REPUBLIC OF NIGER

Fraternité – Travail – Progrès

OFFICE OF THE PRIME MINISTER

National Environmental Council for Sustainable Development

CNEDD

PNEDD

SECOND NATIONAL COMMUNICATION ON CLIMATE CHANGE

Fonds pour l'environnement mondial

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PREFACE

Niger, party to the United Nations Framework Convention on Climate Change, like all other parties, has to make an inventory of the implementation of the aforesaid Convention. Commonly called National Communication, this one provides information on : (I) the national greenhouse gases inventory ; (II) the vulnerability of Niger on the climatic changes ; (III) the adaptation to the climate change ; (iv) the measurements taken and planned to attenuate the greenhouse gas emissions and ; (v) the organization of the State as regards climate change.

After the elaboration of his initial national communication in 2000, Niger would like to reiterate to the international community, through this second communication, its message of solidarity and mutual confidence to fight against the climate perturbation mainly due to human activities.

The initiatives developed and the actions of education and sensitizing which it undertook since the ratification of the United Nations Framework Convention on Climate Change on July 25, 1995, led the Nigerien people entire to become aware that the safeguarding of the world environment is a duty for all the nations and all the people.

That is why, in this combat against the destruction by man of our environment, these valiant people undertake daily positive actions like the restoration of the soils, the afforestation and the rational management of the natural resources.

For its part, vis-a-vis to the climate change, Niger remains convinced that each nation must assume its responsibilities and affirms that it will also ensure his responsibility.

Also, it confirms its firm engagement to apply the obligations related with Convention by taking account of the principle of common but differentiated responsibility.

Moreover, enriched by the important information contained in the second national communication, Niger undertakes the integration, in all its strategies and policies of development as well at the local, regional to national level, of the problems of the environment in particular its climate change dimension, because that represents for him the pledge for to reach the Millenium Development Goals and a lever to ensure the sustainable development.

The Director of the Prime Minister Cabinet,
President of the National Council of the Environment for Sustainable Development

OUSMANE Mahaman

TABLE OF CONTENTS

LIST OF ACRONYMS

ACMAD:	African Center of Meteorological Applications for Development
AMESD:	African Monitoring of the Environment for Sustainable Development
AMMA:	African Monsoon Multidisciplinary Analyses
ANPIP:	Nigerien Association for the Promotion of Private Irrigation
ASAPI:	Programs Support to Food Safety by the Small Irrigation
BDR:	Road Data Bank
BOD:	Biochemical Oxygen Demand
CC:	Climate Change
CDM:	Clean Development Mechanism
CERMES:	Centre for Medical and Social Research
CES/DRS:	Conservation of Water and Soils/Defense and Restoration of Soils
CFP:	Center of Formation and Improvement
CFTTR:	Center of Training in Techniques of Road Transport
CMC:	Modern Cooking Fuels
CNEDD:	National Council of the Environment for Sustainable Development]
CNES:	National Center for Solar energy
COD:	Chemical Oxygen Demand
COMINAK:	Mining company of Akouta
CoP:	Conference of Parties
CPA:	Artificial Portland Cement
CR/AGRHYMET:	Regional Center for Training and Application in Agrometeorology and Operational Hydrology
CRESA:	Research Center on the Specialized Teaching in Agriculture
CSI:	Integrated Health Center
CSO:	Civil Society Organizations
CT3:	Continental Terminal 3
CTCVC:	Technical Committee on Climate Changes and Variability
DA:	Analysis Division
DAF:	Finance and Administration Direction
DCDS:	Coordination and Statistic Development Direction
DCPB:	Biological Products Control Division
DCR:	Cash Crop Direction
DCV:	Food Crops Direction
DDER:	Diagnosis, Epidemiology and Recycling Division
DDP:	Pastoral Development Division
DDPA:	Animal Production Development Division
DE:	Environment Direction
DEP/AP:	Prospective Studies and Policy Analysis Division
DEP:	Study and Planning Directorate
DER:	Road Maintenance Direction
DER:	Survey and Census Directorat
DES:	Livestock Statistics Division
DESE:	Statistical and Economic Studies Direction
DFCM:	Finance, Accounting and Maintenance Division
DFPP:	Fauna, Fisheries and fish farming Direction
DGD:	Customs General Administration
DGTP:	Public Works General Administration
DLV:	Veterinary Laboratories Direction
DMN:	National Meteorology Department
DP/AI:	Planning and Impact Analyze Division
DP:	Programming Division
DPA/PF:	Animal Production and Industry Promotion Direction
DPE:	Declaration on Energy Policy
DPF:	Industry Promotion Division

DPS/SPV:	Health Control Police and Veterinary Public Health Division
DPSC:	Livestock Health Protection Division
DPV:	Crop Protection Division
DPV:	Vaccine Production Division
DRE:	Water Resource Directorat
DRR:	Rural Road Direction
DSE/PA:	Livestock Statistics and Animal Products Direction
DS/E:	Monitoring and Evaluation Division
DSA:	Animal Health Directorate
DSEDS:	Statistics and Demographic and Social Studies Directorate
DSM:	Solid Municipal Waste
DTN:	New Works Directorate
DV/RD:	Extension and Development-Research Division
DWS:	Drinking Water Supply
ECA:	Economic Commission for Africa
ECOWAS:	Economic Community of West African States
Enda-TM:	Enda Tiers Monde
EnR:	Renewable Energy
EPA:	Administrative State-Owned Company
EST:	Environmentally Sound Technology
ETP:	Potential Evapotranspiration
EU:	European Union
EUMETSAT:	European Organization for Exploitation of METerological SATellites
FAO:	Food and Agriculture Organization
FCFA:	African Financial Community Franc
FCM:	Methane Conversion Factor
FIT:	Intertropical Front
FRA:	Forest Resource Assessment
GAW:	Global Atmosphere Watch
GCM:	General Circulation Model
GCOS:	Global Climate Observation System
GDP:	Gross Domestic Product
GEF:	Global Environment Facility
GHG:	Greenhouse Gas
GIS:	Geographic Information System
GMW:	Global Meteorology Watch
GPP:	Major Oil Producers
GSN:	Global Satellite Network
GUAN:	GCOS Upper Air Network
HDI:	Human Development Index
HFC:	Hydrofluorocarbon
HPI:	Human Poverty Index
ICRISAT:	International Crops Research Institute for the Semi-Arid Tropics
ICT:	Information and Communication Technology
IFDC:	International Center for Soil Fertility & Agricultural Development
IGA:	Income Generating Activities
IGES:	Greenhouse Gaz Inventory]
INC:	Initial National Communication
INRAN:	Niger National Institute of Agricultural Research
INS:	National Institute of Statistics
IPCC:	Intergovernmental Panel on Climate Change
IRD:	Development Research Institute
IREM/LCD:	Regional Initiative for the Global Environment and the Fight against Desertification
IRI:	Radioisotop Institute
IRSH:	Human Science Research Institute
ITCZ:	Intertropical Convergence Zone

IUCN:	International Union for Conservation of Nature and Natural Resources
JFM:	January-February-March
JICA:	Japan International Cooperation Agency
JJAS:	June-July-August-September
LABOCEL:	Central Veterinary Laboratory
LAC:	Less Advanced Countries
LDC:	Less Developed Country
LPG:	Liquefied Petroleum Gas
LTU:	Livestock Tropical Unit
LULUCF:	Land Use and Land Use Change and Forestry
LULUCF:	Land Use Land Use Cover and Forestry
MA:	Multivariate Analysis
MDA:	Ministry of Agricultural Development
ME/F:	Ministry of Economy and Finance
ME/LCD:	Ministry of Environment and Desertification Control
ME:	Ministry of Infrastructure
MESS/RT:	Ministry of Advanced and Secondary Education, Research and Technology
MH:	Ministry of Water Resources
MIAT:	Ministry of Interior and Land Management
MIT:	Intermediate means of Transportation
MME:	Ministry of Mines and Energy
MRA:	Ministry of Animal Resources
MSP/LCE:	Ministry of Public Health and Endemic Diseases Control
MSU:	Microwave Sounding Units
MT:	Ministry of Transport
NAPA:	National Adaptation Program of Action
NBA:	Niger Basin Authority
NCF:	Nigerian Conservation Foundation
NDVI:	Normalized Difference Vegetation Index
NEPAD:	New African Partnership for Development
NGO:	Non-Governmental Organization
NICI:	National Information and Communication Technology Development
NIGELEC:	Nigerien Company of Electricity
NIGETIP:	Nigerien Agency of Work of Public Share
ODmg:	Oven Dry megagram
ONAHA:	National office of Hydroagricoles Installations of Niger
OPEN:	Office of the Promotion of the Company in Niger
PAN-LCD/GRN:	National Action Plan for Desertification Control and Natural Resource Management
PDDE:	Decennial Program for Education Development
PFC:	Perfluorocarbon
PFM:	Multifunctional Platforms
PK:	milestone
PLECO:	Oasis Micro-Basin Sand Invasion Control Project
PNDC:	National Communication Program for Development
PNEDD:	National Environmental Plan for Sustainable Development
PNWN:	Niger W national Park
PRECIS:	Providing Regional Climates for Impacts Studies
PRIPAN:	Project of Institutional Strengthening of the National Action Plan
PUMA:	Preparation for the Use of the Data of EUMESAT Météosat satellites of the Second Generation
PV:	Photovoltaic
R&D:	Research & Development
RANET:	Radio and Internet
RDS:	Rural Development Strategy
RegCM:	Regional Climate Model
RGP/H:	Census of Population and Housing

ROSELT/OSS:	Network of Observatories and Ecological Monitoring in Long Term in the Sahara and the Sahel
RTV:	Radiotelevision
SBSTA:	Subsidiary Body for Scientific and Technical Advice
SD:	Sustainable Development
SDDS:	Solid Waste Dumping Sites
SDRP:	Fast-Track Development and Poverty Reduction Strategy
SEM:	Modern Energy Services
SML:	Company of the Mines of Liptako
SNASEM:	National Strategy for Access to Modern Energy Services
SNC:	Second National Communication
SNIS:	National Health Information System
SNT:	National Transport Strategy
SOMAIR:	Company of the Mines of Aïr
SONICHAR:	Nigerien Company of Coal of Anou Araren
TT:	Technology Transfer
UAM:	Abdou Moumouni University
UDP:	Urea Deep Placement
UEMOA:	West African Economic and Monetary Union
UNCED:	United Nations Conference on Environment and Development
UNDP:	United Nations Development Program
UNFCCC:	United Nations Framework Convention on Climate Change
USGS:	United States Geogical Science
WAM:	West African Monsoon
WMO:	World Meteorological Organization
WWF:	World Wide Fund for Nature

LIST OF CHEMICAL FORMULA AND UNITS

Al_2O_3:	Aluminum oxide
$CaCO_3$:	Calcium carbonate
CaO:	Calcium oxide
CH_2:	Methane
CO_2:	Carbon dioxide
Fe_2O_3:	Ferric trioxide
HNO_3:	Nitric acid
N_2O:	Nitrous oxide
NH_3:	Ammoniac
NO_x:	Nitrous Protoxide
SF_6:	Sulfur hexafluoride
SiO_2:	Silica
SO_2:	Sulfur dioxide
U4:	Uranium 4
U6:	Uranium 6
Cv:	Metric horsepower
Eq- CO_2:	Equivalent CO_2
Gg:	Gigagram
Kep:	Kilogram oil equivalent
tep:	Ton oil equivalent
ha:	Hectare
mm:	Millimeter
m/s:	Meter per second
m^2:	Square meter
m^3:	Cubic meter
km:	Kilometer
km^2:	Square kilometer
°C:	Degree Celsius
%:	Percentage
Kw:	Kilowatt
W:	Watt
MW:	Megawatt
Wh:	Watt-hour
GWh:	Gigawatt-hour
kV:	Kilovolt
KWh:	Kilowatt-hour
kWh/m^2:	Kilowatt-hour per square meter
kg/an:	Kilogram per year
kg de N/an:	Nitrogen kilogram per year
kcal/kg:	Kilocalorie per kilogram
g/kWh:	Gram per kilowatt-hour
st/ha/an:	Stere per hectare per year
t/ms/ha:	Oven dry megagram per hectare
kt/ms/ha:	Oven dry kiloton per hectare
l/h:	Liter per hour

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

With a total land area of 1,267,000 sq km, Niger is a landlocked country. Its nearest border to the sea is located at about 700 km i.e from the Gulf of Guinea. The country is bordered in the North by Algeria and Libya, in the East by Chad, in the South by Nigeria and Benin and in the West by Burkina Faso and Mali.
Its natural environment is harsh, with a climatic pattern characterized by low rainfall that is variable in time and space, and by high temperatures which increase its aridity. In spite of these natural constraints, the rural sector plays a key role in the national economy. It is the most important sector of activity in view of its contribution to the GDP (41% in 2001) and to export earnings (44%). In addition, it is the main source of employment: the greatest majority of rural dwellers (83.8% of the total population) practice agriculture and animal husbandry, and exploit forest, fauna and fishery resources.

The Second National Communication deals with the following issues: greenhouse gases; capacity to reduce gas emissions; vulnerability to climate change and variability; adaptation measures and strategies; institutional arrangement set up by the Government to face climate change and requirements to address the adverse effects of climate change.

Table 1 below summarizes total GHG emissions in Niger in 2000.

Table 1: Estimates of total emissions for the year 2000

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total National Emissions and Removals		**1 905**	**-16 917**	**330**	**16**	**23**	**677**	**77**	**2 140**
1 Energy	Reference Approach(1)	**756**							
	Sectoral Approach(1)	**1 887**		**35**	**0**	**21**	**614**	**76**	**2 140**
A Fuel Combustion		1 887		35	0	21	614	76	
B Fugitive Emissions from Fuels		0		0		0	0	0	0
2 Industrial Processes		**18**		**0**	**0**	**0**	**0**	**1**	**0**
3 Solvent and Other Product Use		**0**			**0**			**0**	
4 Agriculture				**286**	**15**	**0**	**10**		
5 Land-Use Change & Forestry		**(2) 0**	**(2) -16 917**	**6**	**0**	**2**	**54**		
6 Waste				**3**	**1**				
7 Other (please specify)		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Memo Items:									
International Bunkers		**37**		**0**	**0**	**0**	**0**	**0**	**0**
Aviation		37		0	0	0	0	0	0
Marine		0		0	0	0	0	0	0
CO_2 Emissions from Biomass		**5 590**							

Total emissions of GHG are estimated at 18,911 Gg for CO_2, 330 Gg for CH_4 and 16 Gg for N_2O. Potential for sequestration is - 33,922 Gg for CO_2. The detailed analysis of emissions by key source is summarized in the table below:

Table 2: Estimates of emissions per key sub-sector for the year 2000

Greenhouse gas source and sink categories	CO_2 emissions (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg)	NO_x (Gg)	CO (Gg)	NMVOCs (Gg)	SO_x (Gg)
Total national emissions and removals	**1 905**	**-16 917**	**330**	**16**	**23**	**677**	**77**	**2 140**
1. Energy	**1 887**	**0**	**35**	**0**	**21**	**614**	**76**	**2 140**
A. Fuel combustion (sectoral approach)	1 887		35	0	21	614	76	2 140
1. Energy Industries	276		0	0	1	0	0	1 523
2. Manufacturing industries and construction	102		0	0	0	0	0	101
3. Transport	757		0	0	8	38	7	345
4. Other sectors	750		35	0	13	575	69	171
5. Other (please specify)	2		0	0	0	0	0	0
B. Fugitive emissions from fuels	0		0		0	0	0	0
1. Solid fuels			0		0	0	0	0
2. Oil and natural gas			0		0	0	0	0
2. Industrial processes	**18**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
A. Mineral products	18				0	0	0	0
B. Chemical industry	0		0	0	0	0	0	0
C. Metal production	0		0	0	0	0	0	0
D. Other production	0		0	0	0	0	1	0
E. Production of halocarbons and sulphur hexafluoride								
F. Consumption of halocarbons and sulphur hexafluoride								
G. Other (please specify)	0		0	0	0	0	0	0
3. Solvent and other product use	**0**			**0**			**0**	
4. Agriculture			**286**	**15**	**0**	**10**	**0**	**0**
A. Enteric fermentation			271					
B. Manure management			12	0			0	
C. Rice cultivation			2				0	
D. Agricultural soils				15			0	
E. Prescribed burning of savannahs			0	0	0	6	0	
F. Field burning of agricultural residues			0	0	0	4	0	
G. Other (please specify)			0	0	0	0	0	
5. Land-use change and forestry [1]	**0**	**-16 917**	**6**	**0**	**2**	**54**	**0**	**0**
A. Changes in forest and other woody biomass stocks	0	-33 922						
B. Forest and grassland conversion	4 765	0	6	0	2	54		

C. Abandonment of managed lands		0						
D. CO_2 emissions and removals from soil	12 241	0						
E. Other (please specify)	0	0	0	0	0	0		
6. Waste			**3**	**1**	**0**	**0**	**0**	**0**
A. Solid waste disposal on land			0		0		0	
B. Waste-water handling			2	1	0	0	0	
C. Waste incineration					0	0	0	0
D. Other (please specify)			0	0	0	0	0	0
7. Other (please specify)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Memo items								
International bunkers	**37**		**0**	**0**	**0**	**0**	**0**	**0**
Aviation	37		0	0	0	0	0	0
Marine	0		0	0	0	0	0	0
CO_2 emissions from biomass	**5 590**							

The analysis shows that the Land Use Land Use Change and Forestry (LULUCF) sector is the most important source of CO_2 emission with 17,006 Gg CO_2, including 12,241 Gg CO_2 from land use sub-sector and 4,765 Gg CO_2 from the forestry and grassland subsector. Energy sector is second, with a total of 1,887 Gg CO_2 distributed among the following sub-sectors: transport (757 Gg CO_2), mines (750 Gg CO_2), energy industries (276 Gg CO_2) and manufacturing industries and construction (102 Gg CO_2).

Emissions from international bunkers are estimated at 37 Gg CO_2, mainly in the aviation. The use of fuel wood for cooking results in about 5590 Gg CO_2 emissions which are not taken into account in the sector as recommended by the IPCC.

Total emissions of CH_4 stand at 329.90 Gg, including 286 Gg from the agricultural sector, 35 Gg from the energy sector, 6 Gg from the LUCF sector and 3 Gg from the waste management sector.

The enteric fermentation is the greatest source of CH_4 emissions because of the importance of animal husbandry in Niger (more than 30 million animals recorded according to the Agricultural and animal census (RGAC) carried out from 2004 to 2007).

Total emissions of N_2O amount to 16 Gg and are mainly from the key agricultural sector, and in particular from the agricultural land subsector (15 Gg). The emissions from other sectors are very marginal (with a total of 1 Gg).

Finally, with regards to the Global Warming Potential (GWP), Niger's emissions for 2000 amount to **30,801 Gg Eq-CO_2** including 17,132 Gg (55.62%) from the LULUCF sector, 10,66 Gg (34,60%) from the agriculture sector, 2,622 Gg (8.51%) from the energy sector, 373 Gg (1.21%) from the waste sector and 18 Gg (0.06%) from the industrial process sector.

The inventory of total emissions of GHG (**30,801 Gg Eq-CO_2**) and sequestration of GHG **(-33 922 Gg Eq-CO_2)** : **Niger is not a source but a sink**.

Since Niger is not a member of Annex I, it is not committed to any GHG emission reduction policy and measures. However, as a party to the Convention, it must contribute to the global effort aimed at stabilizing emissions by presenting the country's capacity to reduce its emissions. This capacity lies on the implementation of sector-based policies for a sustainable development.

The latest IPCC report concluded that the African continent is the most vulnerable to climatic change and, for the first time, it was recognized that the Sahel became drier during the 20th century. Niger is located in an area which is already experiencing the effects of global warming. As a result, the country is particularly vulnerable to the adverse effects of this phenomenon.

A study of climate variability over the period 1950-2000 shows a significant decrease in annual rainfall as well as a serious increase in minimum temperatures. Regarding future projection, the increase in average annual maximum temperatures will reach 2.3 °C according to the B2 scenario and goes up to 2.6 °C according the A2 scenario over the 2020-2049 period. The highest increase will be recorded in the stations of Agadez, Maine, Konni and Maradi. The stations of Niamey and Gaya will experience the lowest increase, yet with warming which may reach 1.5 °C. With regards to the rainfall projections, the study indicates a slight increase in the cumulative rainfall over the 2020-2049 period for most of stations observed as well as a later start of the rainy season. This will certainly affect the predominant rain-fed agriculture and food security in general. This situation is confirmed by yield increase forecasted by the modeling described in the chapter devoted to vulnerability.

Based on the conclusions of the 4th IPCC report and baseline studies for this national communication, adaptation to climate change is, for a country like Niger, a matter of priority concern. A certain number of adaptation measures and strategies, with a program for raising stakeholders' awareness on the impacts of climate change, are recommended for the main socioeconomic sectors. It is clear that the most sustainable solution will require the integration of adaptation to climate change into economic and social development policies, particularly into the Fast Track Development and Poverty Reduction Strategy.

Following the signature of the United Nations Framework Convention on Climate Change (UNFCCC) and its ratification in 1995, Niger developed a National Plan for Sustainable Development (PNEDD) which serves as a framework for all environmental and sustainable development policies and whose implementation is coordinated by the National Environmental Council for Sustainable Development

(CNEDD). In addition, the National Strategy and Action Plan for climate change and variability was developed, validated and adopted, with the support of UNDP/GEF.

Regarding the country priority needs to address adverse effects of climate change, it is important that the technology transfer process for mitigation and adaptation to climate change takes into account economic and social development priorities, as defined by strategic frameworks, i.e. the Fast Track Development and Poverty Reduction Strategy (SDRP), the Rural Development Strategy (SDR), the National Adaptation Program of Action (NAPA), the Declaration on Energy Policy (DPE), the National Strategy for Access to Modern Energy Services (SNASEM) and other strategic documents on sub-regional integration. Strategic development options contained in these program documents set quantitative goals which are quite ambitious and achievable. It should be noted that the issue of technology transfer is particularly important in the energy sector in view of the resource potential of the country. Thus 15 projects profiles are presented in this document and are focused on mitigation as well as on adaptation to climate change. They also anticipate the integration of climate change into national development strategic frameworks. Regarding adaptation in particular, Niger, which features among the Least Developed Countries (LDC), has formulated and submitted for funding, a National Adaption Program of Action (NAPA), in accordance with the Marrakech agreement

This document contains detailed project with the needs on capacity building in the fields of research and systematic observation, funding, information, awareness, education and training. However, it appears that these initiatives and projects do not target enough decision makers, the rural dwellers and pupils who represent a special audience.

Yet, there are shortcomings and constraints that hinder the effective implementation of the Convention. So far many actions have been set up to overcome these obstacles.

