefits provided by logged forests will be greater where RIL techniques are used.

In 2011 a GEF-based climate change project[68] was proposed and is currently being implemented. The main objective of this project is to promote the use and development of *Renewable Energy and Energy Efficiency* systems in Suriname. This project will demonstrate the use of hydro energy and solar technologies as an option for the electrification of the Hinterland. It will also assist with reducing the energy consumption, and demonstrate energy efficiency practices in Suriname mainly by using efficient lighting and solar water heaters.

As previously stated in the IPCC definition of technology transfer, Suriname can play an active role in climate change issues when it has the capacity to understand, utilize and replicate the technology. Capacity building is therefore very important for successful ôtechnology transferô. Capacity building generates competence, improves the effectiveness of the institutions that work within the context of climate change and promotes an enabling environment for implementing climate change projects among others.

[68] Project title: The Development of Renewable Energy, Energy Efficiency and Electrification of Suriname.

After submitting the First National Communication to the UNFCCC, Suriname made efforts in building capacity to address climate change issues in both the public and the private sector. Some of these main capacity building projects are mentioned below:

In 2006 a **Summer Research School**[69] was held as part of a larger EU-Star project, which was a joint effort of research groups from Europe, Suriname and Japan to establish a shared atmospheric observatory in Paramaribo, Suriname. Some of the key topics, which were discussed during this training session, were the dynamical processes in the tropical atmosphere, atmospheric chemistry of the tropics and satellite observations of the chemical composition of the tropical atmosphere. This summer school was intended for advanced students interested in environmental science or related fields, as well as researchers involved in tropical atmospheric research. A number of Government officials also attended the training.

Suriname focuses on increasing its knowledge to cope with threatening situations along their coast. The ñVLIR-OI Capacity Building Projectò focuses on capacity building of the Anton de Kom University of Suriname (AdeKUS) in order to carry out research and teaching in engineering (i.e., technological) aspects of **coastal zone management** (CZM). More of this project is described in section 6 ñInformation on education, training and public awarenessôô.

Following the flooding in 2006 and 2008, a project was executed by the *National Coordination Center For Disaster Management* (NCCR) to install five water level measurement devices in the Tapanahony River basin as part of the establishment of an **Early Warning System (EWS)** in Suriname[70]. One of the objectives of this project was to enhance the capacity of the communities in order to understand and respond appropriately to climate warning. All of the water level reading devices are installed in the Upper Suriname and Tapanahony Area. Data, representing daily reading of water levels of these areas, are gathered by the AdeKUS and NCCR and are also available through the website of the Meteorological Services for the public. Staff of NCCR, AdeKUS and other institutions are trained in the use of this system and interpretation of the data.

[69] Self Assesment Second National Communication, 2007
[70] UNDP, 2009

In 2008 the project **“Capacity Development for Clean Development Mechanism” (CD4CDM),** that is an initiative funded by the Netherlands Government and implemented by UNEP RISOE CENTRE (URC) in Denmark, was implemented in Suriname. The collaboration of the Ministry of Labour, Technological Development and Environment (ATM with the UNEP RISOE contributed to the awareness and capacity building with regards to CDM. Various workshops, training and information events for ministries, institutes, organizations and the private sector were organized. As a result, information brochures, an investorôs guide, a CDM portfolio and a CDM website were developed. Furthermore the Designated National Authority (DNA) was established within the Ministry of ATM. In order to evaluate the submitted Project Idea Notes (PINs), the DNA was assisted by a CDM Commission consisting of representatives of key ministries. After the change in government this commission was disbanded.

Currently the Ministry of ATM is carrying out the project **"Capacity building in and Mainstreaming of Sustainable Land Management in Suriname”** in order to achieve sustainable land management. An important part of this project is to provide a GIS-(Geographic Information Systems) and land use training to ministries and other organizations that are involved in land management in Suriname. The aim of the training is to provide the key stakeholders with some insight into methods for proper storage and efficient management of data.

As Suriname can be categorized as a High Forest Cover, Low Deforestation (HFLD) country, the **REDD+ mechanism** is most likely to create promising opportunities for Suriname for its standing forests.

REDD+

The Reducing Emissions from Deforestation and Forest Degradation (REDD) initiative is a set of steps designed to use market/financial incentives to reduce the emissions of greenhouse gases from deforestation and forest degradation, with "co-benefits" such as biodiversity conservation and poverty alleviation. REDD-plus supports activities that enable CO2 reductions caused by deforestation and forest degradation. It also aims to strengthen and expand the role of forests as carbon pools by conservation of forests, the sustainable management of forests and the enhancement of forest carbon stocks.

Box 5.1Description of REDD+

REDD+ focuses on retaining sequestered carbon in forests, and might create promising opportunities for Suriname. Therefore the Government has started several projects and activities to enhance awareness and capacity building. Although Suriname has not finalized its Readiness Preparation Proposal (RPP) for REDD+, it is actively involved in the program and advocates for compensation for conserving forests, increase carbon stock and applying sustainable forest management.

Other activities that the Ministry of ATM conducts are **yearly activities in the context of environmental days**. During those days (World Environment Day, International Day for Biodiversity, etc.) awareness activities are carried out. For example, every year since 2009, the Ministry has organized a walk, in collaboration with the UNDP, in which the theme of World Environment Day for that year is promoted . The NIMOS and other NGO organizations also organize activities in the context of environmental days.

The UNFCCC encourages its (non-Annex I) parties to submit their priority technology needs for mitigation and adaptation. Suriname has not yet conducted this assessment. It is recommended to do so, because this will provide the country with information on the technologies needed to mitigate GHG emissions.

5.4 CLIMATE CHANGE SYSTEMATIC OBSERVATION AND RESEARCH/STUDIES TO ADAPT TO AND MITIGATE CLIMATE CHANGE

Recent and future changes in climate in Suriname have been explored using a combination of observations and climate model projections mostly executed by AdeKUS. This information can provide Suriname with some very useful indications of the changes to the characteristics of regional climate that we might expect under a warmer global climate.

5.4.1 CLIMATE CHANGE SYSTEMATIC OBSERVATION

The Meteorological Service of Suriname (MDS) as part of the Ministry of Public Works is the leading governmental authority in providing the nation with climate-based data derived from systematic and accurate monitoring and data collection and analysis. The Service maintains and manages all meteorological data of the country. They are responsible for all weather forecasts and meteorological data for Suriname.

Records on temperature and rainfall are available from the year 1900. Currently, the MDS has a network of about 60 points compared to 180 posts in the early eighties. At present, observations are made at 21 stations, 5 synoptic stations, 11 climate stations and 2 automatic stations[71] (NIMOS, 2005). 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.

Currently cooperation on modest scale is taking place with other institutes like AdeKUS, The Royal Netherlands Meteorological Institute (KNMI (Netherlands)), the University of Bremen (Germany), the Alfred Wegener Institute Bremerhaven (Germany) and the University of Heidelberg (Germany).

Most of the meteorological stations do not have records exceeding a 30-year period. This data gap is among others due to the civil war (1986-1992), which led to the closure of all stations in the Hinterland in that period. Climate data from suitable stations are used to make climate projections for temperature and rainfall. This information is used to conduct vulnerability

[71] NIMOS, 2005

assessments in different sectors like Agriculture, Coastal Zone, Fisheries, Health and Water Resources and to design adaptation strategies[72].

Most of the instruments of the MDS are outdated and in urgent need of calibration or renewal.

At present most of the existing staff consists of government representatives who are approaching retirement age. Therefore there will be a need to recruit new staff.

The greatest obstacle for improvements to the MDS is budgetary constraints and other more urgent political priorities that lower the priority of systematic observation programs. This has significantly reduced the maintenance and monitoring of systematic observing systems of the MDS network stations.

Although the requirement for the meteorological services is accepted in certain international conventions ratified by Suriname, it is not being implemented on the national level as yet. The establishment of the Law on Meteorological Service is therefore necessary. This Law has been prepared for almost ten years, but has not yet been passed.

Looking at global developments and changing environmental factors in Suriname, an expansion of its organizational setting and service points of the MDS must take place. This can result in better monitoring and guidance. In addition, certain sectors like agriculture and the aviation sector, which depend on climatic data can be provided with better with qualitative and quantitative data.

Recently, in March 2011, Suriname participated in the Caribbean Regional test of a tsunami early warning system. This demonstrates the awareness Suriname has of the high vulnerability of the coastal regions. The test highlighted the need to reinforce preparations and to improve communication, evacuation plans and the role of the private sector[73].

[72]The Caribsave Partnership, Climate Change Risk Profile for Suriname, 2012
[73] UNESCO Media Services, 2011

5.4.2 CLIMATE CHANGE RESEARCH AND STUDIES

Suriname has considerable cause for concern as the threats posed by a changing climate to the development prospects of the country are severe (IPCC, 2007). The Caribbean region is currently also dealing with climatic variability and extreme events, and is projected to be confronted with considerable impacts associated with a changing climate. In the past years several research activities have taken place, most of them in collaboration with other universities from the Caribbean. The knowledge gained out of these research activities can assist decision makers in the public and private sector in understanding the predicted changes in climate, their impacts and socio-economic effects in the Caribbean region.

Currently Suriname is participating in the research project called **'Climate Modeling, and Impact and Economic Modeling Implementation Plan (2011 – 2021)'**[74]. This Caribbean Climate Modeling Initiative is being conducted with the participation of several universities and institutions from the Caribbean. Some expected main outputs and benefits of this project are: increased technical, human and physical capacity, increased resilience to climate change, strengthened basis for adaptation and mitigation support and sustainable socio-economic development.

As part of the Caribbean Climate Modeling Initiative, a modeling project called **"Future change of the climate in Suriname is currently being conducted by AdeKUS (Department Infrastructure). It is derived from the PRECIS[75] regional climate modeling system (phase 2)"**. The main objective of this project is to model climate change in Suriname with PRECIS for the period 1979-1983 and 1961-2100 under the SRES A1, A2, B1 and B2 conditions.

In 2009 the ADEKUS started a project **"Management of water resources in north-west Suriname under climate change conditions (2009-2011/2013)"** in collaboration with Waternet-Nederland. This project aims to develop water resources management strategies for sufficient drinking water supply in urban and rural areas and irrigation water supply in the

[74] Caribbean Regional Research Diagnostic, 2012
[75] Providing Regional Climates for Impacts Studies, regional climate modelling system

agricultural areas in district Nickerie by 2050. All necessary data are now collected and the next step is to analyze and prepare modeling strategies.

In January 2010, AdekUS in collaboration with the Katholieke Universiteit Leuven (Belgium) started a mangrove planting project in order to protect the coast of Suriname: **"Enhancing resilience of the coastline through removing stress, rehabilitation and mangrove planting".** The main objective of this project is to protect and strengthen the coastline through planting of mangrove plants initially on the bare mud bank / mudflat found in the Coronie district at the location Moy and in the following phase in the Wanica district at Weg naar Zee. Realization of this project will demonstrate the technical feasibility of afforestation of the mud banks / mudflats by *Avicennia germinans* L. The University of Suriname is responsible for the execution of the project. The project is still being conducted and so far the progress can be seen as being positive.

In 2010 the project **'Support for Improving Disaster Risk Management for Climate-Resilient Development'**, is being implemented through the NCCR and aims to render development which is more resilient to climate-related disasters, especially floods. Its goal is to reduce the loss of life and socioeconomic losses due to climate related hazards and disasters in Suriname[76].

Suriname is highly vulnerable to climate- induced sea level rise, because of its extensive low-lying coast where the vast majority of the population lives. The Government of Suriname has therefore undertaken studies focusing on the promotion of sustainable livelihoods in the coastal zone and carried out several studies containing measures to mitigate climate change, as well as measures to facilitate adequate adaptation to climate change. Different institutions have been involved in conducting and implementing these studies.