FOREWORD

Few decades ago, the international scientific community sounded the alarm about the probable impacts of human activities on the balance of the global climate. It is now an established fact that global warming observed over a fifty-year period or so, is mostly attributable to human activities and non-natural phenomena. These climatic disturbances (recurrent droughts, frequent floods, strong winds, heat waves, sea level rise, etc.), that scientists initially forecasted for the end of the 21st Century are already occurring and at more frequent intervals in several regions of the world. They are increasingly affecting many people worldwide. By and large, these phenomena have various consequences (famine, disease, migration and loss of thousands of life) which the poorest countries cannot cope with.

These phenomena have not spared Niger, a country whose economy is highly dependent on the rural sector and which is paying the heaviest toll. In fact, for nearly three decades, there have been recurrent droughts with negative effects on water resources (disturbance of rainfall and hydrologic regimes, etc.); a real degradation of agricultural lands; depletion of the natural environment resulting in a significant reduction of tree, shrub and grass resources, both quantitatively and in qualitatively, as well as genetic depletion. All of these effects result partly from, the very high human pressure.

This is the reason why, Niger, like other countries involved in the protection of global environment with the view to delivering a habitable planet for future generations, signed the United Nations Framework Convention on Climate Change on June 12th, 1992.

The ratification of this Convention by Niger on 25 July 1995 as well as all the efforts made to conform to its provisions, as stated in the Second National Communication, are the expression of Niger's commitment to contribute to the fight against global warming to which Niger is vulnerable in view of its fragile ecosystems and/or its economy that is highly dependent on climate-sensitive sectors.

The country is currently looking towards stepping up some adaptation efforts. To that end, it needs financial and technical support to achieve its adaptation strategy. Such is the major challenge of the multilateral cooperation.

INTRODUCTION

In January 1996 and in accordance with the Rio commitments, Niger established the National Environmental Council for Sustainable Development (CNEDD). This Council, which is under the supervision of the Prime Minister's Office, developed the National Environmental Plan for Sustainable Development (PNEDD) which is made up of six priority programs, including one related to climate change.

The implementation of this PNEDD is coordinated by the National Environmental Council for a Sustainable Development (CNEDD) and serves as a framework for all policies related to environment and sustainable development.

To implement these priority programs, specialized technical committees were set up including the technical Committee for Climate Change and Variability (CNCVC). This committee was established in 1997 and is made up of the representatives of Government agencies, semi-public bodies, research and training institutions, university, civil society and private sector. Its mission is to support the Executive Secretariat of the National Environmental Council for a Sustainable Development (SE/CNEDD) in implementing the Climate Change/Variability Program. One of the major objectives of this program is to implement the provisions of the United Nations Framework Convention on Climate Change at national level. It is under the supervision of this Program that Niger prepared its Initial National Communication (INC) with the support of PNUD/FEM/NER/97/G33 "Climatic Change" funded by the Global Environment Facility (GEF).

A self-assessment of the Initial National Communication revealed that there was little involvement of stakeholders with relevant data in this committee. As a result, the making up of this body was reviewed and five thematic working groups were established: Energy-Water-Road Infrastructure; Agriculture-Livestock; Forestry, Fisheries and Humid Zones; Industrial Process; Wastes and Health; Mechanism for a Clean Development.

Following the publication of its Initial Communication, Niger carried out a certain number of activities including:

- Development, validation and adoption of the National Strategy and Action Plan for Climate Change and Variability with the support of UNDP/GEF;
- Organization of several workshops for information sharing and awareness raising on climate Change;
- Publication of five articles in newspapers and development of a booklet on climate change;
- Organization of several training workshops on Clean Development Mechanism (CDM) for Government entities, the civil society, NGOs and the private sector. These sessions made it possible to identify nine project ideas;
- Development of a National Adaptation Program of Action (NAPA) for Climate Change to help mitigate the adverse effects of Climate Change on the most vulnerable population with a view to promote sustainable development and fight against poverty in Niger;
- Implementation of PNUD/FEM/RAF02-G31 project entitled "Capacity building for improving Greenhouse Gas Inventories in West and Central Africa" which aims at building the capacity of beneficiary countries to improve the data quality and emission factors used in their national greenhouse gas inventories (IGES);
- Implementation of the "Self-assessment of the Initial National Communication Project" which was aimed at identifying the shortcomings and weaknesses of the Communication and making suggestions for improving the Second National Communication;
- Development and implementation of the National Self-assessment of Capacity Building Needs for managing global environment (ANCR). The objective of this project was to assess the needs for capacity building and come up with a strategy and a plan of action to implement capacity building activities in connection with Conventions on Desertification Control, Biodiversity and Climate Change.

The content of this Second National Communication is defined by the provisions of Decision

17/COP.8 related to the preparation of the National Communication of countries that are not members of Annex I of the Convention. Chapter one of this document sets the national circumstances, and in particular the aspects of development policies related to the major components of Climate Change Process. Then, chapter two is devoted to greenhouse gases inventories, in accordance with the methodology recommended by the Convention Secretariat and the IPCC. This inventory is complemented by tables providing details on calculations carried out. Capacity for mitigating the effects of greenhouse gas emissions is the focus of the third chapter; this capacity is related to social and economic development policies of the country.

Chapter IV deals with vulnerability to climate change and variability. It is followed by chapter V which is devoted to climate change adaptation which requires external assistance. Finally chapter VI makes a detailed assessment of Niger's requirements to efficiently implement the Convention.

I. NATIONAL CIRCUMSTANCES

I.1 CHARACTERIZATION OF THE COUNTRY

I.1.1 Location

Niger is a landlocked country with a total land area of 1,267,000 sq km. It lies between 12 and 23° N. It is at the junction of North Africa and Sub-Saharan Africa on the one hand and of West and Central Africa on the other hand. It is bordered in the North, by Algeria and Libya, in the East by Chad, in the South by Nigeria and Benin and in the West by Burkina Faso and Mali (see figure 1), and it belongs to the group of continental countries of the Western sub-region. Niger is very far from the costal line (1,900 km from the Atlantic coast and about 700 km from the Gulf of Guinea (distance from Gaya and Niamey) where the ports of Tema and Cotonou are located.

Figure 1: Location of Niger

I.1.2 Climate

Niger's natural environment is harsh, with a climatic pattern characterized by low rainfall that is variable in time and space and by high temperatures which make its aridity more severe. There are four climatic zones (see figure 2 on the next page):

- the Sudano-Sahelian zone which represents about 1% of the country's total land area, with an annual rainfall ranging from 600 to 800 mm during normal years;
- the Sahelian zone which accounts for 10% of the total land area of the country, with an annual rainfall ranging from 350 to 600 mm;
- the Sahelo-Saharan zone (12% of the total land area) with annual rainfall that varies between 150 mm and 350 mm;
- the Saharan zone, which is desert, occupies 77% of the country (less than 150 mm).

In spite of these natural constraints, the rural sector plays a key role in the national economy. It is the most important sector of activity in view of its contribution to the GDP (41% in 2001) and to export earnings (44%). In addition, it is a major source of employment for the greatest majority of rural dwellers (83.8% of the total population) who practice agriculture and animal husbandry, and extract forest, fauna and fishery resources.

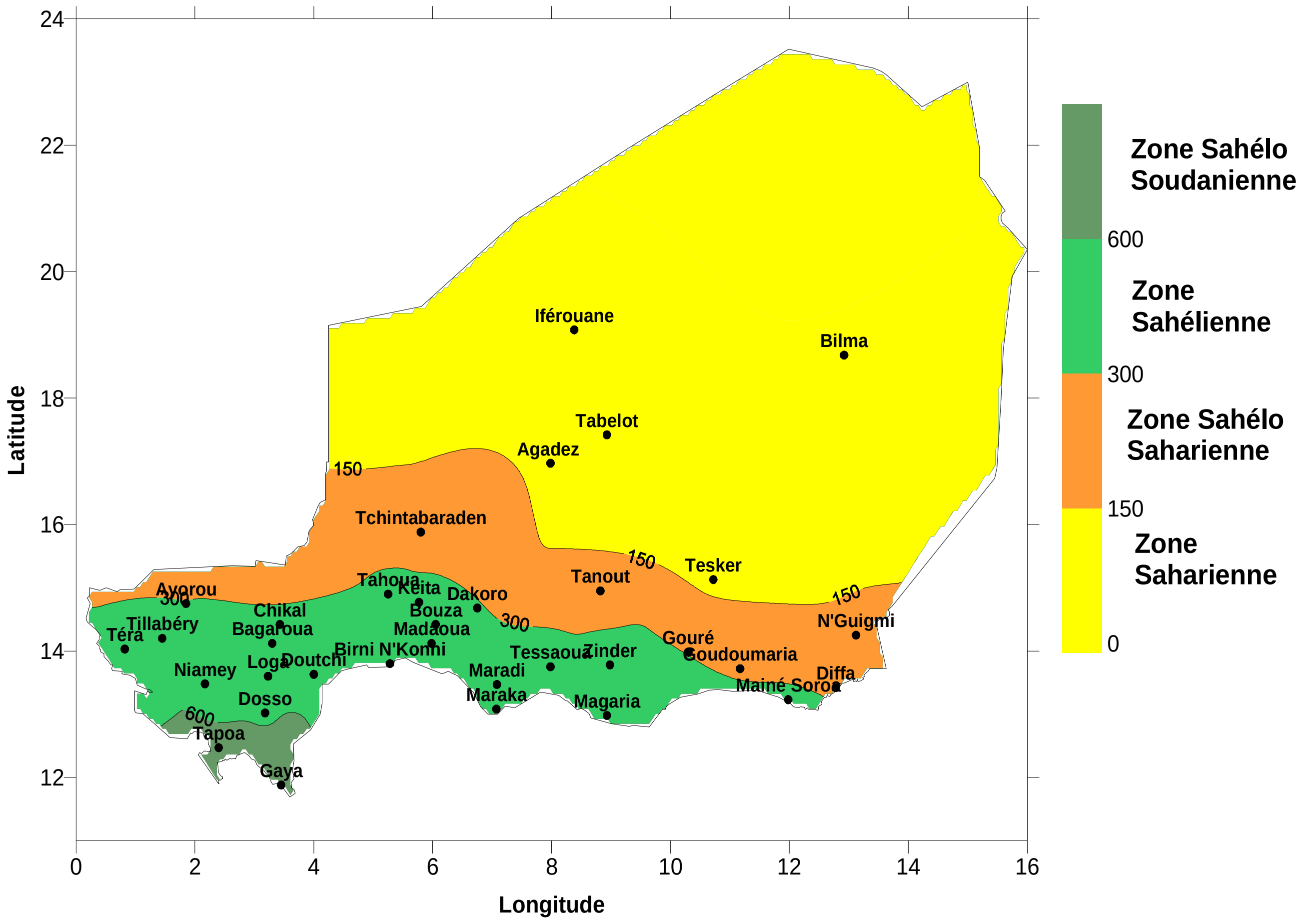


Figure 2: Main climatic zones in Niger

I.3.3 landscape

The landscape of Niger (figure 3, below) is characterized:

- in its southern part, by a succession of plains and plateaus interspersed with:
  - outcrops of Precambrian rocks, in the west;
  - range of hills from the cretaceous and the tertiary periods, in the Center and the West;
  - valleys and basins, from West to East ;
- in its northern part, by vast geomorphic zones. The major ones include:
  - the crystalline massif of the Air-Ténéré in the Center and which culminates at more than 2000 m.
  - Large areas flooded by waters from the Aïr;
  - Irazer in the West, Tadress in the South, Kawar in the East;
  - Termit Sandstone;
  - Barren plateaus;
  - Large sandy and desert stretches.

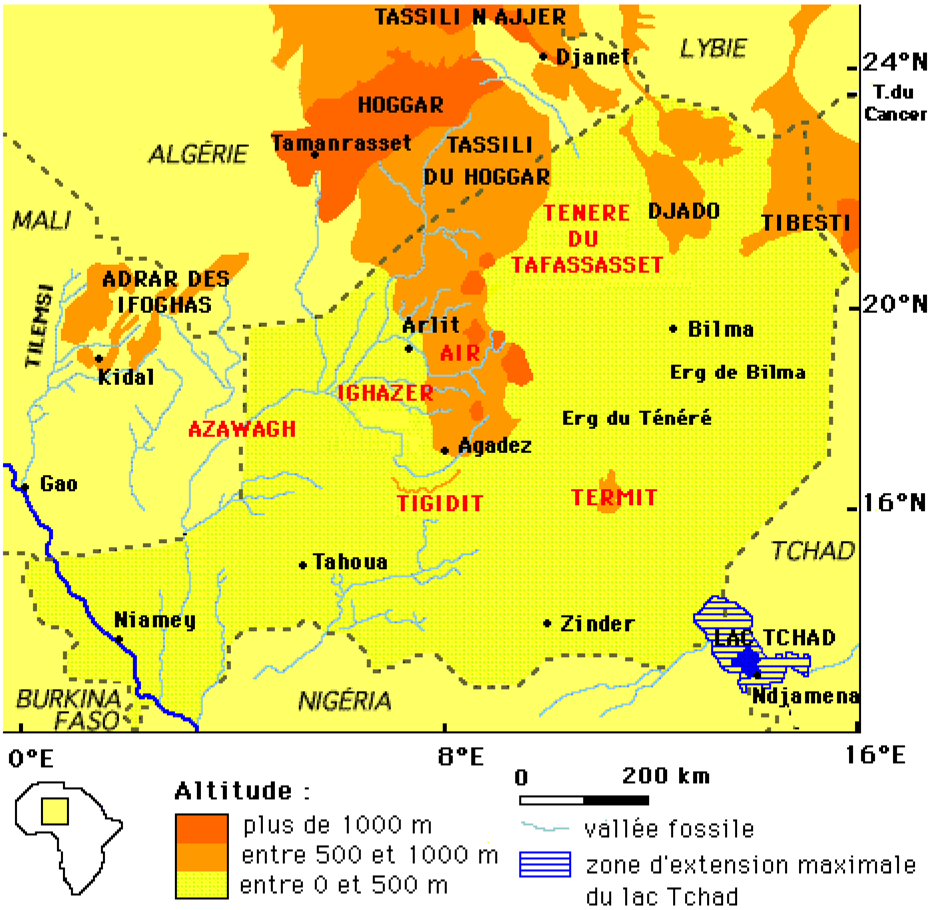


Figure 3: Map of Niger showing the landscape[1]

I.1.4 Land use systems

The Niger[2] land use systems include:

- The Niger River valley system in the portion of the Niger River that goes through the territory of Niger over 550 km, in its western part. This system covers an area of about 175,200 ha;
- The Dallols which are part of the Oulliminenden River system. These are fossil valleys, ancient tributaries of the left bank of the Niger River, which generally stretch from North to South;

- The Adder-Doutchi-Maggia-Tarka which includes the Maggia Valley that lies between 13°5’ and 14°30’ Nord. It occupies a land area of 2000 sq km. The average altitude within the valley

[1] Source: http://www.ird.fr/bani/cartes/document
[2] TORQUEBIAU.E and MOUSSA, H, 1990

is 300 m;
- The Maradi Goulbi which is a long alluvial plain with a flood bed;
- Plains, which are made up of stretches of flat and monotonous agricultural lands; they cover a surface area estimated at 6,000 sq km;
- Plateaus which essentially cover the western portion of the semi-arid zone. The plateaus occupy a surface area of about 100,000 sq km.

I.2. NATURAL RESOURCES

I.2.1 Land

Arable areas are estimated at 15 million ha, representing less than 12% of the total land area of the country while cultivated lands are estimated at 6 millions ha. Irrigation lands are estimated at about 270,000 ha, that is 4% of the total land area, including 140,000 ha that are located in the Niger River Valley. Land distribution according to climatic zones reveals that 65% of lands are in the Sahelian zone (annual rainfall less than 200 mm), 12% in the Sahel-Saharan zone (200 to 300 mm), 12% in the Sahelian zone, 9.8% in the Sudano-Sahelian zone and 0.9 % in the Sudanian zone where annual rainfall is higher than 600 mm.


I.2.2 Water

Niger's water resources consist of rainfall, surface water and groundwater. In spite of its dry climate, Niger has great water resource potential made up of surface water and groundwater.[3]

In Niger, rainfall varies in space (rainfall varies from 0 to 800 mm/year, from North to South) and time (it rains from June to September. The rest of the year is totally dry). There is also inter-annual variability (the ratio between annual rainfall of the decadal wet year and the dry decadal year reaches 2.5 towards the 500mm isohyets and is higher than 3 towards the 200 mm isohyets).

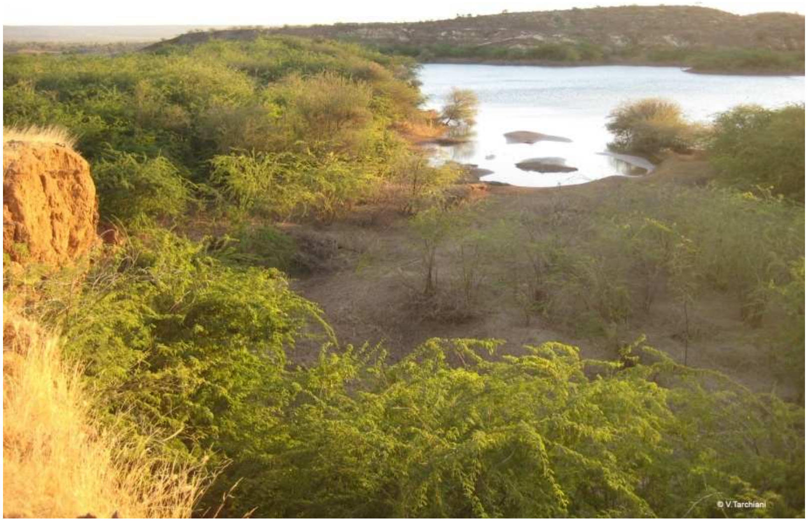
In general, surface water resources are plenty in Niger (more than 30 billion cubic meters/year) of which only 1% is being exploited.


These water resources largely come from the Niger River and its right bank tributaries i.e more than

[3] MHE, 2005

29 billion cubic meters/year. There are few streams in the rest of the country and their flow varies significantly from one year to the other. Artificial water reservoirs (dams) make it possible to store large quantity of water. Today there are about 20 of them with 100 million cubic meters in total.

There are plans to construct dozens of dams. The most important ones include: the Kandadji and Gambou dams on the Niger River and the Dyondyonga dam, on the Mekrou River. In addition, there is a great number of permanent or seasonal ponds.



There are several ponds in Niger, 175 of which are permanent. Very few of these water bodies have been studied or subjected to any hydrological monitoring.

Table 3: Distribution of ponds per region[3]

Region	Agadez	Diffa	Dosso	Maradi	Tahoua	Tillabery	Zinder	U.C. Niamey
Number of ponds	10	120	113	40	282	145	300	13
Permanent ponds	-	5	54	4	39	51	20	2

Groundwater represents 2.5 billion cubic meters that is renewable every year, 20% of which are exploited and 2000 billion cubic meters that are not renewable; a marginal portion of this water is exploited for mining activities in the northern part of the country.

I.2.3 Soil

In Niger, soils are generally poor in nutrients and have low organic matter content. They are characterized by decreasing level of fertility, increased acidification, exposure to water and wind erosion, low water retention capacity thus level of fertility.

They are also subjected to alkanization and salinization. Potential cultivated land is estimated at 15 million ha, representing at least 12% of the total surface area of the country. It should be noted that 80 to 85% of arable land are located on dunes and only 15 to 20% are moderately clay hydromorphic soils.[4] Soils in areas with mountains and large plateaus (Aïr, Ader Doutchi, Continental terminal) are litho soils. Fossil valleys are mostly litho soils. In fossil valleys (Dallols, Goulbi, and Korama), river valleys, the Komadougou, Lake Chad and Manga basin soils are mostly hydromorphic and vertisols.

I.2.4 Vegetation

Niger is home to species and plant formation represented by several bio-geographic layers.



Niger's flora is made up of about 1,600 species. The land area occupied by forest is estimated at 14,000,000 ha. Forests are the main source of domestic energy for population. They are used for fodder, traditional medicine and scientific research.

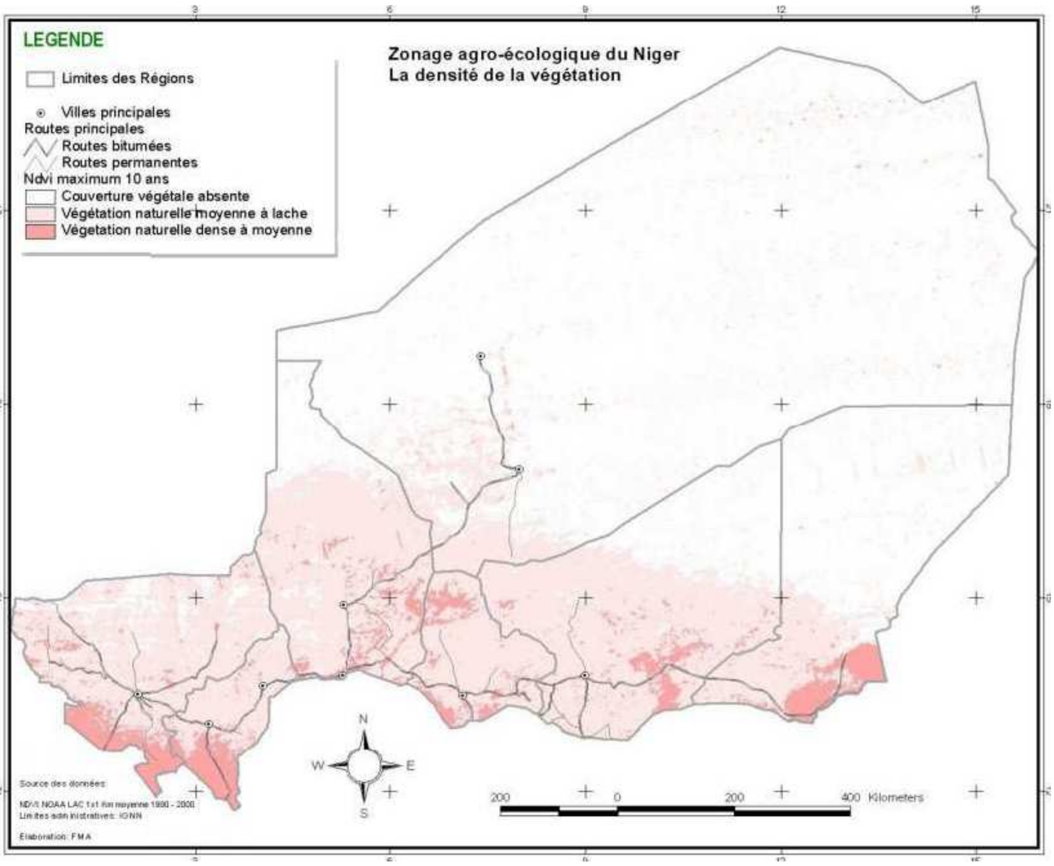


Figure 4: Map of vegetation density

Source: Website: www2.polito.it/ricerca/cctm cctm@polito.it

NB: Classification of values is as follows: NDVI -1 - 0.205 vegetation cover nonexistent to loose; NDVI 0.205 - 0.386 vegetation cover from loose to medium; NDVI 0.386 - 1 vegetation cover from medium to dense.

The major bioclimatic zones include: (i) the Saharan zone where vegetation, when it exists, consists of

[4] PAN-LCD/GRN, 1998

sparse shrub steppe which provides shelter to some critically endangered species such as *Oryx* and *Addax*; (ii) the Sahel-Saharan zone, which virtually corresponds to the inhabited part of Niger, is characterized by vegetation ranging from contracted plant formation or sparse shrubs to more diffuse tree vegetation in the South; (iii) the Sahelian zone which is characterized by scattered grass savanna and low density shrub layer with more trees in wet lowlands where *Acacia tortilis* et *Aristida mutabilis* are the dominant species; finally (iv) the Sudano-Sahelian zone which occupies the South-most part of the country; its vegetation is mostly savanna characterized by more or less sparse grass layer. It generally consists of combretaceae and woody species with economic value such as shea (*Vittelaria paradoxum*), African locust (*Parkia biglobosa*), baobab (*Adansonia digitata*), etc.[5]

I.2.5 Fauna

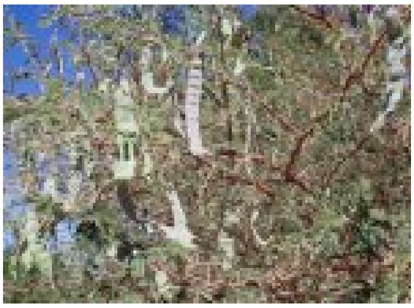
The various bioclimatic layers and ecosystems of Niger harbor a rich fauna resource. Recent scientific studies have focused only on vertebrates and in particular mammals.[6]



The fauna consists of species from the Sudanian zone and the South of the Sahelian and the Sahara-desert zone. There is little knowledge of most of animal species (mammals, birds, reptiles, amphibians, fish, invertebrate, etc.) and natural habitats.

Studies carried out in connection with the development of the National Strategy and Action Plan for biodiversity, indicate that Niger is home to 3,200 animal species, including 168 mammals species, 512 bird species, 150 reptiles and amphibian species, 112 fish species and a great number of invertebrates (molluscs, insects).[5]





I.2.6 Mineral resources

Regarding mineral resources, the various mine and oil exploration operations carried out over more than 50 years in Niger revealed the existence of a huge and diverse oil and mineral potential: a total of thirty mineral substances and up to 300 occurrences and deposits were identified.

In addition to hydrocarbon and mineral substances which have been or are subjected to industrial or semi-industrial mining (uranium, coal, limestone, phosphate, tin…), there are occurrences and deposits of precious metals (gold, platinum, silver), special metals (lithium, cobalt, chrome, manganese) and base metal (copper, lead, zinc).

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[5] PAN-LCD/GRN, 1998
[6] SNPA/DB, 1998

I.2.7 Energy resources

The energy consumption is low and is estimated at 150 kilograms of oil equivalent per capita and per year i.e. one of the lowest in the world. The sources of energy include fuelwood (87%), petroleum products (7%), and electricity (2%).

The Energy sector has three main characteristics[7]: (i) predominance of fuel wood in the energy balance; this source of energy covers more than 80% of energy demand and comes from forest formations and (ii) predominance of domestic energy sector in the national energy balance. It has great impact on the national environment and economy.

Power is supplied both by national sources and imports from Nigeria. At the national level, power (189.39 GWh in 2003) is generated by the National Power Company [*Société Nigérienne d'Electricité* (NIGELEC)] and the Niger Anou Araren Coal Mining Company [*Société Nigérienne de Charbon d'Anou Araren* (SONICHAR)]. In 2003, imports from Nigeria amounted to 275.5 GWh. Imports from Nigeria covered 59% of the 465 GWh national energy demand in 2003.The National electrification rate was around 6.5% in 2003.

Oil exploration in Niger was intensified in the early 1990s through the implementation of a large scale program of review of previous geological and geophysical data . This resulted in the development of a document aimed at promoting oil potential in Niger. It should be noted that international oil companies conducted several prospecting operations on the national territory from 1958 to 2000. Niger is not yet an oil producing country despite the discovery of promising occurrences of oil and gas. This is the reason why the Government of Niger decided to further promote its oil potential by diversifying its partners with the prospect of increasing chances to discover new oil deposits. Niger is endowed with mineral coal deposits but only the Anou-Araren deposit is currently being developed. The country has a great hydrocarbon storage capacity amounting to 47,808 cubic meters. It imports all the oil products it needs. In 2003, the national oil products consumption was 178,856 cubic meters.

Renewable energy sources in Niger include: biomass, solar energy, wind energy and biogas. With regard to biomass, firewood is the major source of energy and it is used by more than 91% of households. More than 200,000 tons of wood are removed every year from national forest resources. Regarding solar energy, all parts of the country get a lot of sunshine, with maximum sunshine in the Northern part. Sunshine is quite regular except during the rainy season, when sometimes clouds significantly reduce its intensity.

Average monthly values recorded vary from 5 kWh/sq. meters to 7 kWh/sq. meters per day, and average sunshine varies from 7 to 10 hours per day. Research-development activities in thermodynamics, conducted by the *Office National de Recherche en Energie Solaire (ONERSOL)* since its establishment in 1965, resulted in the production and marketing of thermal solar equipment, including solar water heaters, stills, cookers, etc. In Niger, large scale use of solar energy began in mid 1970s with the installation of 1,370 television sets using photovoltaic system throughout the country. Solar energy was also used for other purposes, such as water pumping, irrigation, telecommunications, lighting, refrigeration, etc. Currently, this source of energy is rapidly developing through the electrification of rural areas and remote centers. There is also a great potential of wind energy in northern part of the country where average wind speed is 5 m/s while 2.5 m/s is recorded in the South. To date, about forty energy generating wind systems are being used for water supply, irrigation and fish farming.

The domestic energy sub-sector is dominated by traditional energies (wood energy and crop residues) that are mainly used to meet cooking needs of households. In response to such situation, many steps aimed at reducing the demand have been taken since the early 1970. In mid 1980s, The Government of Niger decided to adopt a more holistic and concerted approach, matching demand and supply, in other words set a balance between energy demand and forest resources. This resulted in the development, as of 1986/1987, of a Domestic Energy Development Strategy (*SED*), focused on a sound, efficient and controlled management of forest resources; limitation of fuel wood demand; diversification of domestic energy sources in urban areas by using alternative energy sources (paraffin, butane and mineral coal) and dissemination of improved cooking equipment.

[7] SIE/MME, 2005

I.3 POPULATION

In 2001, Niger population was estimated at 11,060,291 inhabitants[8] living mostly in rural areas (83.8%),.This population derives most of its income from natural resources.

The population growth rate was 3.3% in 2001 i.e one of the highest in the world. Fertility index, representing the average number of children per woman (15-49 years old), was 7.5.

According to the trend scenario, based on national statistics, the population will reach 17.3 million inhabitants in 2015 and 24.1 million inhabitants in 2025. There are eight (8) socio-linguistic groups in Niger (Hausa, Sonraï-Djerma, Fulani, Tuareg, Kanuri, Gourmantché, Arab and Toubou). The two largest groups in number (Hausa and Songhaï-Zarma) account for about 80% of the population and are in general sedentary farmers. On the other hand, the number of monadic populations (less than 10%) is continuously decreasing, as a consequence of droughts and changes in life style which resulted in their settlement either in rural or urban centers. Due to this change in the population structure, the traditional distinction between farmers and pastoralists has become blurred, as settled pastoralists have become farmers and more and more farmers also own animals. Table 4 summarizes the evolution of the population in various regions of Niger, based on the 1977 and 2001[9] censuses.

Table 4: Evolution of Niger population per region, from 1977 to 2001

Regions	1977 RGP/H		1988 RGP/H		2001 RGP/H	
	Number	**%**	**Number**	**%**	**Number**	**%**
Agadez	124 985	2.4	208 828	2.9	321 639	2.9
Diffa	167 389	3.3	189 091	2.6	346 595	3.1
Dosso	693 207	13.6	1 018 895	14.0	1 505 864	13.6
Maradi	949 747	18.6	1 389 433	19.2	2 235 748	20.2
Tahoua	993 615	19.5	1 308 433	18.0	1 972 729	17.9
Tillabery	928 849	18.2	1 328 283	18.3	1889 515	17.1
Zinder	1 002 225	19.6	1 411 061	19.5	2 080250	18.8
UCN [*CUN*]	242 973	4.8	397 437	5.5	707 951	6.4
Niger	**5 102 990**	**100**	**7 251 626**	**100**	**11 060 291**	**100**

Analysis of table 4 shows that regions with the greatest population growth are located in the central parts of the country, notably the Maradi and Zinder regions; it should be noted that the Maradi region has the highest growth rates, especially in rural areas.

Table 5: Projected total population growth at national and regional levels, from 2002 to 2008

	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Agadez	333 154	344 147	355 504	367 236	379 355	391 873	437 210
Diffa	359 002	370 850	383 087	395 730	408 789	422 278	446 651
Dosso	1 559 772	1 611 244	1 664 416	1 719 341	1 776 079	1 834 690	1 921 202
Maradi	2 315 785	2 392 205	2 471 149	2 552 696	2 636 935	2 723 954	2 865 219
Niamey	733 295	757 494	782 491	808 313	834 987	862 541	1 033 295
Tahoua	2 043 350	2 110 781	2 180 436	2 252 391	2 326 720	2 403 501	2 524 514
Tillabery	1 957 157	2 021 743	2 088 461	2 157 380	2 228 574	2 302 116	2 396 411
Zinder	2 154 720	2 225 826	2 299 278	2 375 154	2 453 534	2 534 501	2 672 314
Niger	**11456235**	**11834290**	**12224822**	**12628241**	**13044973**	**13475457**	**14296816**

Source: National Institute of Statistics

[8] 2001 General Census Of Population and Housing (RGP/H)
[9] 2001 General Census Of Population and Housing (RGP/H)

Table 5 shows that the population is unevenly distributed on the national territory. Southern regions are more densely populated than northern regions. Density varies from1 inhabitant per sq. km in Agadez (in the North) to 53.5 inhabitants per sq. km in Maradi (in the South). The average population density is 8.7 inhabitants per sq. km. The greatest part of this population lives in the southern strip which is more favorable to farming and animals breeding.

Table 6: Average annual population growth (%) per region[9].

	1977-1988 period	1988-2001 period
Agadez	4.98	3.38
Diffa	1.16	4.77
Dosso	3.71	3.05
Maradi	3.66	3.73
Tahoua	2.64	3.21
Tillabery	3.44	2.75
Zinder	3.29	3.03
UCN	4.70	4.50
National	**3.38**	**3.30**

The table on the left shows that the average annual population growth (one of the highest in the world) was 3.38% during the 1977-1988 period, and 3.30% during the 1988-2001 period. Over the period 1988-2001, this population growth varied from one region to the other, from 2.75% in Tillabery to 4.77% in Diffa. This table also shows that in the Diffa and Maradi regions as well as in the Urban Community of Niamey, population growth rate is higher than the national average.

I.4 ECONOMIC AND SOCIAL DEVELOPMENT

Niger is one the poorest countries in the world. It is highly vulnerable to climatic hazards and many external factors, including world commodities market, economies of neighboring countries such as Nigeria and Benin and donors' funding. According to UNDP reports on Human Development Index, Niger ranked last in the world (174th out of 174 countries) from 2000 to 2005. It records a slight progress in 2006, ranking 172nd. This change was due to the socio-economic growth of the country. The annual per capita income of Niger, LDC, is said to be less than $ US 300 over the 2000-2006 period. The tertiary sector is the major source of employment (85%) (see table below).

Table 7: Distribution of GDP per activity sector

	% GDP distribution per year					
Sectors	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Agriculture	27	28	24	26	28	28
Livestock	10	10	11	10	10	10
Fisheries/ Fish farming	3	3	4	4	4	4
Mining	6	5	5	5	5	5
Industries	6	5	5	5	5	5
Services	48	49	51	50	48	48

Niger remains an under-developed country: imports of goods and services have increased by 4.5% while exports increased by only 2.0% in 2003.

Livestock sector is one of the pillars of the economy and ranks second after uranium in Niger exports (agriculture comes in the third position). It is a major source of foreign exchange currency for the country. Niger is the 19th cattle exporter in the world. It occupies the 3rd position for goat exports, and 15th position for sheep exports.[10] In nearly all the regions, agriculture and livestock are the two (2) major sources of income for households. For example, in the Tahoua and Diffa regions, agriculture

[10] **Source:** FAO, 2003

represents 43% and 44.39% respectively, and livestock 28% and 29.80% respectively.

In Niger, 63% of the population live in extreme poverty with less than $US 1 per day. As a result, the Government of Niger endorsed the Millennium Development Goals, with the objective of: "*Reducing by half the proportion of people living in extreme poverty by 2015*".

As a member of the African Union, Niger has also joined NEPAD. The objective of the energy component of this initiative is to "*improve from 10 to 35% access to energy for African populations, i.e. 60 to 300 millions people in the next twenty years*".

At sub-regional level, Niger is a member of the West African Monetary and Economic Union (UEMOA) and the Economic Community of West African States (ECOWAS), whose energy policy objective, as stated in its White Paper, is the following: "*By 2015, facilitate access to modern energy services for at least half the population, representing 36 million additional households and 49.000 additional centers with access to modern energy services. The number of beneficiaries is thus multiplied by 4 compared with the figures in 2005*".

These international commitments resulted in the adoption of a number of national policy frameworks under the Fast Track Development and Poverty Reduction Strategy (DPRS) adopted in 2007. The overall objective is to "improve *the welfare of the population of Niger through increased income, improved health and nutritional status, increased educational level, sound environment, better access to modern energy services and drinking water, involvement in institutional decision-making, better access to towns and villages using appropriate infrastructure, and universal access to ICT*". To achieve this objective, *PRS* has been structured around seven thrusts with the followings targets (indicators):

i. *Economic growth rate (at least 7%/year)*
ii. *Poverty rate (42%)*
iii. *Malnutrition rate (24%);*
iv. *Gross primary education enrolment (94%);*
v. *Adult literacy rate (45%) taking into account gender equality*
vi. *Infant and child mortality rate (108 per 1,000 live births);*
vii. *Aids prevalence rates (less than0. 7%);*
viii. *Mother mortality rate (200 for100,000 live births);*
ix. *Rate of access to drinking water (80%);*
x. *Household access to electricity services (3% increase in rural areas and 65% increase in urban areas);*
xi. *Rate of utilization of impregnated mosquito nets with insecticide for children and pregnant women (35%);*
xii. *Synthetic fecundity rate (6 children by woman);*
xiii. *Protected areas at least 8% of the national territory;*
xiv. *Satisfaction of the national cereal demand (at least 110%).*

I.5 FAST TRACK DEVELOPMENT AND POVERTY REDUCTION STRATEGY

For the initial five-year period (2008-2012), the DPRS plan includes the following reference frameworks:

- Rural Development Strategy (*SDR*);
- National Strategy for Access to Modern Energy Services (*SNASEM*);
- National Strategy and Action Plan for Renewable Energies (*SNPA/ER*);
- National Environment Plan for Sustainable Development (*PNEDD*);
- Ten-year Education Development Plan (*PDDE*);
- Health Development Plan (PDS).

The analysis of the objectives and indicators of these frameworks shows the concern by Niger in taking into account its commitments regarding the United Nations Framework Convention on Climate Change.

I.5.1 Rural Development Strategy

The overall objective of *PRS* is to "*Reduce the incidence of rural poverty from 66 to 52% by 2015 by creating conditions for sustainable economic and social development that could ensure to community* *food security and sustainable natural resources management*". It includes several sector-based sub-programs. The sub-programs with most significant impact on greenhouse gas emissions and/or mitigation are summarized in table 8 below. This table reveals that this strategy has four (4) major thrusts, namely: (i) improved food security through the promotion of irrigation; (ii) environmental preservation through the reduction of biomass fuel consumption; (iii) access to drinking water and sanitation through the dissemination of renewable energies; (iv) access to modern energy services through increasing supply of hydroelectricity.

One of the priorities of Niger is to reduce the incidence of poverty from 66 to 52% by 2015.

The above-mentioned strategic thrusts are part of the sustainable development options and provide a better opportunity for reducing pressure on forest resources. Thus, in addition to increasing sequestration capacity through improved land use, these thrusts promote improved technologies that are not greenhouse gas emission sources. This makes it possible to reduce emissions while ensuring the country's development.

Table 8: Objectives and indicators of PRS sub-programs

PRS and other programs	Objective	Indicators
PRS	"Reduce the incidence of rural poverty from 66 to 52% by 2015 by creating conditions for sustainable economic and social development that could ensure to community food security and sustainable natural resources management"	
Program No 4: Rural Infrastructure	Develop major infrastructures to support rural development.	
Sub-Program No 4-1: Hydro agricultural infrastructure	Increase the contribution of irrigation to the agricultural GDP from 14 to 28% by 2015.	Small scale irrigation is developed
Sub-Program No 4-2: Transport Infrastructure	Make agro-sylvo-pastoral production zones accessible to enhance socio-economic exchanges.	Intermediary transport means are promoted.
Sub-Program No 4-3: Communication infrastructures	Improve rural communities' access to modern communication means	Radio coverage in rural areas is improved.
Sub-Program No 4-4: Rural electrification :	Improve the rate of access to renewable energies for economic development and improved living conditions of rural communities.	Renewable energies are developed
Program No 8: Drinking water and sanitation	Improve access to drinking water and sanitation	The coverage rate of drinking water needs in rural areas increased from 59% in 2004 to 65% in 2009 and to 80% in 2015
Program No 10: Environmental protection	Protect the environment to promote sound and sustainable exploitation	Wood is saved through dissemination of alternative techniques.
Program No 11: Food security	Ensure food security through development of irrigation	Irrigated areas increase from 85,000 ha to 160,000 ha by 2015
		At least one agribusiness and agricultural product processing unit is created every year beginning from 2007.
Program No 13: Land restoration and reforestation	Reverse the trend of large-scale degradation of land and vegetation cover.	7,000,000 tons of wood are saved through the dissemination of appropriate techniques.
Program No14: Kandadji Dam	Reduce poverty through environment regeneration; improved food security; and satisfaction of water and energy needs.	Hydro-electric power plant with a capacity of 125 MW built together with a 132 KV transmission line (167 km long).

I.5.2 National Strategy for Access to Modern Energy Services

National Strategy for Access to Modern Energy Services (SNASEM) resulted from the Energy Policy Declaration (*DPE*) adopted by Niger in 2005 following the adoption of the National Environmental Plan for Sustainable Development (*PNEDD*) and conversion of the 2001 Poverty Reduction Strategy Paper (*SRP*) into the 2007 Fast Track Development and Poverty Reduction Strategy (SDRP). This strategy also builds on the ECOWAS/UEMOA White Paper on access to modern energy services is aimed, among other things, at creating the necessary conditions for supplying energy to rural and peri-urban communities of member countries with the view to achieving the Millennium Development Goals (MDG). The table below summarizes the major thrusts of the *SNASEM* and indicators defined for 2012 and 2015.

Table 9: Objectives and indicators of *SNASEM*

	Objectives	**Indicators**
SNASEM	By 2015, enable at least half the population of Niger to access to modern energy services	
Domestic energy	Enable the entire population of Niger to access to modern cooking fuels by 2015	2.5 million coal stoves are provided to rural and urban households
		312,500 gas stoves are provided to urban households
		375,000 paraffin stoves are provided to rural households
		50,000 solar energy cooks are provided to urban and rural households
		268 solar energy cooks are provided to *CSI* [IHC]
		268 solar energy water-heaters are provided to *CSI*
Income-generating activities	Provide all villages of Niger with more than 1,000 inhabitants with motive power by 2015	2, 000 multifunctional platforms are installed
		100 handicraft centers and workshops are equipped with motive power.
		26,500 ha are equipped with motive power for water-lifting
		706 modern water points are equipped with small drinking water supply for water-lifting
Rural electrification	Increase coverage rate to 66%, i.e. 11.55 million people in urban, peri-urban and rural areas with access to individual electricity services	263,122 new urban households are supplied with electricity
		1,380 rural villages with a population ranging from 1,000 to 2,000 inhabitants are connected to the grid
		218 *CSIs* are supplied with electricity from renewable energy sources.
		2,682 schools are supplied with electricity from renewable energy sources.

SNASEM focuses on household access to cooking energy to reduce pressure on forest resources through the dissemination of alternative fuels, such as solar stoves, improved stoves and mineral coal. In the same vein, it is expected that 66% of Niger's population will have access to energy, i.e. 11.5 million people, representing some 263,000 households and more than 1,360 rural villages whose population exceeds 1,000 inhabitants.

Solar photovoltaic will be used as source of energy for health centers, drinking wate systemsr and the promotion of basic education.

The use renewable sources of energy as well as the extention of the interconnected grid to include new energy industrial units will enable the country to avoid significant greenhouse gas emissions.

I.5.3 National Environmental Plan for Sustainable Development (*PNEDD*)

The development and adoption process of a National Environmental Plan for Sustainable Development was initiated in 1995 as part of the implementation by Niger of Rio Summit commitments. The process was facilitated by the National Environmental Council for Sustainable Development (*CNEDD*) as the focal point of the Convention. *CNEDD* has an executive secretariat which is hosted by the Office of the Prime Minister. The council has set up a Technical Committee for Climate Change and Variability (*CTCVC*) in 1997. This committee is made up of stakeholders from both public and private sectors..

The primary objective of *PNEDD* is to ensure energy security and an integrated management of the various national resources in Niger.

The objectives, results and indicators of *PNEDD* are summarized in table 10 below.

PNEDD's objectives in connection with the promotion of renewable energy and reduction of pressure on biomass fuels are similar to those of NASE, but PNEDD focuses on the use of renewable energy for agricultural production, through small-scale irrigation and dissemination of Multifunctional Platforms to develop income-generating activities in rural areas. In addition to the reduction of food insecurity and poverty, PNEDD is aimed at reducing deforestation due to the expansion of agricultural lands and deforestation. The Plan is therefore one of the major strategic plans developed and implemented by Niger to achieve its development objectives and contribute to the global effort aimed at protecting the environment through the mitigation of greenhouse gases emission.