In 1996 the program **Nederlands Climate Assistance Programme (NCAP) phase I** was implemented is Suriname, with the assistance of the Dutch ministry of foreign affairs. The objective of phase I (NCAP I) of the program was to determine and map the vulnerability of Groot-Paramaribo. The 2nd phase (NCAP II) started in 2005 and was based on the results of NCAP I and Surinameôs FNC. Its aim was to develop methods and capacities in order to

[76] Review of current and planned Adaptation Actions: South America

build resilience to the effects of CC. Furthermore it focused on raising awareness on CC, increase the involvement of policymakers, scientists and the general public and the development of legislation and regulation. The main outcome of the project is a set of detailed recommendations and suggestions that can be integrated into a climate change strategy and action plan for Paramaribo and Wanica[77].

Surinameôs **First National Communication**[78] , identifies the low lying coastal zone as a priority area, within which a number of sectors are at risk with regard to sea level rise, these are: water resources, ecosystems & geomorphology, agriculture, socio-economy and human health[79]. Many of the adaptation and mitigation measures as stated in the FNC relate to the vulnerability of its coastal areas. The impact of rising global sea levels is a growing and uncertain element in coastal zone management. Rising sea levels will significantly impact all human populations and economic investments within the coastal plain[80].

In addition, a draft **National Climate Change Action Plan** (NCCAP, 2008) was developed in order to create a framework for better guidance, coordination and implementation of adaptation and mitigation measures through participatory processes. Its aim is also to establish synergies between other environmental related development programs. The NCCAP is focused on coastal areas and river banks, water resources, health, agriculture, energy, education and awareness, capacity development, scientific research and financing of adaptation and mitigation measures.

In the FNC several adaptation and mitigation measures are listed for various sectors. However due to insufficient capacity (qualitatively and quantitatively) Suriname cannot fully act on these measures. In order to identify its needs, Suriname conducted a **National Capacity Self-Assessment (NCSA)** in 2009. The NCSA has among others served to increase peopleôs awareness of climate change and the links to other ongoing sectoral programs. The NCSA Report was guided by three conventions, the Convention on Biological Diversity (UNCBD), the Framework Convention on Climate Change (UNFCCC), and the Convention

[77] www.weadapt.org
[78] FNC, 2005
[79] Adaptation Partnership, Review of Current and Planned Adaptation Action: South America.
[80] Integrated Coastal Zone Management Plan, Plan of Operations, IDB, 2007

to Combat Desertification (UNCCD).The NCSA report highlights the need for the rehabilitation, conservation and sustainable management of land and water resources (de Wolf and Bosques, 2009). In addition, a Capacity Development Action Plan (CDAP) was formulated but not yet implemented.

The **Case Study on the Impact of Climate Change on Agriculture and Housing on Indigenous Communities in Surinam**e was conducted in 2009 on behalf of the UNDP. Its aim was to increase awareness of the differential impact of the 2006 floods on men and on women in the selected communities and specifically to assess how agriculture and housing were affected[81].

In order to maintain the environmental and ecological integrity of its coastal zone, the Government of Suriname decided to integrate the results of all previous work into **The Integrated Coastal Zone Management Plan (ICZM).** This Plan will help the GoS to move ahead to achieve sustainable development of the coastal zone in a coordinated way. The ICZM consists of a coordinated approach to manage on-going and planned economic activities for the coastal zone, and promotes sustainable use and conservation of the natural resources.

In 2011, the Ministry of ATM in collaboration with the UNDP, conducted consultation sessions for the formulation of the **Ecosystem Based Adaptation Project**. This project has been budgeted for $ 8 million and has been submitted to the Special Climate Change Fund of the GEF. The overall goal of the project is to enhance Surinameôs capacity to mitigate and adapt to the impacts of climate change. The objective of the project is to incorporate ecosystem based adaptation approaches into the countryôs climate change risk management system, with a specific focus on reducing the impacts of coastal flooding, erosion and saltwater intrusion on the sustainable development and well-being of Surinameôs population.

[81] Case Study on the Impact of Climate Change on Agriculture and Housing on Indigenous Communities in Suriname, UNDP, 2009

5.5 INFORMATION ON EDUCATION, TRAINING AND PUBLIC AWARENESS

A vast majority of the population lives and works in the coastal zone of Suriname and is not fully aware of the possible effects of climate change e.g. sea level rise. This was confirmed by a survey[82] that was conducted in 2003 in determining environmental awareness among school-aged children. One of the outcomes of this survey was that youngsters between the age of 16 and 30 were unaware of the international environmental treaties and had no idea of the national institutions involved in environmental management. The survey can be seen as a first step that needs to be elaborated in a further study on efficient and effective awareness raising.

After submission of the FNC to the UNFCCC, several training, public awareness and capacity building activities related to climate change have been conducted in Suriname.

Over the past years many organizations (government, NGOôs) and institutions have become involved in education and public awareness on issues regarding climate change. For instance several environmental NGOôs, in collaboration with the large-scale companies, have developed successful awareness campaigns for maintaining a clean environment and conducted activities associated with waste collection.

Unfortunately, there is no system in place at present to record and monitor the outcome of these activities. Other constraints are the costs and time that are involved in sustainable campaigns.

5.5.1 EDUCATIONAL PROGRAMS

The most promising group to start with awareness and education on environmental issues are young people between the age of 6 and 18. Information on climate change and its risk, educated to these children, will automatically be transferred to adults. In this way basic knowledge about threats and proper response, can help improve community-level resilience.

[82] Van der Kooye, 2003

In collaboration with the Ministry of Education and ATM/NIMOS, curricula can be developed that include educational demonstration projects together with the formal dissemination of environmental information. The youngsters will learn to collectively work on an environmental awareness and education project for the school. Such initiatives have already been taken at various primary schools in Paramaribo and the districts (e.g. waste collection, environmental fairs). Issues that can be considered for such school projects are awareness of waste management, biodiversity, climate change, and pesticide. To successfully develop such an initiative, it is recommended that training courses be provided for teachers and schools be encouraged with a yearly award for the best project.

Recently (2010) **the GLOBE project** has been reactivated in Suriname through the Ministry of Education. The GLOBE Program is an international hands-on, primary and secondary school-based science and education program with 111 member countries. Suriname joined in 1997, but hasn't been active since 1999. In Box 5.2 below, more information about this project is given.

GLOBE Program

Global Learning and Observations to Benefit the Environment (GLOBE) is a hands-on international environmental science and education program. GLOBE links students, teachers, and the scientific research community in an effort to learn more about our environment through student data collection and observation.

The goals of GLOBE are:

1. to improve student achievement across the curriculum with a focus on student research in environmental and Earth system science;
2. to enhance awareness and support activities of individuals throughout the world to benefits the environment;
3. to contribute to scientific understanding of Earth as a system; and
4. to connect and inspire the next generation of global scientists.

Students from the ages of approximately five through eighteen years in schools throughout the world conduct a continuing program of scientifically meaningful environmental measurements.

Box 5.2 The GLOBE Program

5.5.2 STUDIES AND COURSES AT THE UNIVERSITY

The understanding and management of the impacts of climate change in Suriname requires academically trained scientists and engineers, and advanced research capacity. AdeKUS, in collaboration with the Flemish universities of Flanders (Belgium), has developed a 2-year Master of Science program in **Sustainable Management of Natural Resources (SMNR)**. At the same time, the research capacity (standards of research, knowledge, skills, equipment) at AdeKUS is strengthened in the fields of sustainable land- and water management, renewable energy resources, mineral resources, biodiversity, sustainable forestry, sustainable agriculture and natural products[83].

Within the SMNR, **three courses regarding climate chang e**are provided. These courses are ñWater resources managementò, ñClimatology and Hydrologyò and ñGeohydrology and modelingò. The aim of these courses is to educate students in methods used in water resources management, climatology and hydrology, as well as to obtain interdisciplinary understanding.

5.5.3 PUBLIC AWARENESS

After completing the FNC, NIMOS implemented an awareness plan for three months. The objective of the **"Climate Change Awareness Programme"** was to increase the public awareness (especially schools and the media) on global climate change and its impact on Suriname. A media campaign was set up for implementing the program and this campaign concluded with a climate change exhibition.

To promote the awareness on climate change several conferences were organized. In 2007 a **Water conference** was held in Paramaribo with the aim to share information on and discuss the ôWater and future development of Surinameô. Later in 2009 a **National Conference on Climate** was held in Paramaribo. The objective of this conference was to increase the

[83] Paper ñMaster Education and Research Program on Sustainable Management of Natural Resources in Surinameò, R. Nurmohamed et al.

awareness of citizens on climate change issues. Presentations covered topics such as climate modeling, coastal zone management, REDD and vulnerability and adaptation assessments (agriculture, health, water resources, socio-economics, ecology and geomorphology) of the coastal zone.

5.6 INFORMATION AND NETWORKING

Suriname participates in several international climate change initiatives and in organizations which aim is to enhance knowledge on climate change and to take action on climate change issues.

Suriname participates in the óPeace Corps Energy and Climate Partnership of the Americas (ECPA) initiative, with the objective to increase municipal, school and communities óawareness and knowledge of climate change and support community-led projects, including adaptation. The Peace Corps Suriname's ECPA initiative focuses on energy poverty and climate change efforts[84].. The U.S. State Department supports this program and it is run by Peace Corps volunteers with the Anton de Kom University of Suriname.

As a member of the Caribbean Community Climate Change Centre (CCCCC) Suriname participates in the board of Directors per 2012 for a period of three years.

In April 2012, Suriname signed an agreement with the CCCCC to participate in **the Global Climate Change Alliance (GCCA) Caribbean Support Project**. This project, which has a duration of 42 months, aims at strengthening capacities within the CARIFORUM countries through the implementation of pilot projects, training courses and workshops. The project activities, can be divided into six technical components, namely: capacity building in the use of climate models, improving climate monitoring and data collection, assistance in the implementation of a pilot Risk Assessment project, assisting in the implementation of a pilot adaptation project, construction of regional and national capacities in the field of Carbon Financing and Project Management.

[84] www.ecpamericas.org

In May 2012, Suriname signed a **MOU (Memory of Understanding) with Austria** for cooperation in the field of sustainable forest management, renewable energy and environmental sciences (waste, water and climate change). The objective of this MOU is to establish a framework for cooperation with regard to the establishment of the SURINAME-AUSTRIA Rural Development and Climate Change Partnership (RUDECCP).

5.7 CONCLUSION AND RECOMMENDATIONS

Suriname is vulnerable to the negative impacts of climate change due to its characteristic of low lying coastal zone. The GHG inventory (FNC, SNC) shows that the contribution of Suriname to greenhouse gas emissions is relatively low. This is mostly because of the small size of the industry sector. On the other hand, sea level rise may inundate large parts of the coastal zone and can be catastrophic for the country. Hence, Surinameôs highest concern is the vulnerability of the coastal zone.

As an obligation to the UNFCCC, Suriname is expected to take climate change considerations into account, to the extent feasible, in their relevant social, economic and environmental policies and actions, and employ appropriate methods, projects and/or measures undertaken by them to mitigate or adapt to climate change.

In this context, Suriname has put in place several measures and strategies to deal with the adverse effects of extreme climatic events. As stated in the Development Plan, a clear need for adaptation measures in Surinameôs low lying coast is articulated as well as the countryôs cross-sectoral Climate Compatible Development Strategy.

Although the governmentôs development policy is based on an integrated approach towards economic, social and environmental sustainability, an integrated climate change policy is still missing and there is also a lack of cooperation among the several stakeholders.