Table 10: Objectives, results, indicators, current status and projections regarding access to *PNEDD* services

Objectives	Results	Indicators	Current status	Prospects in 2012	Projections for 2105
Access to modern energy services for social sectors	Health	80% of *CSIs* have access to modern energy services	410	981	1 381
	Drinking water (motive power)	20% of *CSIs* have access to modern energy services	501	1 432	7 162
	Education	30% of *CSIs* have access to modern energy services	362	2 823	9 409
Access to modern energy services for the productive sector (agriculture, irrigation schemes)	Irrigation	10% of *CSIs* have access to modern energy services	14 000	27 000	270 000
Access to modern energy services for local communities (rural areas)	Decentralization	80% of *CSIs* have access to modern energy services	10	155	194
Access to modern energy services for income-generating activities in rural areas (motive power)	Fight against poverty	3.5% of *PFM* are created	5	974	13 909
		45% of IGA are initiated	3 520	1 2518	13 909
Access to modern cooking fuels (CMC)	Domestic energy (mineral coal)	20% of rural households and 30% of urban households have access to modern cooking fuels	21 124	524 536	1 029 451
	Domestic energy (Butane)	10% of rural households and 70% of urban households have access to modern cooking fuels	27 659	488 838	1 029 451
Access to electricity	Extension of the electricity grid	0.28% of rural households and 41% of urban households have access to electricity	161 986	249 639 households and 275 towns and villages	852 705 rural households and 353 492 urban households
Strengthening of energy infrastructure	Electricity production	25% of installed capacity produced	50	105	261
Intensification of ICT dissemination in rural and urban areas	Communication	Number of community-based phone centres			
		Number of community-based radio stations			

I.5.4 Ten-year Education Development Program

The objective of Niger Ten-Year Education Development Program (*PDDE*) is to "*promote access and accessibility[to education] to the largest number of children, by improving and diversifying education provision; and by increasing gross enrolment rates from 54% in 2006 to 94% in 2012"*. To achieve this objective, Niger plans to "improve learning environment (in secondary schools) for students, teachers and supervisors". A large-scale electrification program for examination classes of primary and secondary schools in 1,000 villages, using solar energy was launched in 2008. This will increase the number of centers which were electrified through the extension of the electricity grid. This program will cover wide areas without necessarily leading to greenhouse gas emissions.

I.5.5 Healthcare Development Plan

In the health sector, Niger has developed a Healthcare Development Plan (PDS) to "*improve the efficiency and quality of the healthcare for a greater impact on the health conditions of the most vulnerable social groups"*. To achieve this objective, the main strategy is "to improve access to modern energy services with a view to providing better quality healthcare services". This plan resulted in a large-scale program of decentralized healthcare facility construction (Village health posts) which started in 2000, at a rate of 1,000 health posts per year, with a better coverage of the country in terms of health facilities. Village and district reference centers, referred to as Integrated Healthcare Centers (*CSI*), are the main targets for rural electrification using solar energy with the objective of supplying 981 CSI (2012) and 1,381 CSI (2015) with electricity. Integrated Healthcare Centers will be given priority in all villages that will benefit from the extension of electricity grid.

I.5.6 National Transport Strategy and National Communication Plan for Development

Due to the size of the country and its poor infrastructure, the transport sector is a major challenge for the socio-economic development of Niger. A strategic sector-based framework was adopted under Fast Track Development and Poverty Reduction Strategy (DSRP), including the National Transport Strategy (*SNT*) whose objective is "*to contribute to reducing poverty by facilitating access of the poorest to services"* based on a Sector Transport Program (*PST*) aimed at *"improving access to the country, interconnecting existing railways, constructing 2,000 km of railway Benin, Burkina Faso and Togo via Niamey*". The construction of this infrastructure will significantly help to reduce emissions from the energy sector 40.12% of the transport sector emissions are from transport of goods.

In the communication sector, a National Communication Plan for Development (PNCD) was adopted to "*usher Niger into the second global technology revolution, characterized by the combination of computing, telecommunication and audio-visual"*. Also referred to as "*NICI*", this plan is aimed at "im*proving the penetration rates of ICT by increasing the number of community-based phone centres*". To achieve this objective, the main energy source to be used is photovoltaic solar energy. This energy source will also "*increase the coverage rates in community radios and TV*". With some 200 units installed countrywide in these 2 sub-sectors, Niger has chosen clean development, with a large scale use renewable energy, in particular photovoltaic solar energy.

I.5.7 Mining, industries and handicraft

The sectors of mining, industry and handicraft will be the driving forces behind the modernization of the national economy. Thus, according to SDRP, in the mining sector, "*Niger will endeavor to gradually build the capacity for processing local products to consolidate the value added of the 'uranium' cluster"*. Thus at the end of 2007, more than 140 prospecting licences were issued to various international mining companies. The majority of these licences relate to the uranium sub-sector.

Gold and other minerals are also important mining resources for Niger. Thus, according to SDRP, "*the Government will, as a matter of priority, endeavor to improve small-scale mines (gold, tin, salt…) and make them sustainable* [through] p*romotion of artisanal mining (gold washing, salt works, and gypsum) (Upgrading of artisan equipment and tools)"* in addition to industrial development.

Finally, "*Niger has embarked upon the promotion of its oil potential through the diversification of its* *partners"*. Some 10 petroleum prospection licences were issued and the operation of the first refinery with a capacity of 20,000 barrel per day is expected in 2011.

In the rural sector, SDRP will focus on the processing of national production by "s*upporting the establishment of agro-industrial processing units or agricultural product conservation units (canning factories, slaughter houses, dairy industries)"*. Livestock sub-sectors, including meat, hides and skins as well as the cash crops sub-sector (onion and cowpea) in which Niger has comparative advantages (more than 600,000 tons of cowpea produced in 2008) will be especially targeted.

I.5.8 Youth and employment

More than half the population of Niger is under 20, 50% of whom live in rural areas and 40% are educated. Employment is therefore a major challenge and priority for the socio-economic development of the country. This is why the above-mentioned sector policy frameworks are aimed at creating a great number of jobs for both qualified and unqualified labor force. A National Vocational Training Program supported by the creation of several learning centers is being developed. A Ministry in charge of Vocational Training and Youth as well as a Ministry in charge of Integration of Youth have been set up to address this issue. Quantitative annual objectives are presently being reviewed and will be integrated in future strategic plans for the implementation of SDRP.

II GREENHOUSE GASES INVENTORIES

Niger prepared its initial communication in 2000 taking 1990 as a base year. For the Second national communication (SNC), 2000 has been selected as base year. But since that year many reforms have come into effect and have a direct impact on the results of the national communication. Main developments include:

- General census of population and housing (RGP/H) (2001);
- General census of agriculture and livestock (RGAC) (2004-2007);
- Development and adoption of Poverty Reduction Strategy Paper (PRSP) (2000);
- Decentralization with the election of town councilors in 2004;
- Development and adoption of several strategic sector-based frameworks - in particular the Rural Development Strategy (RDS) (2003) - for major sources of emissions in agriculture, forestry, land use and land use change sectors, and the development and adoption of the Strategy on Modern Energy Access (SNASEM) in the energy sector. This latter strategy draws on the white paper of the Economic Community of West African States (ECOWAS);
- Revision of the PRS with the view to convert it into a Fast-track Development and Poverty Reduction Paper (SDRP) (2007);
- Establishment of National Institute of Statistics (2005).

In the Mine and Energy sector, some legal and regulatory documents were also revised, namely the Mining Code, the Oil Code, the Electrical Code, in order to make investments more attractive in these sectors. In addition to the adoption of a new Forest Code in 2004 in the environment sector, the government granted a special status to forestry staff which resulted in the establishment of the Ministry of Environment and Desertification Control in 2006.

For the Second National Communication, the aforementioned reforms contributed to: (i) better national statistics; (ii) building of national capacity and expertise; (iii) appropriate institutional framework; (iv) orientations of policies, in particular more specific policies in agriculture, forestry, land use and land use change and energy sectors.

However, these improvements did not result in a particular methodology of greenhouse gases inventory. Niger used the 1996 IPPC revised manual, including for the selection of emission factors in all the sectors.

II.1 GREENHOUSE GASES EMISSION FOR THE YEAR 2000

The gross emissions of GHG in Niger for 2000 are presented in the table below:

Table 11: Sectoral GHG emissions inventory for 2000

Sector of emissions	CO_2 Emissions (Gg)	CO_2 Sequestration (Gg)	CH_4 Emissions (Gg)	N_2O Emissions (Gg)	NOx Emissions (Gg)	CO Emissions (Gg)	COVNMs (Gg)	SOx Emissions (Gg)
TOTAL	**1 905**	**-16 917**	**330**	**16**	**23**	**677**	**77**	**2 140**
ENERGY	**1 887**	**0**	**35**	**0**	**21**	**614**	**76**	**2 140**
Energy industries	276		35	0	22	613	76	2140
Manufacturing industries and Construction	102		0	0	1	0	0	101
Transport	757		0	0	8	38	7	345
Other sectors	750		35	0	13	575	69	171
Others	2		0	0	0	0	0	0
Industrial processes	**18**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
Mineral products	18		0	0	0	0	0	0
Other products °	0		0	0	0	0	1	0
Agriculture			**286**	**15**	**0**	**10**	**0**	**0**
Enteric fermentation			271					
Manure management			12	0			0	
Rice cultivation			2				0	
Agricultural soils				15			0	
Burning of savannahs			0	0	0	6	0	
Burning of crop residues			0	0	0	4	0	
Land use and forestry	**0**	**-16 917**	**6**	**0**	**2**	**54**	**0**	**0**
Change in biomass stocks	0	-33 922						
Forest and grassland conversion	4 765	0	6	0	2	54		
CO2 emissions and removal from the soils	12 241	0						
Waste			**3**	**1**	**0**	**0**	**0**	**0**
Solid waste			0		0		0	
Waste water			2	1	0	0	0	
International Bunker	**37**		0	0	0	0	0	0
Aviation	37		0	0	0	0	0	0
Biomass emissions	**5590**							

II.1.1 Carbon dioxide emissions for the year 2000

The total carbon dioxide emissions (CO_2) for the year 2000 is **18 911 Gg CO_2.** The distribution per major sectors is as follows:

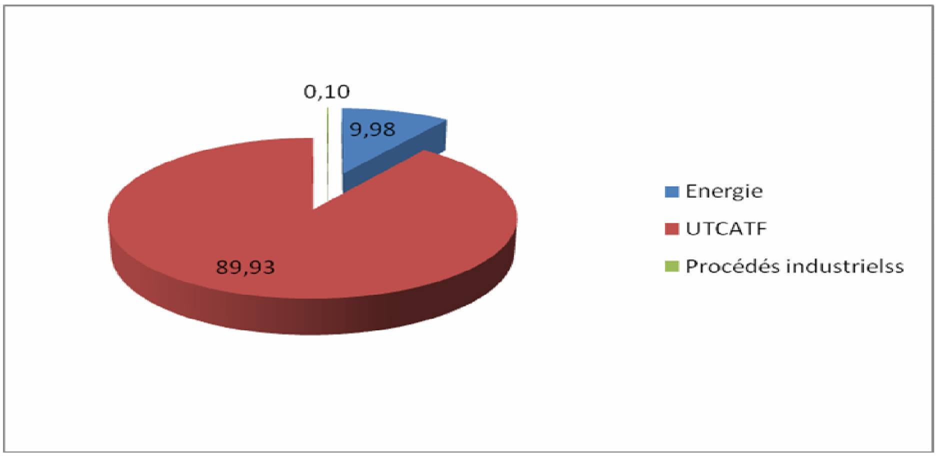

Figure 5: Sectoral distribution of CO_2 per sector

The Land Use, Land Use Change and Forestry (LULUCF) sector is the most significant source of CO_2 emissions (89.93%), followed by the Energy sector (9.98%). Since Niger imports electricity from Nigeria, emissions from energy generation are low in the country. CO_2 emissions from industrial processes are marginal (0.1%).

II.1.2 Methane emissions for the year 2000

Total CH_4 emissions are **Gg 330 Gg CO_2.** Agriculture is the most important source of CH_4 emissions (86.67%), followed by the energy sector (10.61%), the LULUCF sector (1.82%) and finally the waste sector (0.91%). The figure below summarizes the distribution per sector:

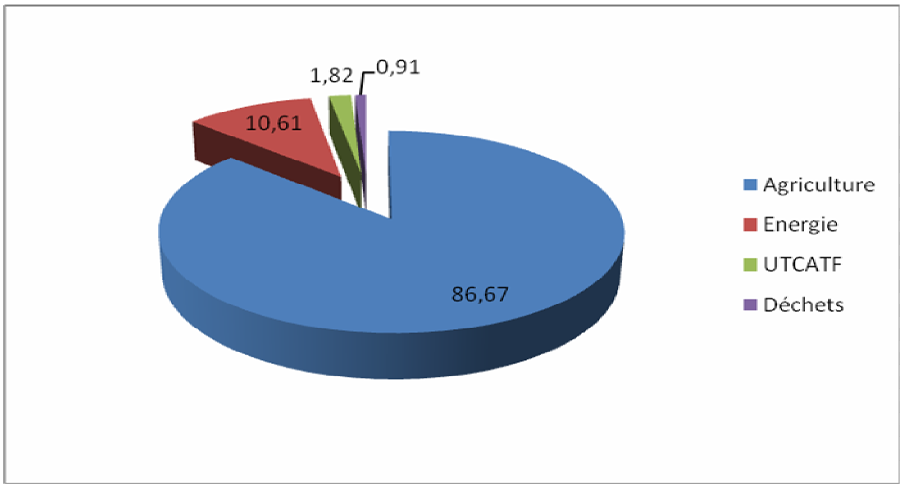

Figure 6: Distribution of CH_4 emissions

The other sectors are not sources of CH_4 emissions.

II.1.3 Nitrogen dioxide emissions for 2000

N_2O emissions are estimated at Gg 16 coming almost exclusively from the agricultural sector with Gg 15 for agricultural soils. The waste sector is also a source of emission (Gg 1).

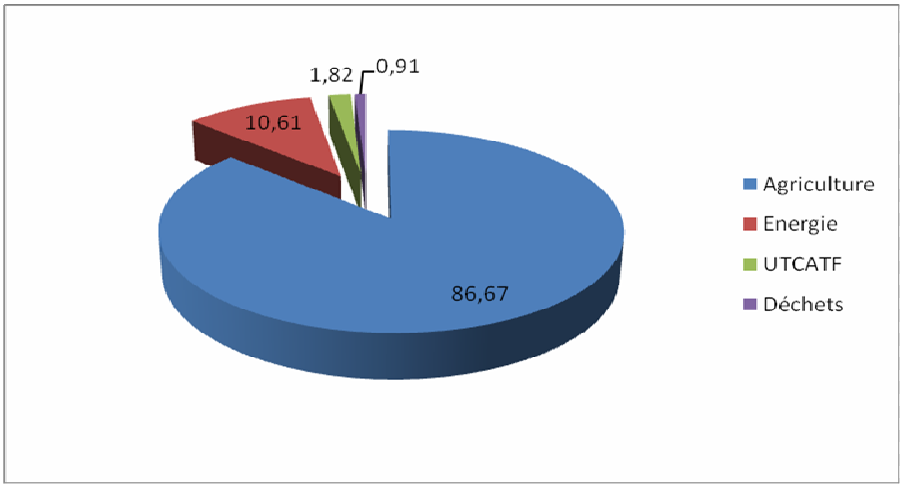

Figure 7: Distribution of N_2O emissions

II.2 EVOLUTION GHG EMISSIONS

Table 12 summarizes the distribution of total GHG emissions per sector:

Table 12: Distribution of total GHG emissions according to the Global Warming Potential (GWP) (eq-CO_2) per sector for the years 1990, 1995 and 2000

	1990		1995		2000	
Sector	**Value (Gg)**	**%**	**Value (Gg)**	**%**	**Value (Gg)**	**%**
Energy	928.47	**10.42**	1 001.20	**5.52**	2 622	**8,51**
Agriculture	1 839.55	**20.64**	1 173.40	**6.47**	10 656	**34,60**
LULUCF	6 106.26	**68.52**	15 552.11	**85.73**	17 132	**55,62**
Industrial processes	9.56	**0.11**	14.44	**0.08**	18	**0,06**
Waste	28.22	**0.32**	399.94	**2.20**	373	**1,21**
Total	**8 912.06**	**100.00**	**18 141.09**	**100.00**	**30 801**	**100,00**

This table shows that, in 2000, the Global Warming Potential (GWP) of emissions in Niger was estimated at **30,801 Gg Eq-CO_2** compared with **8,912 Gg Eq-CO_2** in 1990.

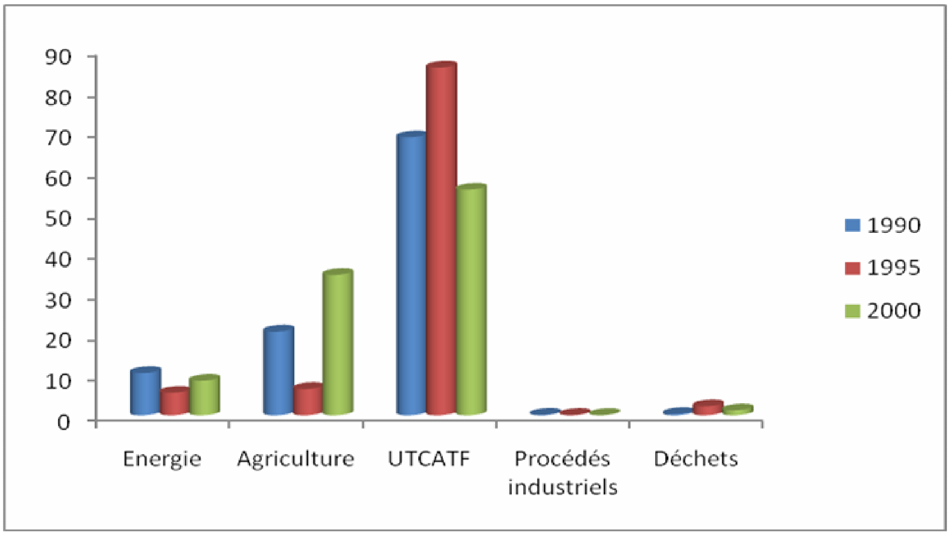

Figure 8: Evolution of total GHG emission for Global Warming Potential (GWP) (eq-CO_2) per sector in 1990, 1995 and 2000

The Agriculture/Livestock sector had the most significant emission in terms of Global Warming

Potential for 2000 with 77.88% of emissions. The Energy sector was the second most important source with 18.35% and the Waste sector (2.57%) came third. Emissions from other sectors are very marginal.

Table 13: Distribution of total GHG emissions based on their Global Warming Potential (GWP) (CO_2 eq.) per gas for the years 1990, 1995 and 2000

	1990		1995		2000	
Gas	**Value (Gg)**	**%**	**Value (Gg)**	**%**	**Value (Gg)**	**%**
CO_2	928.47	**10.46**	1,001.20	**5.65**	18 911	61,40
CH_4 (CO_2 eq.)	1,839.55	**20.73**	1,173.40	**6.62**	6 930	22,50
N_2O (CO_2 eq.)	6,106.26	**68.81**	15,552.11	**87.73**	4960	16,10
Total (CO_2 eq.)	**8,874.28**	**100.00**	**17,726.71**	**100.00**	**30 801**	**100,00**
NO_x	8.00		14.44		22.90	
CO	275.70		399.94		677.41	
COVMN	27.60				77.11	
SO_2	1,566.00				3,139.97	

The table above shows that there is a significant difference in emissions compared to the 1995 revised version of GHG inventory carried out in 2002. This is due to the improved quality of data used for the different national studies (Livestock count, SIE-Niger, etc.).

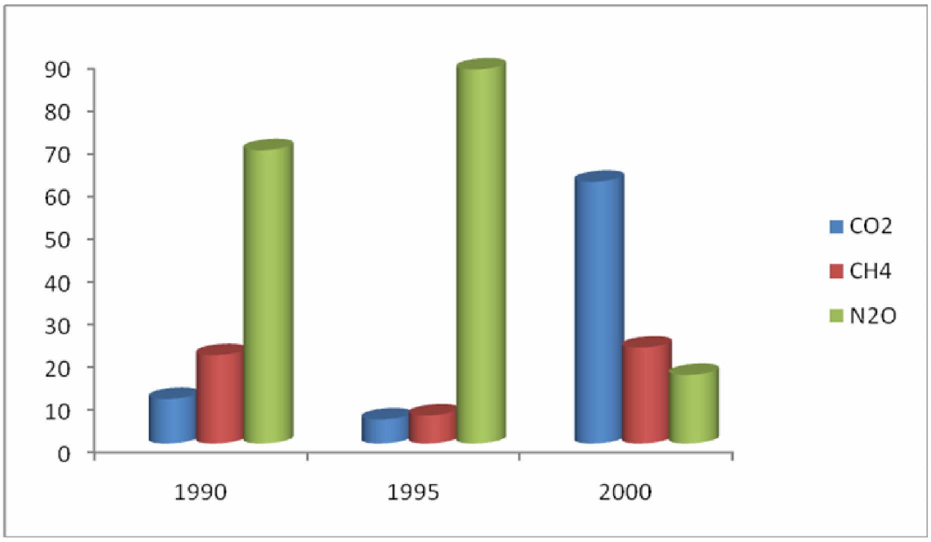

Figure 9: Total emissions based on Global Warming Potential per gas and per year

II.2 SECTORS EMISSIONS

II.1 ENERGY SECTOR

II.3.1.1 Description of sector

II.3.1.1.1 Energy production and transformation in Niger

Primary energy production and transformation sector in Niger can be summarized as follows:

- **Primary energy production**

The mineral coal deposits of Anou-Araren (Agadez) are the only source of power generation used for operating the power plant of SONICHAR. A small part (less than 2,000 tons/year) of this ore is used to produce carbonized coal for cooking. This activity will certainly expand due to the increased demand of domestic energy and power for mining industries. Studies are ongoing for the expansion of the power plant of Tchirozerine (Agadez) and for the development of Sakadalma (Tahoua) reserves with the future construction of a power plant of 200 MW (or 400 MW) in 2012. In addition, the production of about 1,000,000 tons of coal briquettes as a source of domestic energy is planned.

The use of uranium for power generation is not yet planned. Given the intensification of oil and gas exploration at the beginning of 2000, production may start in the coming years.

Biomass energy production was around 3.1 million tons in 2000. It was estimated at 3.7 million tons in 2006, with a yearly growth rate of 3%. Finally, the construction of the Kandadji hydropower was launched in 2008 and it will deliver 130 MW. The hydropower station will be put into service in 2012.

- **Processing of energy resources**

In addition to the mineral coal and lignite mentioned above, secondary petroleum products (mainly diesel and fuel oil) are used for power plants (NIGELEC) and auto-generation. However, the extension of the interconnected grid in the recent years resulted in the significant decrease of the use of these products. The annual production of NIGELEC is 64 GWh whereas, at the end of 2006, it was less than 40 GWh. In 2007, following the extension of the domestic network and strengthening of the interconnected grid, in particular the West line, this production became marginal.

II.3.1.1.2 Import/Export of energy products

Total imports of petroleum products are about 209 ktoe (gasoline, kerosene, petroleum, diesel oil, LPG, lubricants, bitumen, etc.). Electric power imports were estimated at 203.8 GWh in 2000 and Niger does not import any primary energy products nor does it export any energy products. However, given its geographic location (shares borders with Nigeria and uses Cotonou as main port of export), many petroleum products imported by Mali and Burkina Faso transit through Niger. It should also be noted that some retailers of petroleum products (kerosene and gasoline) export to these same country due to the price differences.

II.3.1.1.3 National sector-based policies

Since the beginning of the 2000s, energy policy has focused on rural electrification with the following achievements:

- Development of interconnection of domestic grid with 619 km of 132 kV line, 443.3 km of high voltage line (66 kV),and 1,844.44 km of medium voltage line (33 and 20 kV) in 2005;
- Increase in the number of electrified localities, which rose from 150 in 2000 to 208 in 2006;
- Average rate of household access to electricity which increased from 5.3% in 2000 to 7% in 2005;
- Mining of mineral coal to produce carbonized mineral coal which amounts to 2000 tons per year;
- Increase in the number of solar pumping and power stations in health centers.

These achievements will increase in view of above mentioned good prospects in the energy sector.

II.3.1.1.4 End-user characteristics

Energy consumption per capita was 0.14 metric ton of oil equivalent in 2005 (source SIE). According to the energy audit carried out during the same year, energy consumed at national level is still biomass energy for the largest part (87%). The share of modern energy sources (electricity and hydrocarbons) is only 12%; renewable energies (solar and wind) account for less than 1%, according to SIE.

II.3.1.2 Description of category of sources

II.3.1.2.1. Chemical/manufacturing industries and construction

These industries are distributed as follows:

Table 14: List of chemical/manufacturing industries and construction

	Number		
Types of industries	Total	Closed units	Sample
Steel and wood work	10	2	2
Printing and edition	11	0	1
Chemical and parachemical	12	2	2
Food processing	64	3	9
Building material	7	2	1
Textiles/skin and clothing	5	1	2

Data collected in this sub-sector was related to their power auto-generation and/or heat production.

II.3.1.2.2 Power auto-producers

Independent auto-producers are not included in the classification of industrial units and mining companies/water and power companies. More than 176 generators of 10 kVA have been identified.

II.3.1.2.3 Drinking water supply

In addition to SEEN facilities, some 172 mini drinking water supply (DWS) systems were identified in 2000, including 4 which use mixed sources of energy.

II.3.1.2.4 Energy consumption by the sector agriculture, forestry and fishery

This section deals with energy used for pumping irrigation water, fisheries, cereal processing (grain mill) and ploughing activities. Pumping of water for the animaldrinking is subsumed under DWS.
The irrigation schemes managed by the *Office National des Aménagements Hydroagricoles du Niger* (ONAHA) use the energy generated by NIGELEC. Most schemes use electricity. Other stakeholders involved in the promotion of irrigation include: Nigerien Association for the Promotion of Private Irrigation (*ANPIP*) through its Private Irrigation Promotion Program (PIP) – phases 1 and 2- and the Programs Support to Food Safety by the Small Irrigation *(ASAPI)*. According to estimates from these two entities, some 34,000 small pumps have been installed in the country, including about 25,000 set up in 2000. Moreover, according to statistics from the Commune of Sabon Guida, more than 3,600 pumps have been installed in four villages i.e in the Madaoua Department (Tahoua). A single village (Dabaga) located in the Tabelot Valley (Agadez) has more than 1,000 pumps. Water pumping for irrigation has significantly increased over the past five years.

Concerning cereal processing (grain mill), the grain mill-population ratio is about 1/1,000 according to the Ministry of Agricultural Development. This figure as well as those provided by the Ministry of Energy as part of their electrification policy, made it possible to assess the size of villages and to come up with the following ratios: 1 grain mill for villages with 1,000 to 2, 000 inhabitants; 2 grain mills for villages with 2,000 to 5,000 inhabitants; 3grain mills for villages with 10,000 to 50,000 inhabitants. This makes the total number of mills installed in the country, at 1,859 (including peri-urban areas of major cities).

Regarding ploughing activities, there were officially 212 agricultural tractors in 2000. This figure rose to 700 in 2005.

In the fishery sector, findings from surveys indicate that, in Niger, fishermen mainly use nets and canoes with paddles. Motor boats are mainly used by foreign fishermen who regularly cross the borders. However, this situation does not have any impact on the overall inventory.

II.3.1.2.5 Energy consumption by the transport sector

Categories included in the inventory are related to air transport (both national and international) and land transport. Data on river transport are not available because this sector is quite marginal. The fact that it has not been taken into account does not significantly impact on the overall result.

Data from insurance companies, from the Directory in charge of Government Assets and the National Administrative Garage, made it possible to estimate the number of vehicles, two-wheeled vehicles and special vehicles in Niger. To avoid double counting, emphasis was laid on vehicles and machines insured by private insurance companies.

Most of the vehicles, at national level, are registered in these companies except those that are insured by the legal units of the Government as well as those belonging to the military and the Presidency. It was not possible to obtain detailed information on this last category due to their confidential nature.

These vehicles were classified by size, use and engine power output. Specific consumption was recorded based on statistics from the *Center of Training in Techniques of Road Transport (CFTTR)* and from a study conducted by the World Bank in 1999.

II.3.1.2.6 Energy consumption by the residential sector

The residential sector includes household energy consumption. Energy products used in this sector are the following:

- Biomass fuel for cooking in urban and rural areas;
- Kerosene for lighting in rural and peri-urban areas, and for cooking in urban areas;
- Gas and LPG;
- Mineral coal;
- Carbonized coal.

II.3.1.2.7 Energy consumption by the trade and institutional sector

Petroleum products and electricity are predominant in energy consumption in this sector which includes:

- Public administration;
- Insurance companies;
- Hotels and touristic facilities (airports, restaurants and similar businesses);
- Garages and street petty trade (vulcanizers, etc.);
- Food shops and supply and distribution centers for food products;
- Shops and modern central markets; etc.

To assess their hydrocarbon consumption, production processes (hot water and utility) were identified as well as power generation for specific purposes that have not been taken into consideration in the auto-producer group. Energy consumption for the transport of goods and handling has been included in the transport sector.

II.3.1.2.8 Other sectors (mining industry)

The mining sector includes four major industrial units: (i) two uranium mining companies, COMINAK (with an underground mine) and SOMAIR (in an opencast mine); (ii) SONICHAR which produces mineral coal in an opencast mine and (ii) *Société des Mines du Liptako* for gold mining (opencast mine). In this subsector, the main sources of emission include power production, heat generation, transport and handling of ore.

It is only the latter activity (handling of ore) that has been taken into consideration in this sector. The others activities are under “auto-producers”, “Energy Industries” for power and heat generation, and under “Transport” for commercial and company staff transport.

II.3.1.3 Methodology

In the energy sector, emphasis was laid on the availability of aggregated of data (maximum data available from one source).

This approach made it possible to identify Niger Energy Information System (SIE) as the main source of information. Later on, (i) additional data was collected; (ii) conversion and emission factors were selected; (iii) disaggregated data of end-users was estimated and finally; (iv) emission for the base year and time series were calculated.

II.3.1.3.1 Selection of conversion factors

In most cases, available data is expressed in physical units (in cubic meter for liquids and in tons for solid and gaseous products).

For the purposes of the software used, conversion factors of all products expressed in tons were taken from official documents of the Ministry of Mines and Energy.

These factors depend on the density of products. Thus, the Decrees No 090, 091, 092, 093, 094 and 0095/MME/MDI/C/A/T/MF/P, dated November 22nd, 1998, determine the specifications of petroleum products sold in Niger as follows:

Table 15: Characteristics of petroleum products in Niger

	Quantity				
Petroleum products	**Density (kg/cubic meter)**	**Total sulphur content (%) (m/m) max**	**Ash content (%) (m/m) max**	**Sediments content (%) (m/m) max**	**Conradson carbon (%) (m/m) max**
Fuel No 1	930 to 995	3.5	0.12	0.25	-
Regular gas	720 to 765	$\leq$ 0.25	-	-	-
Fuel No 2	995	4	0.12	0.25	15
Super	740 to 770	0.25	-	-	-
Kerosene	840	0.15	-	-	-
Gas oil	820 to 880	$\leq$ 1	0.01	0.01	0.15
Lignite	-	-	-	-	-

Source: Ministry of Mine and Energy

Average densities were used for conversions whereas sulphur contents are used for SO_2.estimates. Corresponding conversion factors expressed in energy units are as follows:

Table 16: Default conversion factors

Products (tons)	**Conversion factors (TJ/10^3t)**
Gasoline	44.8
Diesel oil	43.33
Jet kerosene	44.59
Kerosene	44.75
Fuel oil	40.19
Lubricants	40.19
LPG	47.31
Avgas	44.8
Bitumen	40.19
Lignite	15.49
Biomass	18.84

Source: Manuel IPCC, 1996 revised version

II.3.1.3.2 Selection of emission factors

Additional surveys indicate that in Niger industries neither measure pollution nor analyze gas emissions.

Only mining companies analyze products of lixiviation processes when processing uranate ore.

Default emission factors were therefore selected as follows:

Table 17: Default emissions factors

Type of fuel	Emission factors tC/TJ	Carbone stored	Oxydized fraction of carbon
Gasoline	18.9	0	0,99
Kerosene	19.5	//	//
Kerosene oil	19.6	//	//
Diesel oil	20.2	//	//
Fuel oil	21.1	//	//
LPG	17.2	//	//
Lubricants	20.0	0.5	//
Bitumen	22.0	1	//
Lignite	27.6	0	0.98
Solid biomass	29.9	//	0.90

Source: IPCC, 1996 revised version

II.3.1.3.3 Selection of approach for calculating greenhouse gas emissions

To estimate emissions, two approaches were recommended in the IPCC manual: (i) the reference approach and (ii) the sectoral approach.

II.3.1.3.3.1 Reference approach (source: 1996 IPCC revised manual)

The reference approach selected has led to the calculation of apparent consumption as follows:

$Ca = P + I - E - SC - IMB$ where:

- Ca: Apparent Consumption:
- P: Production of primary fuels
- I: Imports of energy products
- E: Exports of energy products
- SC: change in stocks of energy products = stock at the end of the year minus stock at the beginning of the year. SIE was using the opposite formula which is also correct but was not in line with the formula used in the IPCC approach.
- IMB: in the case of Niger, international bunkers refer to fuels used by international aviation. Data on consumption of interstate river navigation exists but they are not available. Since this activity is marginal, consumption is deemed marginal.

This method was used to estimate emissions for 2000. However, as data has not been appropriately disaggregated, it has been possible to estimate CO_2 emissions (table 18).

Table 18: CO_2 (Gg) for the year 2000, based on the reference approach

	2000
Fossil fuels	756.30
Solid biomass	5,590

II.3.1.3.3.2 Completeness of data from SIE and primary sources

Processing of SIE-Niger has made it possible to carry out an audit of mass energy for 2000. Based on these data, it is possible to make a rather reliable estimate of mineral coal production as well as a good disaggregation of energy industries (NIGELEC, SONICHAR) for the power subsector, except for water utilities and SONIDEP.

However, official imports of petroleum products, self-consumption of petroleum products and electricity as well as heat production processes are not documented. Data on two auto-producers

(SOMAÏR and COMINAK) exist but do not provide this information either. Regarding missing data, they are related to the following areas:

- Variety of stock (lubricants, bitumen, fuels, avgas, etc.);
- Data on auto-producers (number, quantity and quality of data as well as fuel use);
- Disaggregated end-users estimates for all sectors;
- Data on air transport (both national and international, landing, taking off);
- Characteristics of energy products;
- Anti-pollution measures;
- Productivity of forests and supply of energy biomass;
- Consumption by agriculture/forestry/fishery and trade/institutional sectors; etc.

II.3.1.3.4 Analysis of data quality

Data on coal production are provided and reliable as they have been taken from SONICHAR activity report, and compared to those collected as part of the Second National Communication Project. It is a time series covering more than twenty years. All information, particularly the data related to terminology used, is available provided they have been processed.

The same applies to data on power generated by major companies such as NIGELEC, SONICHAR, COMINAK and SOMAÏR. However, data on imports of hydrocarbons (from SONIDEP, GPP and customs in particular) makes little or no mention of fuel smuggling which GPP estimates at 25%.

This figure is confirmed by SIE-Niger. However, additional data collected indicates that this figure does not reflect the situation on the ground, and using these data to calculate the apparent consumption would lead to an under-estimation of the supply of this commodity.

Moreover, insufficient disaggregation of end-users data from official sources has not made it possible to obtain any details on sub-sectors selected in the software. Therefore, the quality of data available does not help complete the inventory.

Indeed, not only total CO_2 emission would be under-estimated but the estimate of other gases would be impossible. This is the reason why preference was given to the sector-based approach through consumption estimates based on documented reference. This resulted in additional data collection.

II.3.1.3.5 Sector-based approach (IPCC 1996 revised version)

It is based on country energy balance. The energy balance model has been adapted to take into account the requirements of the software, particularly by featuring the above mentioned information as well as the following fuels categories:

1. Production of primary fuels

Production of primary fuels are classify under this heading. These include:

- Solid biomass fuels (energy wood, agricultural residues and animal waste) used only in the residential sector. Statistics from the Direction of Animal Resources indicate that 35% of agricultural and animal wastes are used for non energetic uses such as animal feed otherwise they are destroyed by termites/fires, or converted into fertilizer, etc. Out of the remaining 65%, 1% is actually used as fuel, mainly for cooking in rural and peri-urban areas.
- Solid fossil fuels (coal) selected, such as lignite for its calorific value (3650 kcal/kg) as well as its byproducts (briquettes) used in the residential sector.

2. Imports

All imported fuels consist of hydrocarbons for the largest part. These include:

- Liquid fossil fuels, mainly secondary petroleum products such as gasoline (super and regular gas) or natural gasoline; kerosene considered as aviation fuel or Jet A1; diesel oil; kerosene i.e designated as “other kerosene”; residential fuel; aviation gasoline (small planes) which is under “avgas” and lubricants. These various products are used in almost all the energy subsectors;
- Gaseous secondary fossil fuels such as LPG;
- Solid fossil fuels such as bitumen.

3. Conversion (energy industries)

Conversion of primary or secondary energy sources into secondary and utility fuels has been taken into account. In Niger, this applies to conversions of secondary fuels into electricity by:

- Industries generating power for commercial purposes mainly NIGELEC and SONICHAR as well as companies that sell energy products (SONIDEP) and water utilities (SEEN, mini thermal DWSs).
- Power auto-producers that is any entity with power generator. These mainly include two mining companies (COMINAK and SOMAÏR) and a group of industrial structures, projects, companies and private entities. However, there has been an adjustment so as to take into account power and heat generation. Harmonization with data on Manufacturing Industries and Construction Sector by the software was meant to avoid double counting. For these groups, average specific consumption used as reference is that of NIGELEC, that is 250 g/kWh. It is also assumed that most of these generators function in case where there is a power cut in the distribution system. The average rate of availability of electrical power in the NIGELEC distribution system, that is 98%, is considered as a reference. The outage time is estimated at 2% a day that is an average annual operating time of 07 days for each generator. Cross-checking with the list of generators sold by the largest supplier in Niger (*Manutention Africaine*) from 2000 to 2005, made it possible to estimate the number of generators which are operational.
- Regarding thermal DWS, a sample made up of three regions (Maradi, Tahoua and Dosso, which are the most representative in terms of population and socioeconomic make-up). The findings can be summarized as follows:
    - Consumption from mixed sources (power from the grid and auto production) is marginal due their small number;
    - Proportion of installed power in these three regions is extrapolated from the national level;
    - Generator annual downtime is 2 weeks for maintenance and repair;
    - Average pumping time is 4 hours a day (2 hours in the morning and 2 hours in the evening) to fill the reservoirs, based on the daily consumption of households;
    - Fuel used is gas-oil;
    - Specific consumption is 0.25 l/h.

The table below summarizes estimates of gas-oil consumption in this subsector which is part of the "energy industries and water" sector

Table 19: Estimates of thermal DWS gas-oil consumption

Installed power (KW)	Number of units surveyed	%	Total number (units)	Consumption (cubic meters)
2.40	2.00	0.03	6	4.63
4.40	33.00	0.54	91	139.96
5.00	1.00	0.02	3	4.82
8.00	1.00	0.02	3	7.71
9.60	12.00	0.20	33	111.05
10.00	2.00	0.03	6	19.28
12.00	7.00	0.11	19	80.97
20.00	1.00	0.02	3	19.28
24.00	2.00	0.03	6	46.27
TOTAL	**61**	**1.00**	**168**	**433.96**

4. Manufacturing industries and construction

Data from these industries is available with petroleum products suppliers and through the distribution of these sources. Data processed by SIE-Niger is presented unchanged.

5. Uranium, coal and uranium mining industries

These are industrial units of COMINAK, SOMAIR, SONICHAR and Liptako Mining Society (SML). In this section, the consumption that is referred to does not include energy fuel consumption of power and heat generation as well as passengers and goods transport.

These are fuels for special machines used for mine production and are not processed by the software. They were classified under "other sectors" according to the classification by the software.

6. Agriculture/forestry and fishery sector

For this sector, emphasis is essentially laid on combustions from water pumping and processing of agricultural products (grain mills).

Consumption of agricultural tractors i.e. related to mobile sources, was estimated. Consumption was calculated on the following bases:

- For irrigation pumping:
  - Fuel used is gasoline,
  - Pumps are used during the dry season for 100 days on average, corresponding to three months of the off-season planting;
  - Water is pumped every two days, i.e. 50 days of effective use;
  - On average, four hours of pumping/day for a specific consumption of 20 liters per day.
- For grain mills:
  - Fuel used is gas-oil,
  - Specific consumption is 20 l/day,
  - Annual operation is 350 days and 15 days of maintenance and repair,
  - Daily operation is 4 hours on average.

The Ministry of Agriculture estimates the consumption by agricultural tractors at 0.67 liters per hour. It is assumed that, each year, a tractor is operated for three months on average and this corresponds to the length of the rainy season.

The daily consumption can be estimated at 7 liters/day based on an average of 4 days and 6 hours /day.

7. Transport subsector

The table below gives details on categories and average distance covered annually:

Table 20: Distribution of car fleet by category and specific consumption

Category	Number	Average annual distance (km)	Consumption/ 100 (litre)	Gasoline (cubic meter)	Gas-oil (cubic meter)
Motorcycle	13,680	10,000	2	2,736	0
Pers. vehic.	62,080	13,000	11	88,774	0
Taxi	2,841	89,100	10	25,313	0
Pick-up	22,518	27,000	12	0	72,958
Truck	7,995	14,000	31	0	34,698
Tractor	4,647	20,000	47	0	43,682
Trailer	3,400	2,000	0	0	0
Bus	4,535	9,000	31	0	12,653
Agr. tractors	212			0	0
Total	121, 908			116,824	163,991

Source: CFTTR and World Bank

For the air transport, official statistics from the National Institute of Statistics (INS) were used to estimate national and international air traffic.

For the purpose of classifying aircraft and estimate their specific consumption, ASECNA and the Civil Aviation Direction were surveyed to collect additional information but these were not available.

Consumption of international bunkers was distributed according to the number of flights. Information for characterizing the types of aircrafts and their specific consumption were collected at the Direction of Civil Aviation.

8. Commercial and institutional sector

This sector is made up of public administration, hotels, insurance companies and commercial establishments.

Only data on power and heat auto production was taken into account in order to avoid double counting with the sectors of industries, transport and auto production.

9. Residential sector

According to consumption surveys conducted by SIE-Niger (*Energie II-Energie Domestique* 1993 and 1995, PREDAS 2004) the fuel wood specific consumption stands at 0.6 kg/person/day in urban areas and 0.8 kg/person/day in rural areas,).

For lighting, consumption of kerosene in rural areas is 0.05 litre/person/day while the ratio for cooking is 0.15 litre/person et per day, respectively according to *"l'Etude de marché potentiel pour les applications photovoltaïques en zones rurales ou périurbaines"* by Krüger-Consult in 1991 and "*l'Enquête consommation énergie domestique"* by *Energie II-Energie Domestique* (1995, Isabelle Zotow).

10. Data on sector-based method for the base year 2000

There significant gaps (for three fuels) between official statistics, including estimates of smuggling (25 %) and estimates provided as part of this inventory using a scientifically sound methodology:

- Gasoline, with a gap of about 82.1% between the estimate and the official figure;
- Kerosene, a gap of more than de 2000%;
- Diesel oil, a gap of about 230%.

These gaps show how difficult it is to monitor the sectors as well as the quality of data from official sources.

Table 21 (on the following page) presents disaggregated consumption per sector (thousand of tons) for the base year (2000).