To mitigate and adapt to the adverse effects of climate change, the report makes the following recommendation:

- Approval of the Environmental Framework Act;
- Incorporate climate change adaptations in long-term planning and development programs;

- Improve the Institutional framework by establishing a coordinating body institution;
- Raise critical consciousness at the government and other key stakeholders about climate change and variability through awareness and capacity building campaigns;
- The GoS will need to invest in setting up a strategic awareness program to prevent ad-hoc implementation of awareness campaigns ;
- Conduct a technology-needs assessment, which will amongst others provide information on the technology needs of the country to respond to GHG mitigation as well as to forward national efforts as they relate to climate change adaptation;
- The GoS should allocate more funds for research and development of appropriate technology concerning climate change;
- Improve the MDS in its entire organization and equipment;

6 GAPS AND CONSTRAINTS

6.1 INTRODUCTION

Suriname faced a number of challenges during the preparation of the First National Communication (FNC). Some of these challenges were dealt with while others remain. The inability to resolve these challenges could be because national communications are considered a project based activity rather than being an ongoing process. A number of recommendations from the FNC are integrated in the Development Plans. However, implementation could be more progressive. In practice, implementation depends on political will and availability of funding from donor agencies.

The Second National Communication (SNC) had a delay in the start. Although the project document was signed in July 2009, the project manager was contracted in May 2010 while the consultants actually started after the inception workshop in November 2010. Most of the actual work of the GHG consultants started in the beginning of 2011. Due to the Government administrative procedures, there have also been some delays in contracting and signing of letters during the first phase of the project. Training of the government staff and the Project Manager in UNDP procedures has contributed to the improvement of the administrative process. Most of the delay at the moment comes from overdue submission and approval of these reports. Although some challenges remain unresolved, it should be recognized that national communication (NC) preparation is an ongoing process in resolving financial, institutional and capacity challenges as well as other challenges which may arise.

6.2 FINANCIAL, TECHNICAL & CAPACITY NEEDS; GAPS AND CONSTRAINTS AND THE SNC FOR SURINAME

6.2.1 A SELF-REFLECTION ON PROGRESS AND GAPS

Since the submission of the first national communication report in 2005, there has been some progress in addressing the gaps and constraints in financial, technical and capacity needs. Improvement has been made on the policy level, the upgrading of the legislative and institutional framework, more scientific data analysis and in the area of education, training and awareness. A concise overview of the progress made between the first and current SNC is listed as an introduction to the needs as listed within this chapter.

Policy Framework

The first national communication (FNC) was the first effort of the Republic of Suriname to report on climate change to the UNFCCC. Specific policies on climate change were made after the FNC, and in the development plan 2012-2016 climate change became a stronger prioritized issue. Coordination of specific climate change activities that are aligned with climate change compatible development initiatives in mitigation and adaptation, are now executed by a special agency of the Office of the President (CCDA). These include carbon credit development to diversify the economy, generating income from natural capital, increasing economic resilience to climate change and participating in the green economy. CCDA functions as the national focal point to the UNFCCC.

Institutional Framework

In 1998 the National institute for Environment and Development (NIMOS) was established with the statutory objectives of:

- Preparing and realizing of national environmental legislation in the broadest sense;
- Preparing and the realizing of regulations on protection of the environment;
- Coordination and monitoring of compliance;

NIMOS was by then operational as the executing agency of the National Environmental Board. The FNC was finalized by NIMOS in cooperation with two climate change experts. Anno 2012 this governmental foundation is incorporated within the structure of the Ministry of ATM.

The Ministry itself which was established in 2002 (S.B. No. 2002. 16) with the following tasks related to management and conservation of the natural environment:

a. To coordinate the preparation of the Environmental Policies and monitoring of its implementation, in cooperation with the relevant ministries and relevant organizations and institutions in the private sector;
b. To promote in cooperation with other relevant ministries, organizations and institutions the establishment of national environmental legislation;
c. The development of cooperation mechanisms and networks (partnership) to national and international environmental tasks in an efficient and effective manner;
d. Identifying, preparing and implementing educational, training and education programs to strengthen environmental institutions and organizations;
e. To promote the implementation of conventions on the environment that the Surinamese Government signed and ratified after adapting these to local circumstances;
f. In collaboration with other ministries, organizations and institutions controlling companies and other businesses related to the use of environmentally sensitive materials and technologies related to compliance with environmental legislation;
g. Involvement of the entire community in activities aimed at effectively countering environmental pollution;
h. To encourage the use of environmentally friendly technologies;
i. To promote and maintain contacts with relevant national and international organizations.

In 2011 with the establishment of the presidential taskforce CCDA a new body was added with a primary focus on the environment and climate change. The tasks of the CCDA overlap with that of the Ministry of ATM and NIMOS in coordinating the efforts in the area of climate change, which can create tension between the institutes. During the interviews and the reviewing of the draft version of this document a need was expressed for more clarity on the roles, responsibilities and mandates of NIMOS, ATM and CCDA to prevent any overlap in tasks and roles to be counterproductive.

A division of tasks and responsibilities on the macro, meso and micro level between these institutions is desirable but has to be preceded by an in-depth institutional assessment.

Legislative framework

A framework law on environment has been drafted, revised several times and is waiting to be passed. An environmental law could facilitate the collection of certain data (e.g. amounts of waste) from institutions and corporations. The current law on statistics has not been designed with a mandate to demand specific technical climate change data from the private and other sectors.

Institutionalizing the monitoring of climate change requires a cross cutting approach. Although most technical institutions operate on a sector-specific level, the collaboration between institutions has been improved, especially in the REDD+ efforts. The existing legislation for the sectors that are influenced by climate change has not been significantly changed since the FNC. These include the Nature Protection Act (GB 1954 no. 20, as lastly amended by SB 1992 no.80), Fish Protection Law (GB 1961 no. 44) and the Law on Forest Management (SB 1992 no. 80), Bigi Pan MUMA Ministerial Order (1987 no.4423/0880), Noord-Coronie MUMA Ministerial Order (SB. 2002 no.87), Noord-Saramacca MUMA Ministerial Order (SB. 2002 no. 88), Noord-Commewijne/Marowijne MUMA Ministerial Order (SB. 2002 no. 94), Guidelines for land allocation in Estuarine management areas Ministerial Order (SB. 2005 no. 16).

Scientific Analysis

The most notable gap in the FNC is the availability of data and scientific analysis on topics such as topography, erosion, sedimentation rates, biodiversity, forestry, energy use, meteorology and socio-economy of groups (especially from the rural areas). The data gathering process is hampered by the absence of technology and/or manpower to operate the remote public sector measuring stations. In most cases the scientific technology for observation is not available. In the FNC, the scientific analysis on the specific sectors - human health, energy and transportation, forestry, agriculture ï was limited because topic-specific studies were not available.

Although there has been no significant improvement in the availability of data since the FNC, the second communication provides a higher level of analysis for the human impact on climate change and the selection of mitigation options. It also provides a deeper overall analysis for the Interior of Suriname. This results from the capacity that has been built in

scientists since the FNC. The majority of the lead experts and some of the sub-consultants were involved in both the first and the second national communication. The processes of collecting, analyzing and presenting data were executed with greater vigor during the SNC as a result of the experience gained during the FNC. However, in the SNC, the consultants were not able to obtain GHG inventory data in the format required (with the use of standard forms), or the data was not accurate when cross-referenced between different institutions or data was not available from the time period requested.

Both the FNC and SNC mention little about the current and projected patterns of human adaptation to climate change. Such an analysis requires a higher level of detail of socio-economic data which was not (readily) available at the time of the SNC.

Education, Training and Awareness

Education and training on the topic of climate change was not evident in the FNC. During and shortly after the launch of the FNC some awareness and education activities were undertaken. A documentary film was developed and launched while at the same time a climate change information kit and handouts were distributed to schools. For the purpose of reaching larger audiences the media was also instructed on how to communicate on climate change developments.

In 2009, the Ministry of ATM conducted a national capacity self-assessment on climate change which concluded a need for research, technical, management and social/cultural skills across institutions in civil society and government. During the SNC training sessions were conducted on the long range energy alternative program (LEAP). Participants to this activity were from the public sector, foundations, businesses and individual consultants.

Nowadays, with the inclusion of climate change in the undergraduate level of the studies of Environmental Science at the AdeKUS, and graduate level studies in Urban Planning and Sustainable Natural Resource Management at the Instite for Graduate Studies (IGSR), students and educators are becoming more sensitive to topics related to climate change. Occasional training sessions are being held at the AdeKUS for lecturers, researchers and students. Two doctoral level experts in climate change hydrology and waste management

have been added nationwide to experts (2) since the FNC. Yet the pool of experts is still too small to create multi-disciplinary teams that are able to dedicate their time to long term research efforts.

The awareness raising of the general public was addressed as a priority need in the FNC. Between FNC and SNC, the lead was taken by the Ministry of ATM and awareness campaigns were held in local media. Smaller campaigns were held by local and international NGOs. The limited availability of finances inhibits a larger campaign across the country, including the communities in the Interior of Suriname which require special attention because of differences in languages and worldviews.

On a more generic level the common barriers can be subdivided in the following categories.

Table 6.1 Division of common barriers

Resources	Category
Human	Climate experts with in-depth knowledge on climate change are scarce
Technical	Technology to assess and monitor components of climate change are lacking or outdated
Financial	Financial means for capacity building activities across the country are very limited Scientific observation technology for data collection is lacking
Other	Awareness within public, private and NGO sector on the urgency of the availability of GHG data and other climate change indicators is lacking The need for a stronger cross-sector approach and synergy between the sub-sectors of climate change (e.g through research groups)

The more sectors related gaps and constraints are listed in the following sub-paragraphs. The choice of sectors is based on the grouping as done in the GHG inventory, mitigation and adaptation chapters.

6.2.2 CONSTRAINTS WITHIN THE ENERGY SECTOR

The main issue with regard to the **GHG assessment** was data availability. Some delay in data collection was experienced due to a lack of readily available information necessary for the GHG-inventory. These data sources do not recognize the necessity of generation or gathering and submitting the data, as it is not considered to be part of their core-business. In addition, they (mostly the private sector) needed to be convinced that the data would not be used for

purposes other than the GHG inventory. The Ministry of Environment (ATM) therefore provided the SNC consultants with supporting letters for the stakeholders (data sources).

In general, emissions of each greenhouse gas are calculated by multiplying fuel consumption by the corresponding emission factor. The type of data to be collected would thus only be based on the fuel consumption (or fuel) combusted in the source category. The tier method as described the 2006 IPCC guidelines has been applied. The focus, when questioning the sources (respondents), was therefore more on their quantities of fuel consumption. During the data gathering phase it was noticed that the majority of the respondents have poor data/information filing system(s) while they were also not committed to seek for the data due to the lack of awareness on the importance of such data. This resulted in a delay. In certain instances the received data was not always complete; for instance, not all the used fuel types were mentioned, which also contributed to the delay. Another constraint was also the inconsistency in the data provided; while crosschecking data with other sources there seemed to be inconsistency in data. For example the figures regarding the import of fuel from the Bureau of Statistics and Central Bank differ. Another example concerning inconsistency in data is the amount of fuel used to produce gold. Two sources were consulted about data-material and both sources gave different quantities of fuel used for the production of gold. These issues caused delays in collection and processing. In other instances data was not available from the time period it was requested. The barriers to the implementation of **mitigation measures** within the energy sector are summarized in the following table.