Table 21: Summary of disaggregated consumptions (thousand of tons) per sector, in 2000

	Sources									
Fuel	Energy ind.	Manuf. & Const.	Mine	Com & Inst	Transport	Resid.	Agr. Fish.	**Total**	**Official import.**	**Gap**
Gasoline	0	0	0	0	88.2	0	2.95	**91.15**	**50.06**	**41.9**
Jet Aviation	0	0	0	0	15.23	0	0	**15.23**	**15.23**	**0**
Jet kerosene	0	0	0	0	0.156	0	0	**0.156**	**0.156**	**0**
Crude oil	0	0	0	0	0	220.1	0	**220.1**	**9.99**	**210.11**
Diesel oil	16.87	25.15	0.56	0.37	149.42	0	9.73	**202.1**	**61.60**	**140.6**
Fuel	0.86	7.26	0	0	0	0	0	**8.12**	**8.12**	**0**
LPG	0	0	0	0	0	0.65	0	**0.65**	**0.65**	**0**
Lubricants	0.133	0	0	0	0	0	0	**0.133**	**0.133**	**0**
Bitumen	0	0	0	0	0	0	0	**0.124**	**0.124**	**0**
Lignite	142.8	0	0	0	0	0	0	**142.8**	**142.8**	**0**
Briquette	0	0	0	0	0	0.13	0	**0.13**	**0.13**	**0**
Wood & residues	0	0	0	0	0	3024	0	**3024**	**3024**	**0**
Animal wastes	0	0	0	0	0	45.78	0	**45.78**	**45.78**	**0**

II.3.1.4 Estimate of GHG emission using the sector-based approach

Emissions from the energy sector are summarized below using the sector-based approach:

Table 22: GHG emissions for the year 2000 using the sector-based approach

	Gases						
Fuels	**CO_2**	**CH_4**	**N_2O**	**NO_x**	**CO**	**CVONM**	**SO_2**
Energy industries	275.85						1522.99
Manufacturing industries and construction	102.26						101.05
Transport	762.39						345.25
Commercial/ institutional	1.18						170.67
Residential	702.71						
Agriculture, fishing and fish farming	45.78						
Others (mines)	1.78						
Total	**1875.39**	**34.73**	**0.48**	**21.10**	**613.54**	**76.31**	**2139.96**
Biomass	**5590.09**						
International bunkers	**37.40**						
Total CO_2 equiv. emission	**1875.39**	**729.33**	**148.8**	**-**	**-**	**-**	**-**

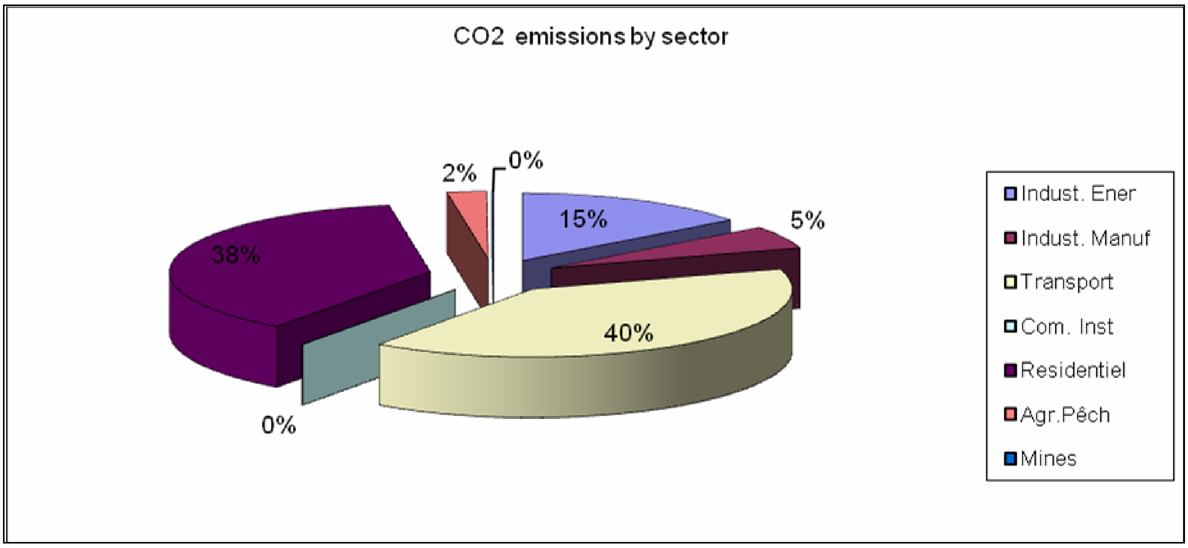

Figure 10: Share of CO_2 emissions per sector

The figure above shows that the transport sector is the most significant source of CO_2 emissions with 40% followed by the residential sector (38%) and the energy industries (15%). In terms of total CO_2 equivalent, total emission stand at 2,765.04 and are distributed by type of gas (CO_2, CH_4 and N_2O) as shown in figure 9 below:

Figure 11: Distribution of emissions per gas

II.3.2 AGRICULTURE SECTOR

II.3.2.1 Description

The agriculture sector includes pastoral and farming activities. Three main livestock production systems exist in Niger. These include:

- pastoral production: as part of pastureland management. Pastoralists move over long distances, from one region to another or from one country to another (transhumance);
- agro-pastoral production: this system is used in the intermediate zone where farming is the main activity of the agro-pastoralists, and cattle breeding makes up their secondary activity. It integrates the urban and peri-urban farming systems which involves supplementary feeding;
- intensive production: in this system, animals are confined and generally used for meat production. This type of cattle farming is called fattening: animals raised in pastureland are given high nutritive feed over a long period of time, which enable them to quickly put on weight, just before being slaughtered.

Crop production is extensive; it is poorly mechanized and uses little inputs. Heavily dependent on rainfall and on irrigated crops grown mainly along the Niger River banks, agriculture is dominated by small family farm. Cereals are the main crop and staple food as they represent 80 to 90% of caloric intake of the population in the country. In addition to cereal crops (millet, sorghum, maize, and so on), there are tubers (cassava, sweet potatoes and potatoes), cash crops (groundnut, cotton, tiger nut, sugar cane and tobacco) and finally vegetable crops (onion, tomato, hot pepper and pepper). Land areas used for cereal production have not changed much over time and represent more than 80% of the total surface areas devoted to these types of crop. As regards cash crops, land areas used for cowpea production are progressively approaching those used for millet and sorghum. This shows the importance of this crop for the population.

II.3.2.2 Description of categories of sources

II.3.2.2.1 Enteric fermentation

Methane emissions (CH_4) from cattle enteric fermentation occurs during the normal digestion process. The quantity of methane gas from enteric fermentation is much higher than that of N_2O from manure management. This is the second most significant source of emission after manure management.

II.3.2.2. 2 Manure management

Methane emissions from manure management are due to animal waste decomposition. In Niger, the predominance of extensive cattle breeding greatly contributes to emissions of large quantities of methane gas produced under anaerobic conditions. Therefore, manure management is a source of nitrous oxide emission (N_2O). Based on N_2O high conversion rate in CO_2 equivalent, manure management is the main source of emission in the subsector of agriculture in general and in particular in the livestock component.

II.3.2.2. 3 On-site burning of crop residues

Crop residues are increasingly used by producers for other purposes (cattle feeding, fuels, etc.) and are therefore collected after harvesting. Hence, burning of crop residues is not very common in Niger. This activity is a source of N_2O, NO_x and CO emissions even if the quantities burnt on-site are not very significant.

II.3.2.2.4 Agricultural soils

In Niger, soils are generally poor in minerals and organic matter. From the agro-geological perspective, soils are categorized as follows: (i) gross mineral soils; (ii) little mature soils; (iii) sub-arid soils; (iv) ferruginous tropical/sandy soils; (v) hydromorphic soils and (vi) vertisols.

There are very few hydromorphic soils and vertisols (categorized as organic soils) which can directly produce N_2O.

When used, agricultural soils may produce or absorb nitrous oxide, carbon dioxide and/or methane. The main emissions are nitrous oxide (N_2O) and include: (i) direct emissions from agricultural soils; (ii) emissions from animal production and (iii) emission linked to the use of inorganic fertilizers in agriculture.

Cultivated areas are the main source of nitrous oxide emission (N_2O). Annual quantities produced vary from one year to another and are quite low. This variation is attributable to the annual variations in the amounts of inorganic fertilizer used, and to the production of grain legumes and other rain-fed crops. As the land areas covered by organic soils are marginal, their contribution is very marginal.

II.3.2.2.5 Rice cultivation

Anaerobic decomposition of organic matter in flooded rice fields produce methane. The quantity produced depends on various factors: rice varieties, number and duration of harvests, type of soils, temperature, irrigation practice and use of fertilizers.

II.3.2.3 Methodology

The inventory methodology used is from the 1996 revised version of the IPCC/OECD/IEA inventory guidelines.

II.3.2.3.1 Enteric fermentation

Table 23 below presents the number of animals in 2000.

Table 23: Number of animals for 2000

	2000
Dairy cows	510 908
Cattle for meat	2 895 151
Sheep	6 625 903
Goats	8 559 434
Camels	1 082 063
Horses	625 353
Mules and donkeys	327 860
Pigs	10 721
Poultry	20 818 000

Sources: National Institut of Statistics (INS) for pigs and poultry, and Direction of Livelihood Staistics and Aminal Products Direction (DSE/PA).

Level 1 method was used in the absence of disaggregated data on animal population and on specific emission factors. To estimate emissions, a distinction was made between dairy and meat cows since the former represent 15% of the total number of cattle head, according to the Ministry in charge of Animal Resources.

II.3.2.3.2 Manure management

- **Methane emission**

Manure management represents the most important source of methane emissions in the agricultural sector. The evolution of emission values of time series correlates with the evolution of the cattle population. Therefore, uncertainties still linger as in the case of CH_4 emissions from enteric fermentation.

- **Nitrous oxide emission**

Nitrous oxide emissions from manure management are almost inexistent since extensive cattle breeding is dominant in Niger. Emission of this gas is more significant in intensive breeding. The cattle population used for the estimate is the same used for enteric fermentation.

II.3.2.3.3. Agricultural soils

Table 24 shows land area devoted to the agricultural production. It includes only areas sown each year with millet, sorghum, maize and groundnut.

Table 24 : land areas under rain-fed crop production (hectares)

Crop	**2000**
Millet	5 151 395
Sorghum	2 144 393
Maize	6 149
Cowpea	3 846 277
Groundnut	360 338
Cereals	7 301 937
Legumes	4 206 615
Rain-fed crops	11 508 552

Source: 2005 Report, DCV/MDA

The table below presents data on fertilizer use.

Table 25: Quantity of fertilizers, production of grain legumes and other rain-fed crops, and areas of organic soils under cultivation

Types of N input to soils	2000
Total quantity of fertilizers in the country (kg of N/year)	2 521 900
Grain legumes produced in the country (kg/year)	594 683 000
Productions of other rain-fed crops (kg/year)	2 119 793 000
Areas of cultivated organic soils (ha)	-

Sources: 2004/2005 annual reports of DCV and *Direction des Cultures de Rentes (DCR)* and *Centrale d'Approvisionnement 2006* of MDA.

The following observations were made:

- the total quantity of fertilizers used in the country (kg of N/year) is equal to the total nitrogen content in the total quantity of the various types of fertilizers used each year. These include: urea with 46% of nitrogen for 100 kg of urea, 15-15-15 with 15% of nitrogen, DAP with 18% of nitrogen;
- the quantity of grain legumes produced in the country (kg/year) refers to the total production of the following crops: cowpea, groundnut, sesame, onion, pepper, garlic;
- Rain-fed crops (kg/year) include: millet, sorghum, rice, maize and bambara groundnut.

II.3.2.3.4 Rice cultivation

In 2000, CH_4 emission from rice cultivation was estimated based on data on large-scale irrigation scheme and areas under rain-fed rice, contained in the *ONAHA* 2005 Report.

Only data on land areas under irrigated rice production has been considered. This area amounted to 12,118 hectares in 2000. Water management regime considered for the two types of rice production are the permanent flooding for large-scale irrigation scheme and the rain flood for rain-fed rice respectively.

II.3.2.4 Evolution of emissions for the years 1990, 1995 and 2000

The table below shows the distribution of emission source for the years 1990, 1995 and 2000.

Table 26: Distribution of total GHG emissions (Gg Eq-CO_2) per subsector for the years 1990, 1995 and 2000

	1990 (Gg CO_2)		1995 (Gg CO_2)		2000 (Gg CO_2)	
Source	**Values (Gg)**	**%**	**Values (Gg)**	**%**	**Values (Gg)**	**%**
Enteric fermentation	8.44	0.45	5.86	0.5	5694.57	53.41
Manure management					245.7	2.30
Rice cultivation	282.33	15.34	139.16	11.96	51,45	0.48
Agricultural soils	1458.92	79.3	1010.9	86.9	4662.4	43.27
Prescribed burning of savannah	81.53	4.43	6.33	6.33	5.04	0.05
Field burning of residues	8.32	4.52	1	0.99	3.57	0.03
Total	**1839.54**	**100**	**1163.25**	**100**	**10662.73**	**100**

In 2000 (base year), for the agriculture/livestock sector, the two main sources of emissions are cattle enteric fermentation and agricultural soils, with 53.41% and 43.27% respectively.

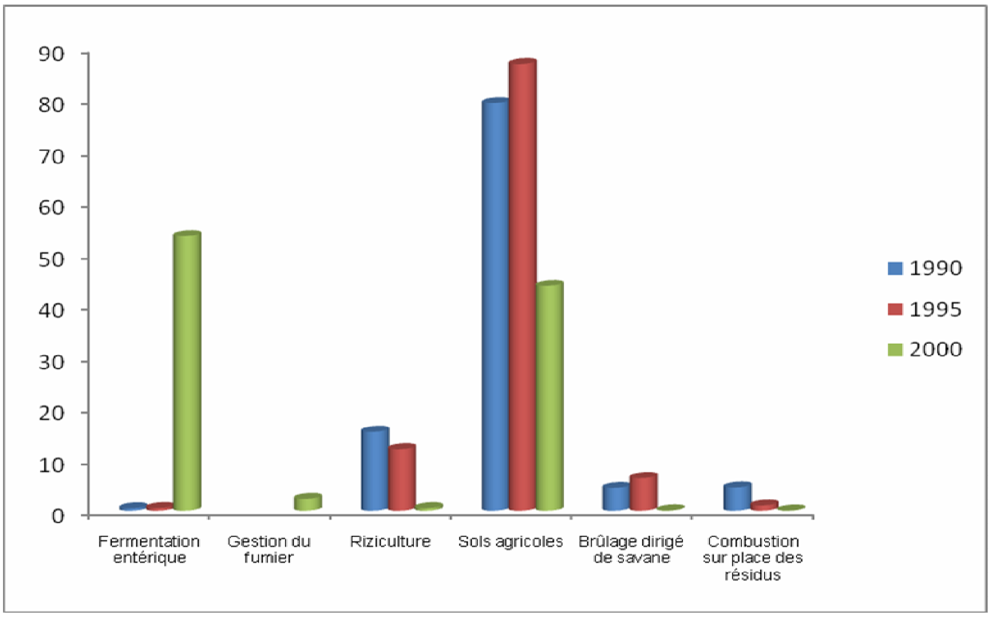

Figure 12: Evolution of total GHG emissions per sector for 1990, 1995 and 2000

Organic soils are not sources of gas emissions as the areas they occupy are marginal. Regarding prescribed burning of savannah and field burning of agricultural residues, emissions do not vary much from one year to another and are low. This small variation may be linked to the fact, on the one hand, that these activities are decreasing because farmers are increasingly using harvested agricultural residues as domestic fuel and, on the other, these residues are not taken into account.

II.3.3 LAND USE, LAND USE CHANGE AND FORESTRY SECTOR

II.3.3.1 Description

The main land use changes and their management systems consist of the following category of sources: (i) evolution of forested area and other stocks of forest biomass; (ii) conversion of forests and pasturelands; (iii) abandonment of cultivated land; and (iv) agricultural soils.

Forest resources of Niger are not well documented because of a lack of comprehensive inventory. However, many estimates were made by the following organizations: *Club du sahel* (1981; 16,096,000 million hectares), PUSF (1989; 14,196,400 ha), FAO (1990; 10.5 million ha), Catinot (1991; 13 million ha), etc. According to the PUSF, these 14,196,400 hectares of forest lands, namely lands where forest or sylvo-pastoral natural resources could be exploited. During these last past decades, forest formations have undergone severe large-scale degradation due to climatic and human factors. There is little information on the productivity of natural forests formations. The table below presents a summary of some research results.

Regarding reforestation, communities were gradually involved in this activity first as salaried labor, then as mobilized stakeholders and finally as partners within the framework of a comprehensive, integrated and participatory approach. After the droughts in the 1970s, major reforestation programs were implemented in order to reverse the trend towards environment degradation. Land clearing for agricultural purposes is a major utilization of forest resources. In fact, land pressure due to population growth resulted in extensive clearing of land to expand cultivated areas, cultivation of marginal land, and shorter or no fallow period.

Table 27: Forest productivity calculated by various institutions

Productivity	Sources	Comments
0.5 stere/ ha/ year*	INRAN (DRF), 1970	Figure provided by the *Centre technique forestier tropical*, following trials carried out to determine the productivity of forests ranging from dry woodland to combretaceae, in Niamey area.
0.34 stere/ ha/ year*	Hopkins C, 1992, PUSF framework	Figure from the monitoring of Guesselbodi forest, which was quite deteriorated at the time of the estimate. Moreover, this estimate was made only on one hectare.
2 to 4 stere/ ha/ year*	*Projet Energie II*, in collaboration with ORSTOM 1995	This productivity was calculated within a combretaceae formation (striped and spotted bush) in the Say area, in 1995. It was calculated for the purpose of monitoring of stand regeneration capacity, in a forest area, which has been under exploitation only recently and which was therefore not very deteriorated at that time.
1.47 stere/ ha/ year**	PAFN and INRAN, 2006	Productivity calculated for linear bush (all facies)
1.127 stere/ ha/ year**	PAFN in collaboration with INRAN, 2006	Productivity calculated for mixed bush (all facies)
1.588 stere/ ha/ year**	PAFN in collaboration with INRAN, 2006	Productivity assessed for diffuse formations in the form of woody savannah
1.128 stere/ ha/ year**	PAFN in collaboration with INRAN, 2006	Productivity calculated for diffuse formations in the form of shrub savannah
1.044 stere/ ha/ year**	PAFN and INRAN, 2006	Productivity calculated for all plateau contracted forest formations.

Source: * *Inventaire national des gaz à effet de serre, 2000* ; ** *rapport de consolidation des acquis et des résultats des recherches d'accompagnement du Projet d'Aménagement des Forêts Naturelles (PAFN), 2006.*

II.3.3.2 Description of categories of sources

II.3.3.2.1 Evolution of forested areas and other biomass stocks

Since the stock of forested areas is affected by human activities, sources of carbon uptake and emission are: natural forest formations, non-forest trees and block plantations. Since 1990, a progressive decrease of forest heritage has been observed. Yet, this stock is a source of CO_2 uptake and removal. Ongoing reforestation efforts contribute to increasing gas sequestering potential at national level. Vegetation grows back when cultivated lands are abandoned. These also represent a rather significant source of carbon dioxide emission uptake, especially for fallow periods which are becoming shorter and shorter because lands are in great demand. Long term fallows are rare.

- **Natural formations**

Depending on stand density, natural forest formations were divided into two categories: (i) contracted forest formations of plateaus (manageable formations), representing 31% of potential with good productivity (1.044 stere/ha/year) and (ii) deteriorated forest formations with low productivity (0.5 stere/ha/year). For base year (2000), forest formations are evaluated at 12,102,000 hectares including 3,751,620 hectares of contracted formations and 8,362,800 hectares for low productivity formations.

Trees include:

- **Non-forest trees**

Non-forest trees comprise: (i) trees in villages; (ii) trees in urban centers; (iii) trees found on agricultural lands (agroforestry parks); and (iv) trees in pastoral areas.

The number of trees is about 291,483,323 million individuals i.e.: 210 million for parklands, 80 million for pastoral areas and 1,483,323 trees for urban and rural centers. Moreover, very little research has been conducted on the annual increase in the number of the various species found in parks. The *Cellule de Suivi des Ressources Ligneuses* of *Projet Energie Domestique* set a system to calculate the annual increase in the number of *Prosopis africana* after cutting, in agricultural lands of Danmazadou, in Maradi region. Annual increase is estimated at 0.064 cubic meters/year/tree.

- **Plantation**

Regarding tree planting in Niger, reforestation has been one of long time and major activities in the forestry sector. For the base year, FAO estimates tree planting at 72,500 hectares including 36,300 hectares of acacia, 3,600 hectares of eucalyptus and 32,600 hectares of other species.

II.3.3.2. 2 Forests and grassland conversion

Forest conversion results mainly from land clearing for agriculture and sylviculture purposes. It is a major practice for utilizing forest resources. Several estimates were made and came up with quite different results. However, the figures used in this inventory are those from the FAO study (1993) which estimated that 190,400 hectares of forest areas are cleared for agricultural purposes. This figure was used in calculations and takes into account loss of forest areas in the two categories of forests (manageable forests and degraded forests). It should be noted that other factors also contribute to the reduction of forest cover, particularly bush fires, cutting of wood for domestic energy, overgrazing, etc.

II.3.3.2. 3 Abandonment of cultivated land

In the case of Niger, demand for land is so great that long term fallows (20 years and more) are rare. This is the reason why this aspect has not been taken into account in the inventory.

II.3.3.2.4 Agricultural soils

Mineral soils are sources of CO_2 emissions. These include irrigated soils, soils under rain-fed crops and forest soils in the case of Niger. Soils under rain-fed agriculture cover about 7,301,937 million hectares, in 2000, while 12,000 ha for irrigated soils.

II.3.3.3 Methodology

Regarding LULUCF sector, the inventory methodology used is contained in the 1996 revised version of IPCC/OECD/IEA manual of inventory guidelines. As IPCC suggested, the base year is 2000. This is justified by the fact that the year 2000 has not experienced any special climatic event and that a minimum data exists even if these data are not disaggregated, which led to applying level 1 method of calculation.

II.3.3.3.1 Evolution of stock of forest

- **Forests**

Forest productivity of 1.044 stere/ha/year has been considered for 31% of the productive potential which are rather good, for all time series. This is a fairly recent data which was obtained through an environmental monitoring system. The rate of 0.5 stere/ha/year has been used for the other resources. The result is reflected in the table below.

Table 27: Status of natural forest areas for the year 2000

Areas	2000
Manageable forest areas (ha)	3 751 620
Applied productivity stere/ha/year	1,044
Degraded forest areas	8 362 800
Total (ha)	**12 102 000**

Source: the study

For conversion equivalence, it is assumed that: (i) 1 stere of dry wood weighs 240 kg on average; (ii) 1 ton of wood is equal to approximately 4.15 steres or 1.15 cubic meter, and (iii) 1 cubic meter of wood is equal to 0.87 ton of dry matter.

Table 28: Annual growth (t/ms/ha)

Acacia *spp* and others	Eucalyptus	Manageable forest	Deteriorated forest	Non-forest trees (kt/ms/1000 trees)
15	14.5	0.25	0.12	0.0557

The emission factor used in this study is the one contained in the IPCC document; it is the same factor which was used for the calculation of emissions/uptakes of non-forest trees and plantations, and carbon fraction in dry matter is equal to 0.5.

- **Non-forest trees**

At present stage, with respect to non-forest tree inventory, very few information is available for serious projections. Yet, some minimal projections have been made, given their vital significance. As for urban and rural centers, the potential assessment has been made based on the number of households in urban centers and in rural ones, as indicated in the 2001 general population census, and which takes into account trees in open spaces for which data is available. Thus, the numbers considered are: 0.75 tree minimum per household[11] in rural areas and one (1) tree per household in urban centers. Woody pastoral areas have been taken into account in calculating the number of trees in pastoral zones for which a density of two (2) trees per hectare was applied. Concerning trees in agroforestry parks, we used data found in studies made in this field, which evaluate the total park area at 3 million hectares. Densities used vary between 10 and 70 trees per hectare depending on the entity studied. As an example, ten (10) trees per hectare in cultivated fields is the figure adopted.