Table 6.2 Mitigation barriers energy sector

Mitigation barriers energy sector	Description
Lack of adequate financial support	Banks and development agencies do not offer soft credit, or programs aimed specifically at energy technologies.
Legal and regulatory framework/ uncertainty in tariffs for renewable energy	Energy supply is subsidized, without incentives for increasing efficiency or evaluation of energy costs. Legislation should be developed / changed to support the use of renewable energy sources
Absence of (or poor) environmental regulations for industrial companies with regard to their waste streams.	No or poor governmental environmental regulations on waste reduction and ï elimination. Industrial companies are not obliged to reduce their waste streams (e.g. CO_2-emission)
Lack of data and capacity to develop	Slow implementation of renewable energy

sustainable renewable energy	systems due to capacity issues

The first constraint to **adaptation** within the energy sector is the lack of data on the new and proposed mega projects for power generation, such as the Nassau large scale gold mining project. This prevents experts from making an accurate projection on the energy use of the population, and subsequently a comprehensive plan for adaptation. A potential barrier is the lack of available new energy efficient technologies which will contribute to the reduction of energy consumption. These technologies should be user-friendly and will potentially reduce the total energy costs for the country. Another barrier mentioned is the granting of land tenure and rights to the tribal communities currently using more than 40% of the countryôs land area. Only with securing these rights, the energy sector can proceed with plans of expansion to the Hinterland that is historically inhabited by nature-dependent communities.

6.2.3 CONSTRAINTS WITHIN THE AGRICULTURAL SECTOR

The national inventory in agriculture was calculated using some rough estimates on fertilizer data, with a lack of activity data and the absence of country specific emission factors. Therefore, Suriname needs to develop the capacity to institutionalize the gathering of data in order to calculate realistic GHG emission so that making estimations may be avoided in the future. The Statistical Department of the Ministry of Agriculture should include the Tier 1 en Tier 2 methods of data collection in its annual statistics report. This will improve the reliability of the activity data, and thus the precision of calculated emissions.

The following barriers were listed with regard to forecasting and mitigation options for the agricultural sector in Suriname.

Table 6.3 Mitigation barriers agricultural sector

Mitigation barriers agricultural sector	Description
Lack of awareness and reluctance of farmers to adopt the proposed measures	Farmers are usually hesitant to adopt new measures, especially when they are not aware of disastrous effects of climate change on their crops.
Availability of knowhow for the implementation of mitigation measures	National research institutions lack access to information, and are not aware of technologies that suit local conditions.
Lack of capacity to implement the research activities	There is not enough capacity available to concentrate on substantial research.

The barriers in mitigation are also present for **adaptation** to climate change in the agricultural sector. Specifically, adaptation in the agricultural sector is focused on changing the production systems, including choosing new breeds/varieties, the introduction of climate protective structures, the alternative use of energy and use of biological pesticides. This is particularly difficult in a sector based on traditional knowledge transfer. The transition process to new production systems should be accompanied by extensive research by academia and sufficient funds to provide incentives and promote behavioral change.

6.2.4 CONSTRAINTS WITHIN THE FORESTRY SECTOR

A major constraint in data gathering is that Suriname lacks a national data base for land management. Land use data is collected and presented by sector institutions responsible for monitoring specific land use category.

The 2006 IPCC software for data entry and calculation of greenhouse gases has been used in favor of other available options due to a lack of available parameters. One of the problems was the disability to enter data for the category Wetland. Even though the emissions of Wetlands are disregarded in the inventory, to allow a complete data entry and sum up to the total land area of Suriname it is required to have also the land size of wetlands to be entered in the Land Matrix. In the category Grassland it is opted to use the Tier 1 method, but the software program seems to be programmed for the higher Tiers. Thus, data handling of the final results became problematic.

Table 6.4 Mitigation barriers for the forestry sector

Mitigation barriers Forestry sector	Description
Lack of technical capability	Lack of funding and technical capabilities limit generation of information required for planning and implementation of forestry mitigation projects. Capacity for monitoring carbon stocks has only just been addressed.
Small and irregular availability of wood chips at single sawmills / wood processing companies	Smaller sawmills and wood factories do not have a continuous availability of large amounts of wood chips, which makes it less or not feasible to generate electricity from wood waste.
Reluctance of timber companies to re-use their wood waste	Wood waste is rarely seen as a resource for other products, and thus treated as waste and burned or dumped in the open air. A mind shift is needed.
Lack of financial resources for mangrove rehabilitation	Additional (external) financial resources need to be allocated
Unclear land tenure or use rights for the	Who is permitted to use the resources from the new

Mitigation barriers Forestry sector	Description
newly created land	mangrove forests and to what extent is cutting trees permitted? Who will be responsible for control and how will control take place? Also, financial incentives, to increase forest area, to reduce deforestation and to maintain and manage forest, should be created.
Obstructed inflow of fresh water for mangrove rehabilitation	Extra diversion channels and/or outlets in the dike should be constructed to improve the diversion of freshwater along the coast. For other locations attention should be given to the possibilities for improved inflow of fresh water.
Fire risks (safety)	Safety policies should be in place to prevent unsafe situations

In the forestry sector, **adaptation** is hampered by the lack of detail in the data that is available for land use analysis and projections. Research results on the potential die-off of the forest in the Interior are unavailable. To evaluate the risk of climate change on these forests, manpower accompanied by the appropriate technology is needed to gather data in the nearly inaccessible forest areas. In that way, sufficient information can be obtained for forest modeling, including satellite imaginary and radar analysis. An important note is that data should be available over longer periods of time for analysis and monitoring purposes and to proactively develop policies based on actual data.

6.3 FROM FNC TO SNC; THE PROCESS AND RECOMMENDATIONS FOR IMPROVEMENT

The process leading to the SNC started in the end of 2010. The startup was somewhat slow with some delays experienced by the project manager in the recruitment and selection of the SNC team. The project was guided by the Ministry of ATM in their capacity as the UNFCCC focal point. The Ministry hired a project manager to guide a total of local 15 consultants in their effort of compiling the greenhouse gas inventory (5), the mitigation assessment (5) and the vulnerability assessment for adaptation (7), and other issues (3). Some of these consultants were part of multiple studies.

Each of these three studies was guided by a team leader of which two also participated in the FNC. The choice was made to rely on expertise available in the country. The output of the national consultants was peer reviewed by an international expert. The selected sub-

consultants all had their expertise within their field and obtained more specific climate-change related skills during the process. The team leaders of VA and GHG are working full time in climate change. All other consultants have another field of expertise which is cross-cutting with climate change. As a result, the tools and techniques gained during the SNC process may be lost if the consultants are not incorporated in other climate change related activities. It is important for the process of monitoring climate change to have a core group established that is continuously working on the mitigation and adaptation aspects of climate change in the country. The knowledge about climate change, which is dynamic, can then be updated and integrated as input in the process. Such a core group is especially important for the scientific decision-making process, especially the choice of methods (scenarios) and assumptions in the studies. This needs to be aligned with the direction given in national policy documents.

Although each consultancy team was tasked with the preparation of a specific segment of the SNC, communication and information sharing was required between teams. Results from the greenhouse gas inventory, for example, were needed for the mitigation assessment. In this way, difficulties experienced by the GHG team in data gathering from the stakeholders also resulted in a delay for the MA team. Several data revisions and subsequent re-analyses of mitigation options were carried out to ensure accuracy and consistency throughout the report. An improvement would be to have the majority of the consultants work in both the GHG and MA teams. In that way the problems can be communicated across teams which will improve synergy between consultants in their quest of finding solutions.

Another improvement for the consultants would be to have a process in which they are able to provide technical information based on a vision for climate change produced by the government. Because there are overlapping areas of interest between the different studies, the process would benefit from better coordination between team members. In that way, the outcome is a product of discussion that relies on the input from a multidisciplinary expert team.

As stated previously the data collection in the SNC has been reported difficult. As Suriname aims at upgrading climate change related activities and the related national communications, it is imperative to institutionalize the related processes. This includes having full time personnel who are engaged in data collection, operating under a mandate to request data from

institutions and corporations. Such a mandate can be temporarily and partly obtained through the statistic law (Law on statistics; SB 2002 no 97), while the environmental framework law is in the process of passing through the legislative body. The process would benefit from requesting data on a yearly basis to avoid having a data gap of several years at the time the next reporting starts. Organizations need to be sensitized for making data available not only for the purpose of the national reports but as valuable input for development and implementation of national policies on sustainable development and environment.

Reflecting on the process of compiling this SNC the recommendations for improvement are:

- Long term vision on climate change from the government and its relation to the scientific decision-making;
- GHG inventory (sub) activities have to be in an advanced stage or finalized before mitigation activities for the national communication start. This to minimize the rework during the process of drafting the different chapters;
- Promote the synergy between the teams associated with GHG inventory, MA and VA;
- Developing clear structures to enable multidisciplinary decision-making, including the rules of decision-making, the authority of consultants, and the handling of potential conflict situations;
- Fully utilizing the scarce human resources by allocating experts to climate change related activities for the long term, in all sector-specific areas;
- Creating the legal and technical infrastructure that effectively and efficiently collects, assesses, monitors and evaluates climate change related indicators in between assessments;
- Creating research groups with dedicated budgets for thematic and specific in-depth analysis of climate change related data;

6.4 PARAGRAPH 50; CONTRIBUTIONS FOR SNC ACTIVITIES

The funds received through the UNDP /GEF facility (US$. 405.000.-) were utilized to prepare the SNC. The contribution made by the executing Ministry of ATM was in allocating personnel and materials for coordinating and facilitating activities. From other multilateral

institutions or annex 2 parties no additional resources were received with the specific objective to contribute to the SNC.

6.5 PARAGRAPH 51; CONTRIBUTIONS FOR CLIMATE CHANGE RELATED ACTIVITIES

For activities related to climate change between the publication of the FNC and this communication various initiatives were funded. An overview of the main climate change related activities that were funded during recent years is listed in the following table.

Table 6.5 Overview of main climate change related activities

Donor – period	Short Project description
UNDP ï 2006-2008	Various studies on the impact of the 2006 and 2008 flooding and establishment of an early flood warning system for the Upper Suriname and Tapanahony. Promoting of resilience and sustaining livelihood of disaster affected communities: action plan, hazard mapping and early recovery strategic framework.
UNDP /GEF ï 2009	National Capacity Self Assessment (NCSA). Aimed at identifying priority issues for action within the thematic areas of biodiversity, climate change and desertification/land degradation. Find synergies across the thematic areas and catalyze targeted and coordinated actions and requests for external assistance. And finally link country actions to protect the global environment to the broader national environmental management and sustainable development framework
IDB 2010	Support for Improving Integrated Disaster Risk Management for Climate resilient Development
GEF/UNDP 2011	Coastal Protected Area Management project to promote the conservation of biodiversity along Surinameôs western coast
Dutch Government	Dutch Climate Change Assistance Program 2, Promotion of Sustainable livelihood in the coastal zone of Suriname with emphasis on greater Paramaribo and the immediate region
GEF -2008 -2012 (LDC/SIDS Portfolio)	Capacity Building in and Mainstreaming of Sustainable Land Management in Suriname
CD4CDM project 2008-2009	Capacity Building for Clean Development Program
ACP/EU Forestry Research Network 2010-2012 (first phase)	Climate change and local communities: Impact of climate change on the practices and livelihoods of local people. Analysis of adaptive capacity of local peoples livelihoods in Suriname and Guyana
IDB 2008/2009	Integrated Coastal Zone Management Plan (ICZM) and legislation

Projects funded and executed in between FNC and this SNC established part of a necessary basis to make Suriname more aware and ready to combat the challenges that come with climate change. It is in many aspects too early to clearly define the impact of many of these projects.

Lead consultants SNC, project managers and key resource persons within funding organizations all agreed however on the huge challenges facing Suriname considering the limited technical, financial and human resources. On an individual level the local pool of senior experts was strengthened and somewhat empowered. This pool of experts is by far not large enough to effectively cover all aspects of climate change.

On the institutional and systemic level the basic and urgent needs are:

- Creation of data and information networks and the initiation of continuous dialogue within the public, NGO and private sectors ;
- Capacity building in project-development and monitoring and evaluation skills to effectively draw on available funding in climate change related areas and subsectors;
- Building of awareness within and among the most vulnerable groups within the coastal zones and the Interior;
- Research on the most viable adaptation scenarios, given the unique challenges with regard to land-tenure and illegal activities on private and government owned property;
- Financial resources for construction of protection mechanisms and other technologies needed for adaptation to climate change;
- Updating and adoption of legislation and the availability of resources to effectively monitor compliance to law and regulations.

6.6 PROPOSED PROJECTS FOR FINANCING

6.6.1 PARAGRAPH 52; PROJECTS PROPOSED FOR FINANCING

The following climate change related projects were recently proposed for financing.

REDD+ readiness preparation proposal

The Climate Compatible Development Agency (CCDA) will be finalizing the REDD+ Readiness Preparation Proposal under the Forest Carbon Partnership Facility of the World Bank in the first quarter of 2013. In this project the focus will be on the participation of stakeholders, in particular the involvement of indigenous and maroon communities that are

dependent on the forest for their livelihood. There is also interest to submit projects into the UNFCCC adaptation fund.

The UNDP Small Grants Program (SGP)

The UNDP has initiated a small grants program designed for communities to obtain funds for adaptation to protect or restore the environment, while creating sustainable livelihoods. SGP finances projects on biodiversity, Persistent Organic Pollutants, Climate, International waters and land. This environmental project will be active from 2011-2016 and is primarily funded by the Australian Government as a way to support Small Island Developing States in the Caribbean region. The project invites requests from community-based organizations on adaption, especially energy supply and biodiversity protection, to a maximum of 50.000 US dollar with an equal contribution from the community itself or from a third party. One out of two projected pilot projects is now being prepared for the wetland and mangrove protection in Johanna Margaretha in the district of Commewijne. Fishing and tourism are livelihoods strategies that need to be incorporated in the adaptation process. The major constraint is the limited support from the technical institutions in the preparation phase and the lack of capacity of communities to write projects. To avoid insufficient use of funds as is experienced with the implementation of the development program in Suriname, the UNDP will also provide opportunities to strengthen the capacity with training in writing project proposals, in collaboration with World Wildlife Fund.

Ecosystem based adaptation project ATM/UNDP

The Ministry of ATM and the UNDP have compiled a project on ecosystem based adaptation to submit to the Special Climate Change Fund. The objective of the project is to incorporate ecosystem based adaptation approaches into the countryôs climate change risk management system, with a specific focus on reducing the impacts of coastal flooding, erosion and saltwater intrusion on the sustainable development and well-being of Surinameôs population. The strategy of the project to achieve this objective is to build on baseline investments in coastal protection through additional investment in the restoration and protection of ecosystems whose services enhance resilience in the coastal zone to climate change impacts through the regulation of water flows and the prevention of floods, erosion and saltwater

intrusion. In doing so, the project will introduce EBA as a new component in the countryôs approach to climate change adaptation, thereby strengthening recognition of the importance of natural ecosystems for climate change risk management, as well as maintenance of socio-economic benefits and conservation of biodiversity. The project will develop and implement field-based activities to preserve and enhance ecosystem services provided by mangroves and wetlands, including building on and up-scaling the results of an existing Pilot Mangrove Afforestation Project. The project also will undertake activities to implement landscape level planning in selected areas of the coastal zone; to mainstream EBA approaches into national development policies, laws, and institutional functions; and to strengthen the capacities and knowledge required for effective and participatory EBA approaches.

The project will be executed in the coastal ecosystems of Weg naar Zee, Coronie and Commewijne by active afforestation initiatives, regulation of water resources and vulnerability assessments of communities. The project is planned to be implemented in 2012-2018 on a budget of 5 million US dollar.

Support for improving integrated disaster risk management for climate resilient development

The Inter American Development Bank initiated a project with the National Coordination center for disaster management (NCCR) called ñSupport for improving integrated disaster risk management for climate resilient developmentò. This project aims to provide technical cooperation to:

- Assess the presence of risk indicators for disaster preparedness,
- Design an early flood warning system in areas in the Interior of Suriname, and
- Incorporate local governance in disaster risk management.

The output of the project will provide a baseline for designing a strategic risk management system. The project that started in 2011 is expected to be completed in 2013, and is an integral part of the IADBôs country strategy for Suriname. No specific projects on climate change are expected for the future, also because in the IADB climate change policy is defined as a cross-cutting issue to be included in all environmental projects.

SURINAME-AUSTRIAN Rural Development and Climate Change Partnership (RUDECCP)

A memorandum of understanding was established between the governments of Suriname and Austria in May 2012. The main objective of the MOU is to establish a framework for cooperation with regard to the establishment of the SURINAME-AUSTRIAN rural Development and Climate Change Partnership (RUDECCP). The framework for Cooperation will be based on various projects of the RUDECCP upon which an understanding will be reached between SURINAME and AUSTRIA. The areas of cooperation mentioned in the MOU are dissemination of:

- Sustainable forest management;
- Renewable energy and low carbon strategies;
- Environmental technologies in terms of waste and waste water treatments as well as of incineration;

Worth mentioning is that cooperation has already started with the execution of a forest inventory for Suriname.

CDM

In 2008, the Capacity Development for Clean Development Mechanism (CD4CDM) project was implemented with the assistance of UNEP Risoe with the objective to build the capacity within Suriname with regards to the CDM. A permanent CDM commission, consisting of the Ministry of ATM and the NIMOS is responsible for evaluating project proposals against the national policies and sustainable development criteria for CDM, while NIMOS guides the project initiators in assessing feasibility and environmental and social impacts. Until now, three project identification notes (PINs) have been approved by the CDM Commission. These are: electricity generation through gasification of rice husk ethanol production from sugar cane as substitution of fossil fuel for the transport sector and combined heat power generation from bagasse. The major constraint in advancing the CDM initiative is the lack of awareness about the initiative and capacity for writing the project proposal. The project proposal requires a significant financial investment in assessing the technical feasibility. Lack of interest by the private sector may also be the result of the small scale of the projects in

Suriname, which in the end may give a profit too small to be profitable on the global carbon credit market.

Global Climate Change Alliance (GCCA) Caribbean Support Project

The CCCCC project aims to deepen dialogue, cooperation and enhance support on climate change between the European and poor developing countries, in particular the Least Developed Countries and the Small Island Developing States. To improve climate monitoring and data retrieval in Suriname, the placement and installation of 8 hydrology stations and 6 meteorological stations is planned for 2012. A second activity aims to enhance the predictive powers of regional climate models and the regionôs ability to design and implement cost-effective adaptation activities. This includes climate modeling and risk analysis, and the results will be incorporated in the national climate action plan. Other activities that are planned are:

- Training of national experts from the University of Suriname in the application of regional climate models;
- Assistance in the collection and management of climate data;
- Assistance for conducting sector-specific vulnerability studies that are expected to provide information for the national climate action plan;
- Assistance for a national risk analysis on climate change.

For Suriname, it is expected that the project will contribute to an increased capacity for modeling climate change, especially sea-level rise. In addition, the project will contribute to assessment of vulnerability of sectors, and the establishment of a national early warning system. It also envisages result in better coordination and management of data related to climate change.

6.6.2 PARAGRAPH 53; ADAPTATION MEASURES THE OPPORTUNITIES AND BARRIERS

Improved coordination between organizations, NGOs and the private sector are necessary to adapt successfully to climate change. In particular, the government should take the lead in designing cross-sectoral systems to ensure climate observation, ecosystem management, water management and risk and disaster management. The Government of Suriname should also start a process of integrated land use planning. The continuation of efforts in designation

of protected areas, the management of land allocation and the proper management of MUMAôs and mangrove-rich areas are important measures to safeguard coastal protection.

Other measures that are needed for successful adaptation are: awareness raising on efficient use of freshwater resources, initiation of incentives for renewable energy programs, changing standards in the transport and construction sector, set up of an insurance fund to compensate for disaster and strengthening disaster risk management and improvement of the medical infrastructure for monitoring disease outbreaks. All these processes will not be successful without a nationwide awareness and education process.

With support of the UNDP and Suriname Conservation Foundation (SCF), the ADEKUS has initiated the planting of mangroves to protect the coast of the district of Coronie against erosion. The pilot project focuses on researching the methodology to plant and successfully grow mangroves, as part of the larger scale observation of the coastline erosion process. The project has the potential to expand to a multi-disciplinary model for managing coast erosion and natural adaptation against sea level rise. The project would benefit from additional expertise on aspects of agriculture, biodiversity and climate observation. The project has high importance; as a fast and cheap adaptation measure for coastal protection and because of its potential for replication in the Guyana shield region. A follow up project is proposed with the Ecosystem Based Adaptation project discussed earlier in this chapter.

Another important adaptation project to undertake is the assessing of new crops and breeds for the agricultural sector. With the projected salt intrusion in the rice cultivation areas and the high sensitivity of the bananas and livestock to global warming, it is essential to start researching and selecting new crops and breeds that are less susceptible to climate change. New crops and breeds are only successful with a fully equipped agricultural extension service (manpower and infrastructure). In that way, the research results are transferred to farmers so that changes can be initiated at the field level.

6.7 COUNTRY-SPECIFIC TECHNOLOGY AND CAPACITY BUILDING NEEDS AND RECEIVED ASSISTANCE

6.7.1 PARAGRAPH 54; TECHNOLOGY TRANSFER

The Suriname national capacity self-assessment provides an overview of the needs for building human capacity that accompanies the technology that is needed for a system for climate change monitoring and management. The current overview of needs is based on this overview, the three technical studies, GHG, MA and VA, and the meetings with the consultants. A more in-depth assessment should be conducted in the future.

Table 6.6 Technology needs according to theme

Theme	Country-specific technology needs	Constraint
Coastal zone management	- Equipment for sea level rise measurement - Analysis of sea currents and streams - Construction of sea protection and mud bank nourishment techniques - Establishment of a system for water and sediment monitoring at sea	Instrumentation and skilled manpower not available. Finances unavailable for construction of sea protection
Climate observation	- Establishment of a network of remote meteorology stations in Suriname (total 180) - Climate change modeling	Finances for the purchase and installation of technology not available. Scarce human resources to maintain a large network of stations
Urban infrastructure	- Development of new building codes for houses and roads - Construction of dykes and other protection structures	Limited technical expertise available. Finances for the construction of dykes limited
Water management	- Establishment of a system for water level and sediment monitoring in rivers - Improve waste water and drainage structure - Construction of artificial reservoirs	Instrumentation and skilled manpower limited available Finances for construction unavailable
Agricultural production	- Introduction of new production systems	Limited technical expertise available and finances for the purchase of new systems and transfer of technology limited
Renewable energy	- Introduction of renewable energy sources as opposed to fossil fuels in households and industry	Limited technical expertise available Finances for the purchase and installation of technology
Forest management	- Technology for obtaining species data for ecosystem management - Technology for modeling and prioritizing areas of importance - Technology transfer for sustainable practices in forest management, including carbon stocks and	Finances for cross-country inventories and baseline studies limited Limited technical expertise and demonstration activities available

Theme	Country-specific technology needs	Constraint
	Payment for Ecosystems	

An important aspect to consider is that Suriname can only manage climate change when there is a countrywide system of monitoring and management. Because more than 80% of the country consist of inaccessible forest, it is mandatory to work side by side with the communities that are living in the forest. This means that they should be trained for conducting assessments and obtaining data for research and monitoring. The local communities can also play a vital role in the maintenance of the equipment. Several organizations have experience in involving local communities in research, especially the ADEKUS, the Meteorological Services and conservation NGOôs such as WWF, Conservation International, Tropenbos and Amazon Conservation Team.