- **Plantations**

Regarding plantations (table 29), the following reflections and suppositions were made: in 2000, Niger artificial forests covered 72,500 hectares including 36,300 hectares of acacia sp (50%), 3,600 hectares of eucalyptus (5%) and 32,600 hectares of other species (45%); as well, the annual growth of planted areas is evaluated at 2,500 hectares for the 1992-1999 period, if we consider a survival rate of 50% (*Rapport d'évaluation des ressources forestières mondiales 2000* presented by FAO).

Table 29: Situation of plantations in 2000

Area	**2000**
Total area of artificial forests in ha	72 500
Total area for acacia *spp* in ha	36 300
Total area for Eucalyptus *spp* in ha	3 600
Other species in ha (mixed hardwoods)	32 600

Data source: FAO

II.3.3.3.2 Forest conversion

In view of the various figures put forward in connection with converted lands, it was recommended to use data provided by FAO (190,400 ha lost each year), indicated in 5-4 of module 5 on Land change and Forestry. For 2000, the forest potential was estimated at 12,102,000 hectares (data from PUSF inventory using FAO regression rate (1990)). For the same year, 598,810 ha of forest areas were degraded by burning (DE/BTPN 2006 reports). As for biomass before and after conversion, it amounted to 25 t/dry matter/ha and 10 t/dry matter/ha respectively.

[11] Opinion of an expert

II.3.3.4 Evolution of emissions for the years 1990, 1995 and 2000

The table below presents the distribution per source of emissions for the years 1990, 1995 and 2000.

Table 30: Distribution of GHG (Gg Eq-CO_2) emissions per subsector for 1990, 1995 and 2000

	1990		1995		2000	
Sequestration inventory (PM)	***-21,689***		***-28,561***		***-33,922***	
Sources	**Values**	**%**	**Values**	**%**	**Values**	**%**
Forest conversion	6,082.48	**99.61**	15,334	**98.59**	4 891	28,55
Agricultural soils	~ $5*10^{-3}$	**8.19^{E}-07**	0.01	**2.85^{E}-07**	12 241	71,45
Forest on-site burning	23.76	**0.389**	218.11	**1.4**	0	**0**
Total emission	**6,106.24**	**100**	**15,552.115**	**100**	**17 132**	**100,00**

Compared with the previous inventory, it should be noted that for 2000, the sub-sectors f forest and pasture land conversion became the second source of emission (28.55%), in the LULUCF sector following the agricultural soil category (71.45%).

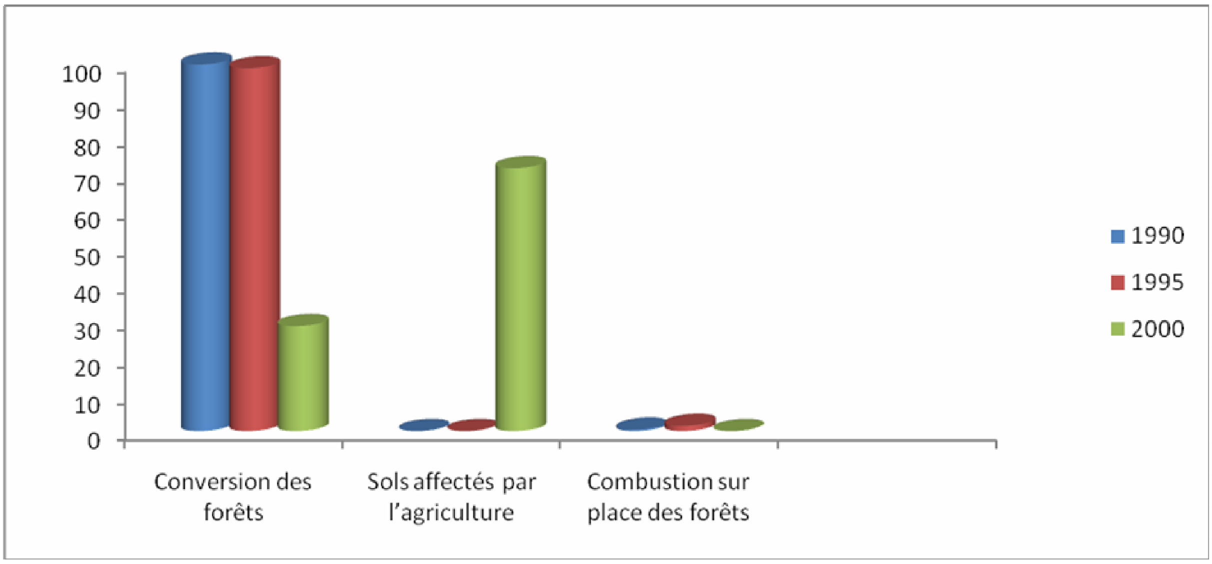

Figure 13: Evolution of GHG emissions per sector for the years 1990, 1995 and 2000

Estimates of emissions from LULUCF sector are presented in the table below.

Table 31: Estimates of emission evaluation from LULUCF sector for the year 2000 (in Gg)

CO_2	CH_4	N_2O	NOx	CO
17,006	6	0.04	2	54

II.3.3.5 Carbon sequestration potential of the forest subsector

The result of the national greenhouse gases inventory (table 2) shows that Niger has a potential of sequestration of **-1 340, 77** Gg Eq-CO_2 despite problems due to data variability.

II.3.4 WASTE SECTOR

This sector is made up of emissions from waste processing and disposal. Sources include solid waste landfills, domestic and commercial waste water treatment, excreta (human feces), etc.

II.3.4.1 Disposal of solid wastes

II.3.4.1.1 Description of source categories

The anaerobic decomposition of organic matter by methanogenic bacteria, in the solid wastes disposal site, results in the release of methane (CH_4) into the atmosphere. In Niger, solid wastes are generated by households, commercial and craft activities, industries, hospital centers, and administrations. However, households are the major producers of solid wastes. Indeed, according to the study on the improvement of sanitation in Niamey, each inhabitant produces an average of 0.75 kg per day (JICA, 2001).

As far as their composition is concerned, solid wastes are made up of variable proportions of sand, paper/cartons, plastics, metal and glass materials. Data on the various urban centers is not available.

As regards to management, no town in Niger has an organized solid collection and dumping system. The only initiatives date back to 1985 with the German GKW project relating to the setting up of a controlled municipal dumping site at 15 km from Niamey interfaced with a compost manufacturing plant. Unfortunately, the latter did not survive after the project due to budgetary constraints at the NUC and also due to poor management.

Since then, collection has been carried out in an irregular manner by staff of the Municipal Sanitation services with the use of garbage trucks. Many of these trucks are today dilapidated. Moreover, the rate of collection of solid household wastes hardly exceeds 30% in Niamey. Out of the 30%, only 10% actually come from “official or known” disposals which are mostly from former or recent quarries where garbage serves as embankments (SOCREGE, 2000).

II.3.4.1.2 Methodology

IPCC’s guidelines for national green house inventories i.e the Revised Version of 1996 describe two methods of estimating CH_4 emissions from solid wastes disposal sites, namely, the default method (level 1) and the Decomposition method (DPO) (level 2). In this inventory, the default method (level 1) was used. The default method is based on the following equation:

Emissions of $CH_4(Gg/yr) = [(DSM_T xDSM_F xL_O) - R]x(1 - OX)$

Where:

DSM_T = Total DSM produced (Gg/year)
DSM_F = Fraction DSM disposed in SWDS
L_0 = Potential of methane emission. It is given by the formula:

$$L_0 = \left[FCMxCODxCODFxFx\frac{16}{12}(GgCH_4 / Gg\ ofwastes) \right]$$

FCM = Methane Correction Factor (fraction)
COD = Degradable organic carbon [fraction (Gg C/Gg DSM)]

CODF = Fraction COD released
F = Fraction per volume of CH_4 in release gases
R = CH_4 recovered (Gg/year)
OX = Oxidation factor (fraction)
The different parameters were obtained as follows:
DSM_T: Total of DSM produced (Gg/year)

- According to SOCREGE (2000), the fraction of DSM that is effectively disposed in SWDS is 10%.
- The methane correction factor was taken as equal to 0.4 (default value in the IPCC revised manual of 1996), corresponding to the unmanaged and shallow disposal site (< 5 m of wastes).
- The estimation of the fraction of degradable organic carbon was made from the following formula:

$$COD = (0{,}4xA) + (0{,}17xB) + (0{,}15xC) + (0{,}3xD)$$

Where:

A = Fraction of DSM from paper and textiles
B = Fraction of DSM of wastes from gardens and parks, or other putrescible non-food organic wastes
C = Fraction of food DSMs
D = Fraction of DSM from wood and straw
A, B, C and D were obtained from table 1 and are equal to 1.6; 19.1; 0 and 0.7 respectively (JICA, 2001). Hence replacing A, B, C and D by their value in the equation, we obtain COD equal to 0.04.
COD_F: Fraction of COD released

COD_F is an estimation of the fraction of carbon degraded and released in SWDS, and reflects the fact that some organic carbons are not degradable or degrade very slowly in SWDS. GIEC Guidelines propose a default value of 0.77 for COD_F.
F: Fraction per volume of CH_4 in release gases

In the calculation of annual production of solid wastes, only the urban population was considered given that the rural population uses waste evacuation methods with emissions of CH_4 that are extremely low. Furthermore, given that the production of solid wastes is a function of standard of living, three groups of urban centers were identified based on the results of the general population and housing census (RGP/H, 2001):

- Niamey, as metropolis with a production of 0.75 kg/day/inhabitant (JICA, 2001);
- Maradi and Zinder, as major towns with a production of 0.65 kg/day/inhabitant (DST/NUC: oral communication);
- All the average and small towns with a production of 0.50 kg/day/inhabitant (expert's judgment).

Based on the urban population of the group of centers given by RGP/H (2001), an average waste production rate in urban areas was calculated as follows:

$$averagerate = \frac{707951x0{,}75 + 318592x0{,}65 + 712753x0{,}5 + 59205x0{,}5}{1798501}$$

Which gives an average rate of 0.62 kg/day/inhabitant, that is an aggregate production of 382.020 Gg for the year 2000 for an urban population of 1 692 532 inhabitants.

II.3.4.2 Treatment of sewage

II.3.4.2.1 Description of source category

The treatment of effluents containing a significant quantity of organic matter amongst which domestic and commercial sewage and some industrial effluents may result in considerable emissions of methane (CH_4). The sources of production of domestic sewage and excreta are basically households, markets, hospital centers and administrations. The characteristics of this sewage vary depending on whether it is kitchen water, shower water or even excreta. With respect to sewage and excreta collection, a study conducted in 1999 by the World Health Organization (WHO) and the Ministry of Public Health shows that 94% of households in Niger do not have toilets (MSP and MIAT, 2000). The same study further points out that only 11% of households use latrines.

Table 32: Physico-chemical characteristics of the various establishments in the Niamey Urban Community

	Physico-chemical characteristic				
Establishments	**PH**	**BOD_5mg/l**	**COD mg/l**	**NH_4^+ mg/l**	**PO_4^{3-} mg/l**
UNILEVER Niger	7,7	300	3778	2	0,014
BRADUNI	7,1	430	1073	7	0,010
ENITEX	11,65	120	1402	2	***
SOLANI	3,75	2150	4198	9	0,119
SLAUGHTER-HOUSE	6,56	2000	6511	35	0,171
TANNERY	5,59	54 000	97 684	2600	-
NATIONAL HOSPITAL	6,81	130	352	29	0,066
LAMORDE HOSPITAL	7,3	180	930	20	0,046
GOUNTOU YÉNA	7,6	200	689	808	0,068
NORMS	5,5/8,5**	40**	125*	2*	2*

Source: Characterization of sewage disposal in the NUC: Environmental impacts on the Niger River, Diallo A.A.S., CRESA 2005. * : European Standards (source: Gaujous, 1995; **: Niger's Standards according to Order No 014/MMH/MDR/MI/MTP/T/U/MAECI of 11/06/76 setting the physico-chemical parameters of emission standards.
***: Over-colored water hindering the reading of the spectrometer; - : Analysis not carried out.

Depending on their origin, sewage is either directly poured in the yard, the street or in the rainwater evacuation gutters. In some cases, it is retrieved in cesspools, sumps, latrines or septic tanks. In fact, according to a survey conducted as part of "the background study on household practices in urban sanitation and household surveys on their behaviors and expectations", 89% of households pour their sewage directly all over the streets, in the yard and in rainwater gutters while 11% use latrines, cesspools and sumps (MAB Conseils Inc., 2000). As regards to excreta, the same source indicates that 92.7% of adults use latrines to defecate compared with 85.9% for children. Furthermore, there is no sewage collection network, nor is there a treatment station of this water. Latrine and septic tanks draining water without prior treatment, is poured directly into fields, green open spaces, streams, etc. Concerning industrial sewage, it is made up of water from processing and manufacturing. In Niger, neither the characteristics, nor the quantities of these wastes are well known due to the fact that unlike household wastes, no specific study has been carried out on them. However, according to the study on the improvement of sanitation in Niamey (JICA, 2001), industrial establishments in Niamey dump averagely 3020 cubic meters sewage per day. Moreover, Diallo (2005) characterized sewage from some industrial establishments in Niamey as part of his dissertation (see previous table, page 50). As indicated above, no industrial unit has residual water treatment stations. This water is thus directly dumped into the receiving body of water without generally any form of depollution. Nevertheless, some industries have storage or aeration tanks, which are settling tanks of their sewage before disposing it into the receiving body of water. It turns out that the detention time of this water is too short which does not allow organic matter degradation and water depollution.

II.3.4.2.2 Methodology

IPCC Guidelines describe a single method to calculate CH_4 emissions related to the treatment of domestic sewage. Emissions depend on the quantity of wastes produced and an emission factor characterizing the degree of production of CH_4 by these wastes. The estimation of emissions was carried out in two stages.

II.3.4.2.2.1 Estimation of annual production of organic sewage and sludge

Only the urban population was taken into consideration given that the rate of access to sanitation is very low in rural areas (about 5%). Organic load is 60 g of BOD/person/day (default value). Thus, the total quantity of BOD produced annually was calculated in the software (worksheet 6.-2; sheet 1 of 4).

II.3.4.2.2.2 Estimation of methane emission from organic sewage and sludge

Methane emission from domestic and commercial sewage is estimated by multiplying the total quantity of BOD produced annually by the emission factor. The value of the emission factor (g CH_4/ g of BOD) taken is equal to 0.6 (default value). This data was later input into the worksheet (worksheet 6.-2; sheet 4 of 4).

Considering the relatively high value found of 22.24 Gg of CH_4, the following quick method was used for the verification of these estimations *(IPCC Recommendations on good practices and management of uncertainties for national inventories): EA =* $PxDxFDxFExFBAx365x10^{-12}$ where:
EA = annual emission of methane from domestic sewage per country
P = population (total or urban in developing countries)
D = organic load (60 g of BOD/person/default day)
FD = fraction of BOD easy to decant, default = 0.5
FE = emission factor (gram of CH_4 per gram of BOD), default = 0.6 or 0.25 gram of CH_4 per gram of COD when COD is used
FBA = fraction of BOD degraded under anaerobic conditions, default = 0.8

In the case of Niger, we take into consideration the urban population exclusively given that the rate of access to sanitation is very low in rural areas as already mentioned above

Thus: $EA = 1692532x60x0,5x0,6x0,8x365x10^{-12}$

Hence annual emissions of methane: EA = 0,009 Gg.

This significant difference could be linked to the absence of detailed data on the types of treatment, the total volume of treated sewage for each type, the emission factor as well as the related methane conversion factor (MCF).

II.3.4.2.2.3 Estimation of nitrous oxide (N_2O) emission from wastes

This was done based on the following parameters: (i) Niger's total population in 2000; (ii) annual average protein intake per capita: 65.3 g/inhabitant/day (Niger's Nutritional Overview, FAO 1990); (iii) fraction of nitrogen contained in proteins: 0.16 kg of N/kg of protein (default value) and (iv) the emission factor EF_6: 0.01 kg of N_2O-N/kg of N wastes produced (default).

II.3.4.2.2.4 Data collection on the annual production of organic sewage and sludge

Given that the access rate to sanitation is very low in rural areas (about 5% according to the Water and Sanitation Policy and Strategy of May 2001 – Short Term and Long Term Action Plans, MRE, 2001), only the urban population was taken into account. Besides, according to a study conducted in 1999 by the World Health Organization (WHO) and the Ministry of Public Health, only 11% of households in Niger use latrines for the collection of sewage and excreta (MSP and MIAT, 2000). The organic load is 60 g of BOD/person/day (default value). Thus, the total quantity of BOD produced in 2000 is 4 077 310 kg (table 33).

Table 33: Estimation of organic sewage and sludge produced in 2000

Population/Quantity	**2000**
Urban population *	1 692 532
Urban population treating its sewage *(11%)*	186 178
Quantity of total BOD per annum (kg)	4 077 310

*Source: National Institute of Statistics

II.3.3.3 Emission of GHG in 2000

Table 34: Emission (Gg) by the Waste sector in 2000

GHG	2000	%
CH_4	3	
CH_4 Eq. CO_2	63	**16.89**
N_2O	1	
N_2O Eq. CO_2	310	**83.11**
Total Eq. CO_2 total	**382**	**100**

The total emissions of GHG recorded in 2000 from the waste sector equal 373 Gg Eq-CO_2; 63 Gg Eq-CO_2 methane emissions that is 16.89% and 310 Gg Eq-CO_2 for N_2O emission that is 83.11%. Furthermore, it should be noticed that the emissions of 2000 clearly progressed as compared with those of 1990 which were 28.22 Gg Eq-CO_2 (table below). This is explained by the increase in population and the improvement in the access to drinking water and sanitation.

II.3.3.5 Evolution of GHG for the years 1990, 1995 and 2000

Table 35: Evolution of GHG emissions (Gg Eq-CO_2) suber-sector for the years 1990, 1995 and 2000

	1990 (Gg CO_2)		1995 (Gg CO_2)		2000 (Gg CO_2)	
Source	Values (Gg)	%	Values (Gg)	%	Values (Gg)	%
Solid wastes disposal			366.87	91.72	57,96	15,75
Treatment of sewage			33.08	8.28	310	84,25
Excreta					0	
Total	**28.22**	**100**	**399.95**	**100**	**367,96**	**100,00**

NB: INC inventory does not specify the distribution of emissions per sub-sector.

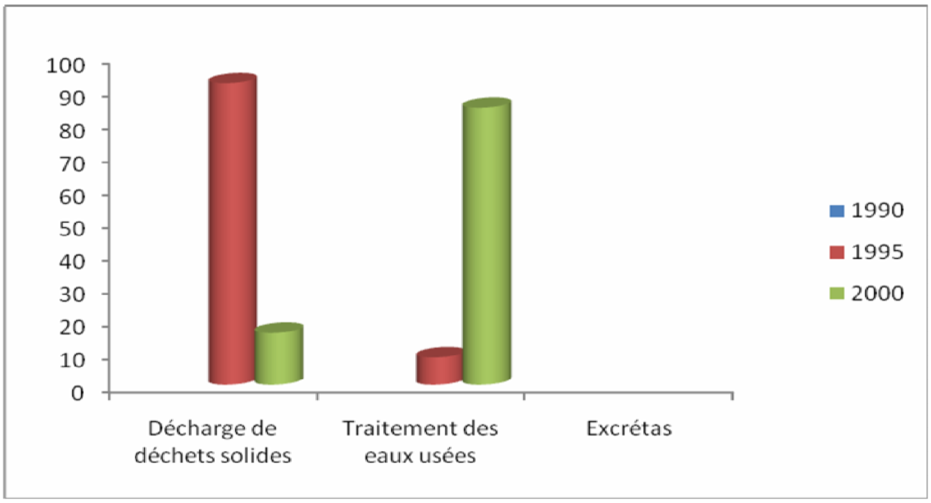

Figure 14: Distribution of total emissions of GHG per gas in 1990, 1995 and 2000

In this figure, one can notice that, in 2000, only sewage treatment and solid wastes disposal subsectors were sources of emission with 93.72% and 6.28% respectively of total emissions.

II.3.5 INDUSTRIAL PROCESSES SECTOR

The sector of industrial processes includes the emissions of all greenhouse gases from industrial activities that are not related to energy. They are the following sub sectors: (i) cement production; (ii) production and use of soda; (iii) production of asphalt for road surfacing; (iv) production of nitric acid; (v) production of sulfuric acid; (vi) consumption of halocarbons (HFC and PFC) and (vii) consumption of sulfur hexafluoride (SF_6).

II.3.5 Description of source categories

The mineral products sub sector represents CO_2 emissions from the production and use of non metallic mineral products such as cement, lime, the production and use of soda, the of asphalt for road surfacing.

II.3.5.1.1 Cement production

Carbon dioxide (CO_2) is produced during the production of clinker, an intermediate product from which cement is manufactured. Calcium carbonate is heated during a process known as calcination or cooking, which produces lime and carbon dioxide:

$$CaCO_3 + heat \rightarrow CaO + CO_2$$

In Niger, the cement production unit is the *Société Nigérienne de Cimenterie*. The manufacturing process is through the integral dry method. The product manufactured is grey cement CPJ35 (CPA325, CPA400, CM250 on request) following two stages:

- Clinkering which is done by a gradual cooking of raw meal at a high temperature of 1450 °C;
- Chemical transformation which takes place in the inclined rotary furnace with a length of 58 meters and a diameter of 2.45 meters in alloyed steel internally lined with high alumina bricks.

The temperature of the fumes (gas + water vapor) is 350 °C at the mouth of the chimney. Limestone reserves in quarries are estimated at 3.5 million tons in drilled areas at Malbaza where limestone has a $CaCO_3$ content of about 80%. To ensure a quality product, SNC has two (2) laboratories where physico-chemical analysis and quality production tests are conducted at each production stage of clinker and cement. These analysis concern the content of chemical products (SiO_2, Fe_2O_3, Al_2O_3).

SO_2 emissions from the sulfur are contained in the fuel and clayey raw material. Fuel emissions are recorded as emissions resulting from energy whereas SO_2 emissions from clay are considered as non combustion emissions.

II.3.5.1.2 Soda production

Carbon dioxide is released during the use of soda and in the course of the production of the latter according to the industrial process of its manufacture. In this case, sodium sequi carbonate, the main mineral from which natural soda is manufactured, is heated in the rotary furnace to turn into crude soda. This process generates by-products namely carbon dioxide and water.
There is no soda production plant in Niger. All of the soda used is imported. Moreover, estimated emissions are those related to its use by SOMAIR.

II.3.5.1.3 Asphalt production for road surfacing

Emissions of non methanogenic volatile organic compounds (NMVOC) come from the production and operations of road surfacing. Asphalt is not produced in Niger; emissions are those related to road tarring and maintenance works.