6.7.2 PARAGRAPH 55; OTHER RELEVANT NEEDS AND AREAS FOR CAPACITY BUILDING

Data-collection and analysis

The general bureau for statistics (ABS) collects and publishes biennial environmental statistical information since 2002; this activity is now funded by Conservation International. The main gaps experienced by ABS are:

- Hardly any data available resulting in the use of estimates (UNDP, OLADE);
- No full time human resource employed for environmental statistics within ABS;
- The current law on statistics does not directly obligate parties to submit data. An amendment to this law has been requested by ABS more than two years ago. This request still has to be processed by the legislative authorities.

The latest environmental publication from ABS is from 2010 and includes data on Climate (rainfall, relative humidity, and wind velocities), biodiversity, energy, waste and demographics. The institute initiated the establishment of an interdisciplinary steering committee to accelerate the process of creating a permanent ñdata collection mindsetò. A representative of Suriname ABS office participates in a UN workgroup on environmental

statistics. This enables Suriname to actively participate within the policy-making and be up to date with the latest developments within this area.

The needs with regard to data collection are in the allocation of resources for:

- Creating a specialized environmental statistics unit within the bureau for statistics;
- Prioritizing an update on the legal framework that enables the unit to demand specific data from various sectors;
- Developing standards for data formats;
- Increasing awareness within the private sector to comply and submit required info.

Research needs and curriculum addition Environmental Sciences ADEKUS University

The Environmental Sciences department of the Faculty of Technology of the AdeKUS acknowledges the need to identify the critical areas that are vulnerable to climate change. Through the establishment of baseline studies and the continuous monitoring of critical measurements, changes can be effectively determined. A linkage with the AdeKUS is possible through the research on the following (among others):

1. Research driven education for example bio-organic chemistry;
2. Reconstructive means;
3. Measure increase or decrease in vulnerability or extreme changes due to human interference or climate change;
4. Monitor microorganism that thrive at rising temperatures and damp conditions;
5. Identify pathogens, causing sickness because of climate change;
6. Early warning systems;
7. Quantify, typify and determine scales of ecosystem services (ecological economic assessment);
8. Determine missing links in time periods.

Curriculum additions to the Faculty of Environmental Sciences that will be highly welcomed are within the fields of marine biology and marine environment.

List of interviewed persons and organizations

List of interviewed organizations and persons (either personally, by telephone or e-mail)

Table 6.7 List of interviewed organizations and persons

Organization	Interviewee
ABS	Mr A. Talea
ADEK University	Ms S. Carilho Mr M. Huisden Mr S. Naipal Mr R. Nurmohamed
ATM	Ms H. Uiterloo Ms P.Setrowidjojo Ms Ch. MansM. Riedewald N. Plet V. Sabajo
CCDA	Mr J Goedschalk
IADB	Mr S. Hofwijks
Lead Consultants UNFCC SNC project	Mrs. Sh. Bhairo Mr. C. Becker Mr S. Naipal
Ministry of Finance	Ch. Jaggan
NIMOS	Ms F. Hausil
UNDP	Mr B. Drakenstein Ms T. Lieuw

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APPENDIX I CH. 2: EMISSION 2008 (IN GGCO2 EQUIVALENTS)

	Emissions CO_2 equivalent (Gg)			
Categories	CO2	CH4	N2O	TOTAL
TOTAL	5677.94	657.16	30.66	6365.75
1 - Energy	3788.15	3.36	7.48	3798.99
1.A - Fuel Combustion Activities	3788.15	3.36	7.48	3798.99
1.A.1 - Energy Industries	120.54	0.12	0.28	120.94
1.A.1.a - Main Activity Electricity and Heat Production	120.54	0.12	0.28	120.94
1.A.1.a.i - Electricity Generation	120.54	0.12	0.28	120.94
1.A.2 - Manufacturing Industries and Construction	2912.47	2.83	6.75	2922.05
1.A.2.c - Chemicals	0.01	0.00	0.00	0.01
1.A.2.e - Food Processing, Beverages and Tobacco	3.01	NE	0.01	3.02
1.A.2.f - Non-Metallic Minerals	1248.63	1.21	2.88	1252.72
1.A.2.i - Mining (excluding fuels) and Quarrying	209.28	0.21	0.50	209.99
1.A.2.k - Construction	0.03	NE	NE	0.03
1.A.2.m - Non-specified Industry	1451.52	1.41	3.36	1456.28
1.A.3 - Transport	622.46	0.01	0.20	622.67
1.A.3.a - Civil Aviation	13.93	NE	0.12	14.05
1.A.3.a.ii - Domestic Aviation	13.93	NE	0.12	14.05
1.A.3.b - Road Transportation	598.49	NE	NE	598.49
1.A.3.b.i - Cars	598.49	NE	NE	598.49
1.A.3.b.i.2 - Passenger cars without 3-way catalysts	598.49	NE	NE	598.49
1.A.3.d - Water-borne Navigation	5.02	NE	NE	5.02
1.A.3.d.ii - Domestic Water-borne Navigation	5.02	NE	NE	5.02
1.A.3.e - Other Transportation	5.02	0.01	0.08	5.10
1.A.3.e.ii - Off-road	5.02	0.01	0.08	5.10
1.A.4 - Other Sectors	132.68	0.40	0.25	133.33
1.A.4.b - Residential	37.99	0.08	0.02	38.09
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	94.69	0.32	0.23	95.24
1.A.4.c.i - Stationary	19.12	0.06	0.05	19.23
1.A.4.c.ii - Off-road Vehicles and Other Machinery	10.07	0.03	0.02	10.13
1.A.4.c.iii - Fishing (mobile combustion)	65.50	0.22	0.16	65.88
2 - Industrial Processes and Product Use	53.20	NE	NE	53.20
2.A - Mineral Industry	53.20	NE	NE	53.20
2.A.4 - Other Process Uses of Carbonates	53.20	NE	NE	53.20
2.A.4.d - Other (please specify) (3)	53.20	NE	NE	53.20

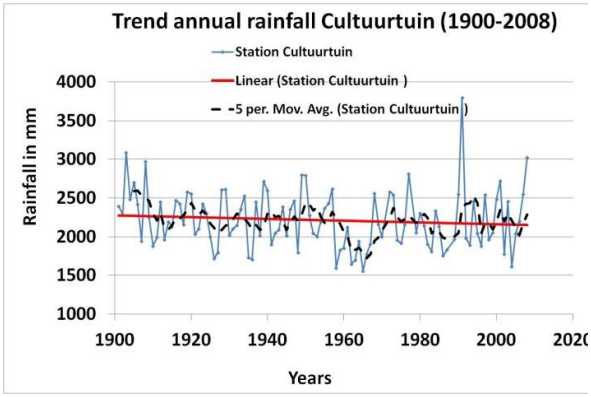
3 - Agriculture, Forestry, and Other Land Use	1836.59	653.80	23.18	2513.57
3.A - Livestock	NE	89.33	NE	89.33
3.A.1 - Enteric Fermentation	NE	71.89	NE	71.89
3.A.1.a - Cattle	NE	67.91	NE	67.91
3.A.1.a.i - Dairy Cows	NE	33.34	NE	33.34
3.A.1.a.ii - Other Cattle	NE	34.57	NE	34.57
3.A.1.b - Buffalo	NE	0.81	NE	0.81
3.A.1.c - Sheep	NE	1.38	NE	1.38
3.A.1.d - Goats	NE	0.70	NE	0.70
3.A.1.f - Horses	NE	0.07	NE	0.07
3.A.1.h - Swine	NE	1.02	NE	1.02
3.A.2 - Manure Management (1)	NE	17.43	NE	17.43
3.A.2.a - Cattle	NE	15.94	NE	15.94
3.A.2.a.i - Dairy cows	NE	15.20	NE	15.20
3.A.2.a.ii - Other cattle	NE	0.74	NE	0.74
3.A.2.b - Buffalo	NE	0.03	NE	0.03
3.A.2.c - Sheep	NE	0.06	NE	0.06
3.A.2.d - Goats	NE	0.04	NE	0.04
3.A.2.e - Camels	NE	NE	NE	NE
3.A.2.f - Horses	NE	0.01	NE	0.01
3.A.2.h - Swine	NE	1.36	NE	1.36
3.B - Land	1827.05	NE	NE	1827.05
3.B.2 - Cropland	5.79	NE	NE	5.79
3.B.2.b - Land Converted to Cropland	5.79	NE	NE	5.79
3.B.2.b.i - Forest Land converted to Cropland	5.79	NE	NE	5.79
3.B.3 - Grassland	81.05	NE	NE	81.05
3.B.3.a - Grassland Remaining Grassland	77.39	NE	NE	77.39
3.B.3.b - Land Converted to Grassland	3.66	NE	NE	3.66
3.B.3.b.ii - Cropland converted to Grassland	3.66	NE	NE	3.66
3.B.6 - Other Land	1740.20	NE	NE	1740.20
3.B.6.a - Other land Remaining Other land	NE	NE	NE	NE
3.B.6.b - Land Converted to Other land	1740.20	NE	NE	1740.20
3.B.6.b.i - Forest Land converted to Other Land	1740.20	NE	NE	1740.20
3.C - Aggregate sources and non-CO2 emissions sources on land (2)	9.54	564.47	23.18	597.19
3.C.1 - Emissions from biomass burning	NE	89.94	4.01	93.94
3.C.1.b - Biomass burning in croplands	NE	89.07	4.01	93.08
3.C.1.c - Biomass burning in grasslands	NE	0.87	NE	0.87
3.C.2 - Liming	0.95	NE	NE	0.95
3.C.3 - Urea application	8.59	NE	NE	8.59
3.C.4 - Direct N2O Emissions from managed soils (3)	NE	NE	18.66	18.66

3.C.5 - Indirect N2O Emissions from managed soils	NE	NE	0.51	0.51
3.C.7 - Rice cultivations	NE	474.53	NE	474.53
3.D - Other	NE	NE	NE	NE
	NE	NE	NE	
	NE	NE	NE	
	Emissions (Gg)			
Categories	**CO2**	**CH4**	**N2O**	
Memo Items (3)	NE	NE	NE	NE
International Bunkers	NE	NE	NE	NE
1.A.3.a.i - International Aviation (International Bunkers) (1)	101.22	NE	NE	101.22
1.A.3.d.i - International water-borne navigation (International bunkers) (1)	0.01	NE	NE	0.01
1.A.5.c - Multilateral Operations (1)(2)	NE	NE	NE	NE
Information Items	NE	NE	NE	NE
CO2 from Biomass Combustion for Energy Production	NE	NE	NE	NE
SINKS				
3.B.1.a - Forest land Remaining Forest land	-1004.03	NE	NE	-1004.03
3.B.1.b.v - Other Land converted to Forest Land	-3.04	NE	NE	-3.04
3.B.2.a - Cropland Remaining Cropland	-7241.77	NE	NE	-7241.77
TOTAL	**-8248.84**	**NE**	**NE**	**-8248.84**

APPENDIX II CH. 2: 2008 GHG ENERGY REFERENCE APPROACH

Fuel Types	Unit	Production	Imports	Exports	International Bunkers	Stock change	Apparent Consumption	Conversion Factor	Apparent Consumption	Carbon content	Total Carbon	Excluded Carbon	Net Carbon Emissions	Fraction of Carbon Oxidised	Actual CO2 Emissions	Actual CO2 Emissions
							TJ/Unit	TJ	t C/TJ	t C	Gg C	Gg C	Gg C		Gg C	Gg CO2
Crude Oil	Gg						0.00	42.30	0.00	20.00	0.00		0.00	0.99	0.00	0.00
Orimulsion	Gg						0.00	27.50	0.00	20.00	0.00		0.00	0.99	0.00	0.00
Natural Gas Liquids	Gg						0.00	44.20	0.00		0.00	0.00	0.00		0.00	0.00
Motor Gasoline	Gg		113.94				113.94	44.30	5047.54	18.90	95.40		95.40	0.99	94.44	346.30
Aviation Gasoline	Gg		0.57				0.57	44.30	25.43	19.10	0.49		0.49	0.99	0.48	1.76
Jet Gasoline	Gg		37.00				37.00	44.30	1639.10	19.10	31.31		31.31	0.99	30.99	113.64
Jet Kerosene	Gg		0.28				0.28	44.10	12.48	19.50	0.24		0.24	0.99	0.24	0.88
Other Kerosene	Gg						0.00	43.80	0.00		0.00	0.00	0.00		0.00	0.00
Shale Oil	Gg						0.00	38.10	0.00		0.00		0.00		0.00	0.00
Gas/ Diesel Oil	Gg		165.52				165.52	43.00	7117.36	20.20	143.77	0.00	143.77	0.99	142.33	521.89
Residual Fuel Oil	Gg		703.59				703.59	40.40	28425.04	21.10	599.77		599.77	0.99	593.77	2177.16
Liquefied Petroleum Gases	Gg		13.79				13.79	47.30	652.27	17.20	11.22	0.00	11.22	0.99	11.11	40.72
Ethane	Gg						0.00	46.40	0.00		0.00	0.00	0.00		0.00	0.00
Naphtha	Gg		3.78				3.78	44.50	168.21	20.00	3.36	0.00	3.36	0.99	3.33	12.21
Bitumen	Gg						0.00	40.20	0.00		0.00	0.00	0.00		0.00	0.00
Lubricants	Gg		12.11				12.11	40.20	486.82	20.00	9.74	0.00	9.74	0.99	9.64	35.34
Petroleum Coke	Gg						0.00	32.50	0.00		0.00	0.00	0.00		0.00	0.00
Refinery Feedstocks	Gg						0.00	43.00	0.00		0.00		0.00		0.00	0.00
Refinery Gas	Gg						0.00	49.50	0.00		0.00	0.00	0.00		0.00	0.00
Paraffin Waxes	Gg						0.00	40.20	0.00		0.00	0.00	0.00		0.00	0.00
White Spirit and SBP	Gg						0.00	40.20	0.00		0.00	0.00	0.00		0.00	0.00
Other Petroleum Products	Gg						0.00	40.20	0.00		0.00		0.00		0.00	0.00
									43574.25		895.29		895.29		886.34	3249.91

APPENDIX III CH. 3:TRENDS IN ANNUAL RAINFALL



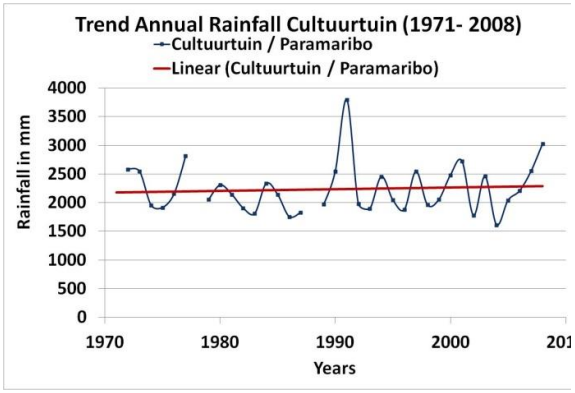
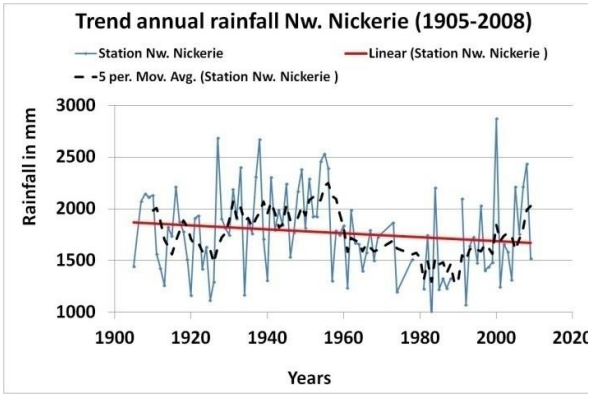


Figure 3c. Trend Annual Rainfall Cultuurtuin *Figure 3d. Trend Annual Rainfall Cultuurtuin*

Source: Amatali, 2011a; Technical Paper Present Profile. Sector Water Resources



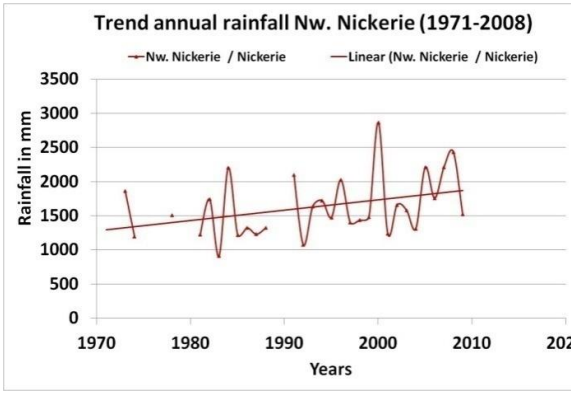
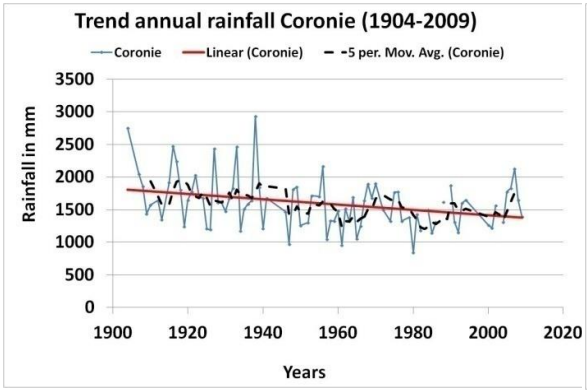


Figure 3e. Trend Annual Rainfall Nw.Nickerie *Figure 3f. Trend Annual Rainfall Nw.Nickerie*

Source: Amatali, 2011a; Technical Paper Present Profile. Sector Water Resources



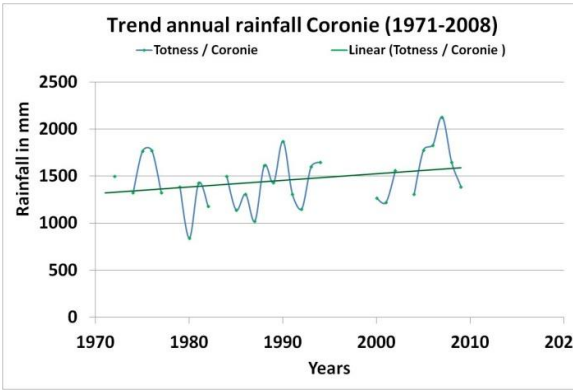
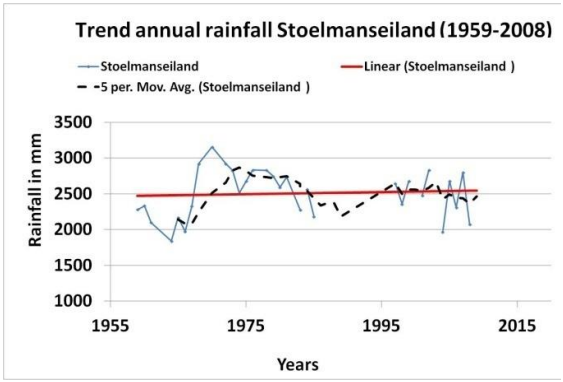


Figure 3g. Trend Annual Rainfall Coronie *Figure 3h. Trend Annual Rainfall Coronie*

Source: Amatali, 2011a; Technical Paper Present Profile. Sector Water Resources



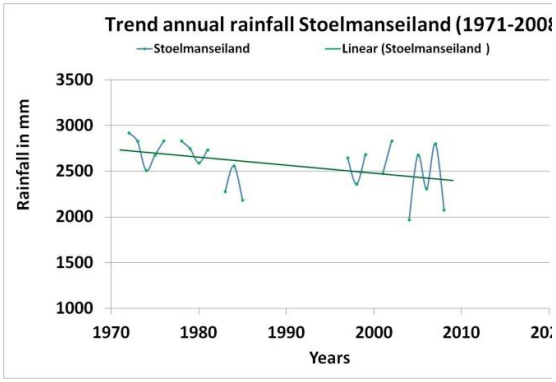
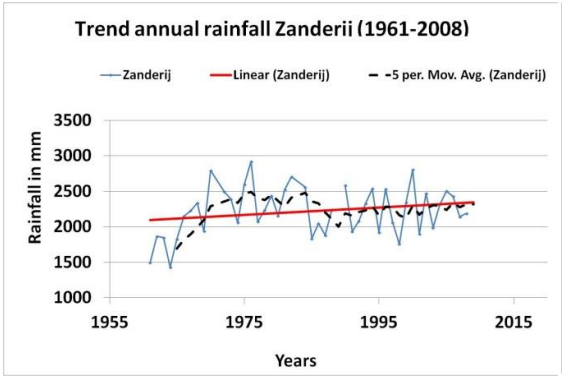


Figure 3i. Trend Annual Rainfall Stoelmanseiland *Figure 3j. Trend Annual Rainfall Stoelmanseiland*

Source: Amatali, 2011a; Technical Paper Present Profile. Sector Water Resources



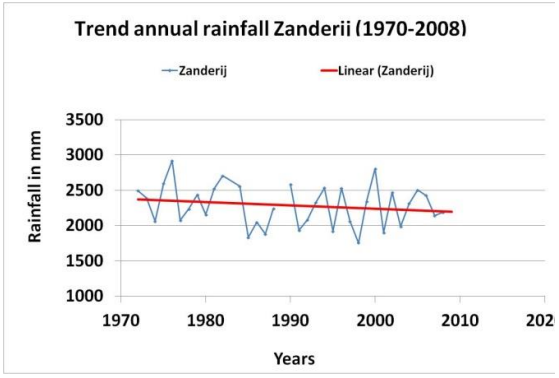
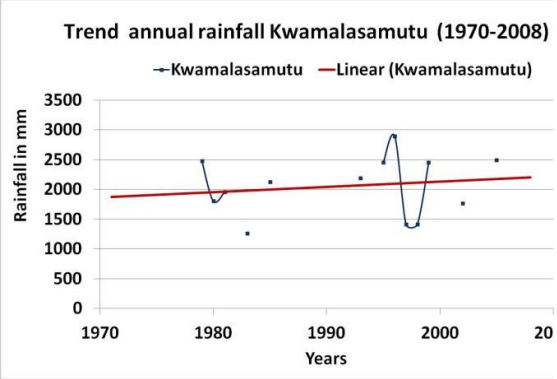


Figure 3k. Trend Annual Rainfall Zanderij *Figure 3l. Trend Annual Rainfall Zanderij*

Source: Amatali, 2011a; Technical Paper Present Profile. Sector Water Resources



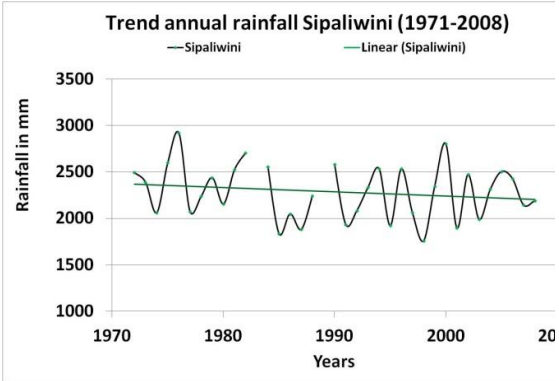


Figure 3m. Trend Annual Rainfall Kwamalasumtu *Figure 3n. Trend Annual Rainfall Kwamalasamutu*

Source: Amatali, 2011a; Technical Paper Present Profile. Sector Water Resources

APPENDIX IV CH. 4: ENERGY SECTOR

Table 1: Total baseline forecast for CO_2-emission regarding Energy Sector

	Electricity Generation (Gg CO_2eq)	Manuf. Industries & Constr. (Gg CO_2eq)	Transport (Gg CO_2eq)	Others (Gg CO_2eq)	Total baseline scenario 'Energy sector' (Gg CO_2eq)
2008	121	2922	623	133	**3799**
2009	200	2647	650	139	**3636**
2010	280	2630	679	145	**3734**
2011	360	2758	709	151	**3978**
2012	440	2941	740	158	**4279**
2013	519	3127	773	165	**4584**
2014	599	3316	807	172	**4894**
2015	679	3524	842	180	**5225**
2016	759	3679	879	188	**5505**
2017	834	3841	918	196	**5789**
2018	919	4010	958	205	**6092**
2019	999	4186	1000	214	**6399**
2020	1079	4370	1044	223	**6716**
2021	1159	4563	1090	233	**7045**
2022	1238	4763	1138	243	**7382**
2023	1318	4973	1188	254	**7733**
2024	1398	5191	1241	265	**8095**
2025	1478	5420	1295	277	**8470**

Table 2: Contributions of solar- and wind energy to the CO2-emission reduction

Mitigation Option	CO2 - reduction 2008	CO2 - reduction 2015	CO2 - reduction 2018	CO2 - reduction 2020	CO2- reduction 2025
Windpower: windmills replacing diesel generators in coastal villages	0 Gg	- 1.7 Gg	- 1.7 Gg	- 1.7 Gg	- 5.1 Gg
Solar power: application of solar panels and solar collectors replacing diesel generators in Hinterland villages	0 Gg	- 1.2 Gg	- 3.4 Gg	- 3.4 Gg	- 8.5 Gg

Table 3: Mitigation scenario vs. baseline scenario for subsector Electricity Generation

	Baseline scenario (Gg CO_2eq)	Mitigation scenario (Gg CO_2eq)	Total Mitigation scenario vs baseline scenario

			(Gg CO_2eq)
2008	121	0	121
2009	200	0	200
2010	280	0	280
2011	360	0	360
2012	440	-85	355
2013	519	3085	3604
2014	599	3071	3670
2015	679	-272	407
2016	759	-285	474
2017	834	3073	3907
2018	919	953	1872
2019	999	-792	207
2020	1079	-1003	76
2021	1159	-1016	143
2022	1238	-1028	210
2023	1318	-1040	278
2024	1398	-1052	346
2025	1478	-1107	371

Table 4: Baseline scenario vs. mitigation scenario Manufacturing Industries & Construction

Year	Baseline scenario (Gg CO_2eq)	Reduction by mitigation options (Gg CO_2eq)	Total mitigation scenario (Gg CO_2eq)
2008	2922	0	2922
2009	2647	0	2647
2010	2630	0	2630
2011	2758	0	2758
2012	2941	0	2941
2013	3127	0	3127
2014	3316	0	3316
2015	3524	0	3524
2016	3679	709	2970
2017	3841	740	3101
2018	4010	773	3237
2019	4186	806	3380
2020	4370	842	3528
2021	4563	879	3684
2022	4763	918	3845
2023	4973	958	4015
2024	5191	1000	4191
2025	5420	1044	4376

Table 5: Baseline scenario vs. mitigation scenario subsector Transport

	Baseline scenario Transport (Gg CO_2eq)	Mitigation scenario Transport (Gg CO_2eq)	Total Mitigation scenario Transport (Gg CO_2eq)
2008	623	0	623
2009	650	0	650
2010	679	0	679
2011	709	0	709
2012	740	0	740
2013	773	0	773
2014	807	0	807
2015	842	292	550
2016	879	305	574
2017	918	318	600
2018	958	332	626
2019	1000	347	653
2020	1044	362	682
2021	1090	378	712
2022	1138	395	743
2023	1188	412	776
2024	1241	430	811
2025	1295	449	846

Table 6: Total mitigation scenario Energy sector

	Electricity Generation (Gg CO_2eq)	Manuf. Ind. & Constr. (Gg CO_2eq)	Transport (Gg CO_2eq)	Others (Gg CO_2eq)	Total mitigation scenario Energy sector (Gg CO_2eq)
2008	121	2922	623	133	3799
2009	200	2647	650	139	3636
2010	280	2630	679	145	3734
2011	360	2758	709	151	3978
2012	440	2941	740	158	4279
2013	3604	3127	773	165	7669
2014	3670	3316	807	172	7965
2015	407	3524	550	180	4661
2016	474	2970	574	188	4206
2017	3907	3101	600	196	7804
2018	1872	3237	626	205	5940
2019	207	3380	653	214	4454
2020	76	3528	682	223	4509
2021	143	3684	712	233	4772
2022	210	3845	743	243	5041
2023	278	4015	776	254	5323
2024	346	4191	811	265	5613
2025	371	4376	846	277	5870

APPENDIX V CH. 4: NON-ENERGY SECTOR

Table 1: Baseline and mitigation forecast for CO2-emission regarding Agriculture sector

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016
Rice Area / yr (ha) **GHG emission**	50790	50790	50790	50790	50790	50790	50790	57246	64746
Dairy cattle #	19614	21444	23944	26444	28944	31444	33944	36444	38944
Other cattle #	29421	32166	33166	34166	35166	36166	37166	38166	39166
CH4 (rice) Gg	19.0	23.7	23.7	23.7	29.5	35.3	41.1	46.9	52.7
Enteric fermentation (Gg)	2.7	3.0	3.2	3.4	3.6	3.8	4.1	4.3	4.5
Field burning (Gg)	.6	.6	.6	.6	.6	.6	.6	.6	.7
Manure management (Gg)	.7	.7	.7	.7	.7	.7	.8	.8	.8
Total emission CH4 agriculture (Gg)	23	28	28.2	34.4	34.4	40.4	46.6	52.6	58.7
Total emission agriculture in CO_2 eq	952.57	1171.9	1180.6	1189.4	1457.1	1345.5	1547.9	1754.8	1952.8
Total GHG emission with project rice (Gg CO_2 eq)	952.57	1171.9	1180.6	1189.4	1457.1	1345.5	1116.4	1260.4	1399.5
Emission sugar cane State oil company	0	0	0	0	0	-13.8	-27.7	-41.5	-55.3
Emission deforestation for project sugarcane	0	0	0	0	1015	1181	1181	1015	0

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025
Rice Area / yr (ha) **GHG emission**	72246	79746	87246	94746	102246	109746	117246	124746	132246
Dairy cattle #	41444	43944	46444	48944	51444	53944	56444	58944	61444
Other cattle #	40166	41166	42166	43166	44166	45166	46166	47166	48166
CH4 rice Gg	58.6	64.4	70.2	76.0	81.8	87.6	93.4	99.2	105.0
Enteric fermentation	2.8	3	3.2	3.3	3.5	3.7	3.8	4.0	4.1
Field burning	.8	.9	1.0	1.0	1.1	1.2	1.3	1.4	1.5
Manure management	.9	.9	.9	1.0	1.0	1.1	1.1	1.2	1.2
Total emission CH4 agriculture (Gg)	65	71.1	77.2	83.4	89.5	95.7	101.8	108	114.1
Total emission agriculture (Gg CO_2 eq)	2162.9	2365.4	2572.2	2770.3	2977.1	3179.5	3382	3584.4	3787.5
Total GHG emission agriculture with project (Gg CO_2eq)	1547.6	1750.1	1835.2	1972.3	2118.1	2257.5	2401.5	2542.9	2685
Emission sugar cane state oil Company (Gg)	-69.2	-69.2	-69.2	-69.2	-69.2	-69.2	-69.2	-69.2	-69.2
Emission deforestation for project sugarcane (Gg)	0	0	0	0	0	0	0	0	0

Table 2: Expected growth of mangrove forests and carbon sequestration

	2011	2012	2013	2014	2015	2016	2017	2018
Total area planted (ha)	0	50	150	350	550	750	950	1,150
Total area natural growth	0	0	100	300	700	1,100	1,500	1,900
$GgCO_2eq$ sequestered per year	0	0	2	5	9	14	18	22
$GgCO_2eq$ sequestered (cumulative)	0	0	2	7	16	30	48	70

	2019	2020	2021	2022	2023	2024	2025
Total area planted (ha)	1,350	1,350	1,350	1,350	1,350	1,350	1,350
Total area natural growth	2,300	2,700	2,700	2,700	2,700	2,700	2,700
$GgCO_2eq$ sequestered per year	27	30	30	30	30	30	30
$GgCO_2eq$ sequestered (cumulative)	97	127	156	186	216	246	275

Table 3: Expected wood and wood waste production and reduction potential

	2012	2013	2014	2015	2016	2017
Total production (m^3)	244,250	276,219	308,188	340,157	372,125	404,094
Available waste (ton)	85,097	94,798	104,167	113,204	121,908	130,280
GHG reduction potential (MWh)	109,775	122,290	134,376	146,033	157,262	168,061
Avoided CH_4 emissions ($GgCO_2eq$)	2	5	7	10	13	15
GHG reduction potential ($GgCO_2eq$)[85]	83	94	106	117	128	139

[85] The sum of GHG reduction potential and avoided CH_4 emissions. The calculation for energy replacement is based on an EFgrid, Paramaribo of 0.000733 $GgCO_2eq$/MWh.

	2018	2019	2020	2021	2022	2023
Total production (m^3)	436,063	468,031	500,000	531,969	563,937	595,906
Available waste (ton)	138,319	146,026	153,400	160,442	167,151	173,528
GHG reduction potential (MWh)	178,432	188,373	197,886	206,970	215,625	223,851
Avoided CH_4 emissions ($GgCO_2eq$)	18	21	24	27	30	34
GHG reduction potential ($GgCO_2eq$)	149	159	169	179	189	198

	2024	2025
Total production (m^3)	627,875	659,843
Available waste (ton)	179,572	185,284
GHG reduction potential (MWh)	231,648	239,016
Avoided CH_4 emissions ($GgCO_2eq$)	37	40
GHG reduction potential ($GgCO_2eq$)	206	215

Table 4: Summary of forest sector baseline and mitigation scenario (emissions in Gg CO_2eq)

	2008	2009	2010	2011	2012	2013
Baseline scenario	832	1,182	1,710	1,833	7,096	7,757
forest mitigation options[86]	0	0	0	0	-83	-96
deforestation because of other sector mitigation options	0	0	0	0	3,726	7,518
Total mitigation scenario:	832	1,182	1,710	1,833	10,739	15,178

	2014	2015	2016	2017	2018	2019
Baseline scenario	6,366	2,166	6,426	5,196	5,007	4,796
- forest mitigation options	-113	-133	-158	-186	-219	-256
- deforestation because of other sector mitigation options	7,518	3,787	3,787	1,394	3,125	1,741
Total mitigation scenario:	13,772	5,820	10,056	6,404	7,913	6,281

	2020	2021	2022	2023	2024	2025
Baseline scenario	4,693	-161	-470	-763	-1,119	-1,433
-forest mitigation options	-296	-335	-375	-413	-452	-490
deforestation because of other sector mitigation options	10	10	10	10	10	10
Total mitigation scenario:	4,406	-487	-834	-1,166	-1,561	-1,913

[86] Forest mitigation options are use of wood waste as bio-fuel and additional afforestation of mangrove. In the report the use of wood waste is incorporated as biofuel in the chapter for Energy sector.