II.3.5.1.4 Nitric acid production

The production of nitric acid (HNO_3) generates nitrous oxide (N_2O) as by-product of the catalytic oxide at high ammonia temperature (NH_3). There is no nitric acid industrial manufacturing unit in Niger. However, the two mining companies (COMINAK and SOMAIR) retrieve nitrous oxide (NO_x) produced by the reaction between sulfuric acid and nitrate during the "processing" of the mineral. Nitrous fumes are drawn out and channeled to perforated plate column where NO_x is absorbed by water to manufacture nitric acid at about 90g/ liters ($xH_2O + yNO_x \rightarrow zHNO_3$).

The nitric acid thus obtained is recycled upon treatment as an oxidizing support, at the same time with fresh ammonium nitrate to ensure the oxidation of the uranium contained in the mineral (U4 $\rightarrow$U6).

II.3.5.1.5 Food and drinks

NMVOC emissions are produced during the making of alcoholic beverages, bread and other food products. The production of alcoholic beverages is done by BRANIGER, the only brewery in Niger. This is basically the local beer (*Bière-Niger*). NMVOC emissions also take place during the heating of fats and oils as well as foods containing them, during the baking of cereals, flour, beans, vegetables, during the fermentation of dough, the cooking of vegetables and meat products, and during the drying of residues. The following categories were considered in Niger: cooking process of meat, fish and poultry, cooking process making use of oils, margarine and other fats, the process of baking bread.

II.3.5.1.6 Consumption of halocarbons and sulfur hexafluoride

The release of substances into the atmosphere could be the result of emissions from by-products released during the manufacturing processes, or releases from fugitive emissions. An emission from a fugitive source is an emission which is neither checked nor controlled, like for instance, a leakage from a piping system or a connection. Data on activities relating to these chemicals is not currently available in Niger. Consequently, estimates of emissions linked to the consumption of halocarbons and sulfur hexafluoride could not be made.

II.3.5.2 Methodology

II.3.5.2.1 Cement production

The methodology used to estimate CO_2 emissions is the level 2 method of the IPCC manual on GHG inventory which uses data on clinker production and data on the lime content of clinker. As regards the estimates of SO_2 emissions from cement production, it was made by applying an off combustion emission factor to the annual production of cement. Concerning the choice of emission factors (EF), results from analysis made at the main laboratory of SNC were used to calculate the EF of CO2 linked to clinker production.

Emission factor (EF): $tCO_2 / tclinker = \frac{0,5701}{0,640} xf$ where f is the fraction of lime contained in clinker.

$$EFclinker = \frac{0,5701x0,6695}{0,646} = 0,5908$$

With regards to the off combustion emission factor, the default value of 0,3 kg of SO_2 per tone of cement produced as given in the IPCC Guidelines for national greenhouse effect inventories, 1996 revised version, was used. Data on activities obtained from the Niger Cement manufacturing Company is 27 542 tons of Clinker and 33 060 tons of cement in 2000.

II.3.5.2.2 Soda production

The method used is the level 1 method because it is based on the use of national data for consumption and on the default emission coefficient drawn from the IPCC software manual, 1996 revised version for inventories. The estimate of CO_2 emissions from the use of soda is made by applying an emission factor per ton to the annual quantity of soda. For the latter, the default value of 415 kg of CO2 per ton was taken into consideration. The quantities of soda used in 2000 by mining companies are 4 300 tons (Source: COMINAK - SOMAIR)

II.3.5.2.3 Production of asphalt for road surfacing

The estimates of NMVOC emissions from road surfacing operations is made by applying an emission factor per ton of asphalt used for road surfacing to the quantity of asphalt used annually. As far as the emission factor is concerned, the default value of 320 kg of NMVOC per ton was considered. The estimate of the quantity of asphalt used annually was made from statistics from the Ministry of Equipment (Direction of New Work) and from the Niger Agency for Public Interest Works

(NIGETIP). In 2000, the quantity of asphalt used was 101.25 tons.

II.3.5.2.4 Nitric acid production

There is no methodology for the estimation of nitrogen monoxide (N_2O) and nitrous oxides (NO_x). For information purposes, one could give the quantities of nitric acid recycled in 2000 by the two uranium ore companies in the table below:

Table 36 : Quantity of nitric acid (in tons) recycled in 2000

Companies	**Quantity**
SOMAIR	2 400
COMINAK	5 401
Total	**7 801**

Source: COMINAK - SOMAIR

II.3.5.2.5 Production of sulfuric acid

The methodology used to estimate SO_2 emissions is based on the annual production of sulfuric acid, to which one applies an emission factor in kg of SO_2 per ton produced. The default emission factor value is17.5 kg of SO_2 per ton. Niger does not have any sulfuric acid industrial manufacturing unit.

However, COMINAK and SOMAIR manufacture sulfuric acid which they use in the uranium processing. Such a production is a source of emission of sulfur dioxide (SO_2).

The quantities produced in 2000 are obtained from these two companies (see the following table).

Table 37: Quantity of sulfuric acid (in tons) produced in 2000

Companies	**Quantity**
SOMAIR	22 798
COMINAK	29 420
Total	**52 218**

II.3.5.2.6 Food and drinks

The quantity of beer produced in 2000 was 71 541.91 hectoliters by BRANIGER. NMVOC emissions also take place in the course of heating oils and fats as well as foods containing them during baking (cereals, flour, beans, vegetables, during the fermentation of dough, during the cooking of vegetables and meat products), and during the drying of residues.

The following categories were considered: cooking process of meat, fish and poultry, cooking process making use of oils, margarine and other fats, and the process of baking bread.

Table 38: Quantity of meat (in tons) consumed in 2000

	2000
Production of cattle meat *	59 237
Production of poultry meat **	27 000
Importof poultry meat **	0
Production of fresh fish ***	6 150
Imported fish ****	723
Exported meat ****	68
Total	**93 042**

Sources: * : DSE/PA/MRA; ** : FAO (DSE/PA/MRA); *** : DFPP/MHE/LCD; **** : DGD/ME/F

The quantities of meat, fish and poultry consumed annually in Niger were calculated based on data obtained from the Direction of Livestock and Animal products Statistics (DSE/PA/MRA), the

Direction of Wildlife, Fishery and Fish farming (DFPP/MHE/LCD), the Customs Headquarters (DGD/ME/F) and the FAO. These annual consumptions are presented in the following table. With regardsto quantities of oils, margarine and other fats consumed each year; statistical data used come from the Customs Headquarters (DGD/ME/F) as well as imports and exports, and the OLGA OIL Company (Maradi) concerning the national production. It should be pointed out that home-made production of oil is not recorded due to the lack of data on this informal sector which is however very important in Niger. The quantities of oil, margarine and other fats consumed in Niger in 2000 are given in the table below:

Table 39: Quantities of oil, margarine and other fats (in tons) consumed annually

	2000
Quantity produced *	*nd*
Quantity imported **	25 512
Quantity exported **	401
Total	**25 111**

Sources: * OLGA OIL and home-made production; **: DGD/ME/F

With regards to the production of bread, the estimate was made based on the average consumption of 100 g per inhabitant per day in urban centers (OPEN Study, 1982). Besides, only the urban population is considered. This gives a total consumption of 61 777 tons of bread in 2000 (Source: National Institute of Statistics).

II.3.5.2.7 Methodologies for estimation of NMVOC emissions

The estimation of NMVOC emissions from the making of alcoholic beverages, bread and other food products are made by applying a corresponding emission factor per hectoliter or per ton of each product drawn from tables 2-25 and 2-26 of *IPCC Guidelines for national greenhouse gas inventories – 1996 revised version.*

These values are 0.035 kg NMVOC/hl of beer produced, 0.3 kg NMVOC/ton of meat, fish and poultry, 10 kg NMVOC per ton of oil, margarine and other fats, and 8 kg NMVOC/ton of bread produced.

Given that data pertaining to activities on the consumption of halocarbons (HFC and PFC) and sulfur hexafluoride (SF_6) is not presently available; the estimates of their emissions were not made.

II.3.5.3 Estimation of GHG emissions for the year 2000

Table 40: Estimations of GHG emissions related to the industrial processes sector in 2000 (in Gg)

	2000
CO_2	18
CH_4	0
N_2O	0
NOx	0
CO	0
NMVOC	1

Emissions related to the industrial processes sub sector are basically made up of carbon dioxide. They are practically due to the production of cement at the Malbaza Cement factory (90.14% of emissions).

The remaining 9.86% emissions are related to the use of caustic soda by the Société des Mines de l'Aïr (SOMAIR).

Emissions from non volatile methanogenic volatile organic compounds (NMVOC), are relatively low for the year 2000 (about 1 Gg). Over half of them are linked to the making of bread. This low value could be explained by the absence of road maintenance work in 2000 (only some sections of the urban highways were tarred).

II.3.5.4 Evolution of GHG emissions for the years 1990, 1995 and 2000

GHG emissions of the Industrial Processes sector are 18.05 Gg in the 2000 national GHG inventory while 9.26 Gg in 1990 as indicated in the table below which shows the distribution per source of emissions for 1990, 1995 and 2000.

They are basically made up of CO_2 and account for 0.06% of total emissions in Niger. They are for the largest part due to the production of cement (90.14%). The use of soda by mining companies generates 9.86% of total emissions.

Table 41: Distribution of GHG emissions (Gg Eq-CO_2) according to sub sector for the years 1990, 1995 and 2000

	1990 (Gg CO2)		1995(Gg CO2)		2000 (Gg CO2)	
	Values (Gg)	**%**	**Values (Gg)**	**%**	**Values (Gg)**	**%**
Production of cement	9.26	100	14.84	100	16,27	**90,14**
Production of asphalt	0	0	0	0	0	**0**
Use of soda	0	0	0	0	1,78	**9,86**
Production of nitric acid	0	0	0	0	0	**0**
Production of sulfuric acid	0	0	0	0	0	**0**
Food and drinks	0	0	0		0	**0**
Total	**9.26**	**100**	**14.84**	**100**	**18,05**	**100**

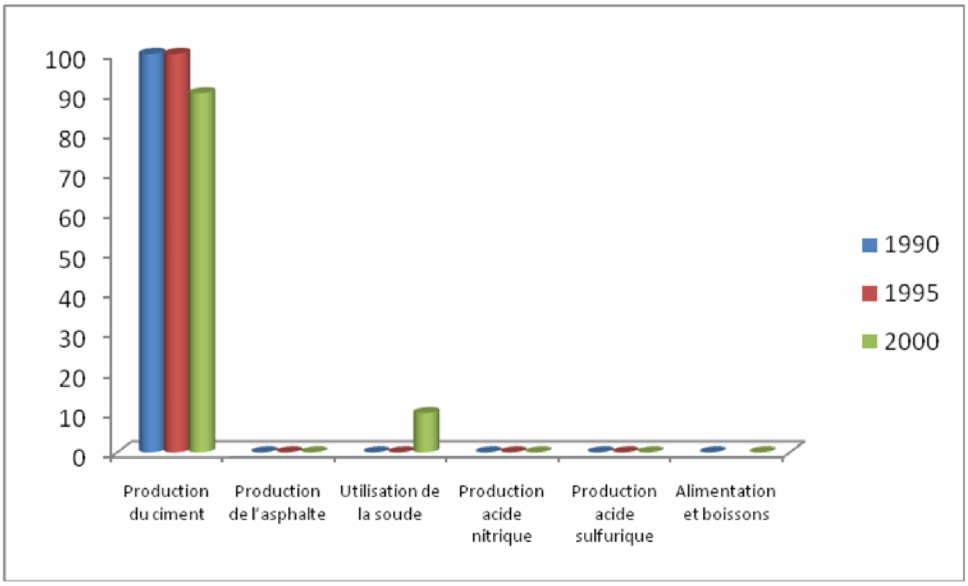

Figure 15 : Evolution of total GHG emissions per gas in 1990, 1995 and 2000

II.3.6 S SECTOR OF SOLVENTS AND OTHER PRODUCTS

Niger is not a producer of solvents. However, some companies, mainly COMINAK and SOMAIR make use of them in their activities. Even if solvents are part of chemicals mentioned in the emission of greenhouse gases, no method of calculation of GHG from this sector is available either for IPCC or for the country.

II.3.7 DIFFICULTIES / RECOMMENDATIONS

Inadequacy or even the absence of statistical data is a general problem in most areas of activity in Niger. This is partly due to the predominance of the informal sector.

The difficulties are generally similar to those encountered during the drafting of the Initial National Communication. The difficulties encountered in the course of this inventory may be classifies into two categories: (i) difficulties common to all the sectors and (ii) difficulties specific to each inventory sector.

II.3.7.1 Difficulties common to all the sectors

They are difficulties relating to:

- Time management : the time allotted is inadequate to cover all issues of data collection, bibliographical analysis and compilation;
- Dispersal of activity data from many economic actors;
- Inconsistency in the collection of activity data from the sectors professionals and absence archiving of these data. There are very few institutions which correctly hold data sheets or even have the requisite skills within the staff to correctly fill the templates requested. Most often, data, when available, is on paper format and difficult to be retrieved from the archives of institutions;
- Low concern of sector professionals about emission and conversion factors;
- Absence of data disaggrated per sector;
- Unreliability of most unprocessed data, including at the level of organized structures;
- Mismatch of data provided by the National Institute of Statistics and data collected from Technical Directorates.

II.3.7.2 Difficulties specific to each sectors

II.3.7.2.1 Energy sector

- Informal hydrocarbons importation channels are not subjected to the formal channels hence difficulties in even the apparent consumption of the country. Only a regular consumption survey will ensure reliable estimates;
- Increase in the price of hydrocarbons on the international market which increase the previous structural grounds;
- Lack of data on auto-producers due to the low keeping of energy statistics either as a result of lack of interest or for reasons of supply in a parallel market;
- Disregard by many private operators of the energy sector's challenges and the challenges related to climate change particularly the opportunities that the Clean Development Mechanism (CDM) offers;
- Existence of too little official figures on energy data, which tends to prove that this sector is hardly considered at the strategic level by vocational and statistical institutions;
- confidentiality of energy data for security grounds (army) or taxation (deductible expenses);
- Low prioritization of the sector in the various development policies and strategies in the country, which does not place it among global challenges which require a provision of all tools and instruments equal to the related challenges;
- Shortage of energy statistics professionals in institutions due to the lack of motivation from the latter to gain such skills.

II.3.7.2.2 Land Use, Land Use Change and Forestry Sector

- Absence of a national forestry inventory which could generate more up-to-date data;
- Anadequate, obsolete or even shortage of data for almost all the Land Use, Land Ue Change and Forestry Sector;
- Unexploitable form of data when they do exist;
- low concern from holder institutions on data relating to inventory activities;

- Inexistence of an inventory of trees outside forests (towns, villages, grazing areas etc.);
- Obsolete nature of the rate of forest regression.

II3..7.2.3 Agriculture and Livestock sector

- Absence of monitoring of farm clearing ;
- Low monitoring capacity of bush fires in the country;
- Total lack of data on some sub sectors such as the use of biomass (notably agricultural residues) as fuels;
- Absence of conversion factors concerning the dry weight of some foodstuffs (vegetables for example) ;
- Inexistence of reliable data on the land areas occupied by organic soils even though they are very few in Niger.

II.3.7.2.4 Waste Management Sector

- unavailability:
  - of the total quantity of soda used in the country;
  - of activities data on the consumption of halocarbons (HFC and PFC) and sulphur hexafluoride;
- absence of data on:
  - the home-made production of oil;
  - the baking of bread through the number of bakeries and the total consumption at national level;
  - the production and characteristics of urban wastes of other towns in Niger (apart from Niamey)

II.3.7.3 General recommendations

Taking into account the foregoing, the following general recommendations are proposed with a view to improving the next inventories:

- integrate the collection of data necessary for the inventory in the routine work of State services;
- perpetuate the SIE;
- reinforce information and training of State services on issues related to GHG inventories;
- take into account data necessary for the inventory in preparing a progress report of forest services;
- propose a data reporting guide for data holders;
- provide additional support to enable the conduct of studies / surveys so as to generate information necessary for the establishment of better quality inventories;
- set up a databank to be provided regular inputs through an annual transmission system of activity data by their holders (the institution most recommended to implement is CNEDD while drawing on data providers);
- define the type of data to be collected concerning formal holders and conduct an awareness campaigns to persuade them to integrate the collection of these data in their activities;
- extend the dissemination of scientific materials by supplying material aid (books, CD,…) and also the construction of a library to that effect; encourage research on climate change issues; considering the importance of this subject on the international scene particularly in the areas of development cooperation and private funding; sensitize public and private policy-makers on funding mechanisms set up by the international community such as CDM which is of interest to data providers to keep reliable statistics;
- organize specialized training sessions particularly for public and private policy-makers results of the inventory and expanding the range of experts;
- build on the successes of institutions specialized in data collection such as INS and SIE-Niger to perpetuate a reliable database; systematically archive available and already processed data after defining a template which is in line with the requirements of the IPCC software.

Consolidate initiatives taken in the second national communication. These initiatives are: set up an inventory multidisciplinary team made up of experts from main institutions holding data from which the major profiles were represented;

- organize information and sensitization sessions for data holders;
- train experts in charge of the inventory;
- archive all data including rocks, by setting up a databank;
- archive in all structures, from which experts came, all data which served in realizing this inventory;
- provide all the means and mechanisms likely to serve in complementary surveys during the inventory to check data or to have solid grounds for expert judgments;
- set up a permanent national team in charge of carrying out the inventories;
- Organize workshops with the goal of showing to institutions the importance of data used in inventories so as to motivate them to integrate it in their reports.

II.3.7.4 Recommendations specific to the sectors

II.3.7.4.1 Energy sector

- fine-tune data to make a better assessment of emissions through the sector method; conduct a survey following a relatively less expensive methodology to establish a baseline case with more elaborate collection tools and;
- use this survey to make a better assessment of the technical characteristics of production tools in anticipation of mitigation measures.

II.3.7.4.2 LULUCF sector

- realize a national forest inventory with a view to having a better knowledge of the sequestering potential;
- conduct surveys to fine-tune the estimate of trees outside forests, in particular trees in urban and rural centers.

II.3.7.4.3 Agricultural sector

- integrate into the next agricultural and livestock censuses the concerns related to the agricultural sector’s inventories;
- set up an efficient monitoring mechanism of the progression of cultivated areas and bush fires.

II.3.7.4.4 Waste management sector

- conduct a survey to know the composition of urban wastes;
- conduct surveys to have: (i) the total amount of soda used in the country; (ii) data on activities relating to the consumption of halocarbons (HFC and PFC) and sulphur hexafluoride;
- conduct surveys to obtain: (i) handicrafts production of oil ; (ii) the baking of bread through the number of bakeries and total consumption at national level.

III. MITIGATION CAPACITY OF GREENHOUSE GAS EMISSIONS

Below are presented the major options, the possible technological resources as well as the list of potential mitigation sectors for the achievement of the quantitative goals set following the national strategic frameworks and classified as follows:

III.1 RESIDENTIAL SECTOR

Household energy consumption is dominated by biomass fuel essentially for cooking and kerosene for lighting. The various consumption needs are: (i) cooking of food and production of hot water; (ii) lighting; (iii) refrigeration and air-conditioning/ventilation. It is however necessary to differentiate the uses in rural with those in urban areas.

III.1.1 Rural areas

Cooking in rural areas is done almost exclusively from biomass (fuel wood and various residues). The current dominant technology makes use of “three stones stoves” with very low energy yield (about 4 to 5%). As rural populations make up about 83% of the total population of the country, the economic potential of fuel is very high there. This economy could be obtained by combining two technologies namely the popularization of metallic improved stoves with a better output (between 12 and 30%) and substitution with a fuel more appropriate to current uses.

The option of disseminating the coal stove is the one chosen by Niger with a conversion target of 50% of rural households in 2015 in SNASEM. The charcoal stove technology has been under large scale experimentation for over two decades in the country. However, there is little evaluation on the CO_2 emission potentials and specifically a comparison with the potential biomass gain.

This subject is still to be pursued depthtly by conducting research on emission factors in rural cooking. The LPG and other petroleum by-products technology is less appropriate in this environment for issues of cost and security. Lighting is dominated by kerosene, oils and grease as well as torches and agricultural residues. The equipment is wick lamps of industrial construction (imported) or home made for liquid fuels.

The Economically Profitable Technologies (EPT) potential, as envisaged in this use, is the extension of the rural electrical and electrification grid by resorting to isolated power plants for 353 000 households by 2015.

Another EPT consists of using portable PV solar lamps. It is a unit made up of a fluorescent tube, 6 to 12 V battery and an amorphous panel of 10 Wc. The reliability of this technology was proven through several pilot experiments conducted in the 1990s. The major obstacles are high cost, unavailability of spare parts and inexistence of skilled staff for the maintenance of this equipment.

III.1.2 Urban areas

As in the case of rural areas, urban household energy consumption is dominated by biomass for cooking and kerosene for lighting as well as battery lamps. The same Technology Transfer strategies are therefore applied.

However, in urban areas, SNASEM plans to electrify 100% of households through a electrical grid extension policy, promote over 50 000 solar cookers as well increase Modern Fuel Cooking stoves (CMC) notably coal stoves and the LPG in order to cover 100% of the needs. The major obstacles here are the cost of new equipment (both solar and fuel), maintenance and especially the high level of the task.

III.2 TRANSPORT SECTOR

In 2000, the transport sector had some 130 000 constituent units for about 2/3 of the passenger vehicles including motorcycles and remaining 1/3 for transportation of goods. Its growth rate is quite high especially since the advent of low cost second-hand car, which increases CO_2 emission potential in the sector.

The ERT potential envisaged in the NTS is the promotion of alternative means of transportation, the modernization of number of motor vehicles and especially the construction of 2000 km of railway lines.

Other strategies can be envisaged which basically make use of energy conservation through the users capacity building, the promotion of urban transport and the technical control of means of transportation. Costs are also a major constraint here both for the renewal of the car fleet and for the promotion of transit in urban centers. The promotion of less pollutant alternative fuels, such as LPG, biofuels or battery-powered vehicles, is other ERT alternatives, though the same obstacles remain.

III.3 ENERGY AND WATER INDUSTRY SECTOR

III.3.1 Production of electrical energy

Niger produces 13% of its electrical needs from the Anou Araren coal-fired plant with an installed power of 32 MW as well as through a network of diesel or fuel-oil thermal power stations (about 50 MW). The rest is imported from Nigeria by two lines of 40 MW at the West and 30 MW at the East. With the national interconnection policy initiated since 2000, most diesel and fuel-oil power plants are on standby, which has considerably reduced the sector's emissions.

The enhancement of this policy began in 2007 with the strengthening of the western line increasing it to 80 MW and the continuation of the interconnection of council capitals and major rural centers. With the construction of the Kandadji dam for an installed power of 130 MW by 2015, the country is seriously looking towards a sustainable reduction of CO_2 emissions. However, the envisaged growth potential, notably with the granting of over 120 prospecting permits in mining, the start-up of the exploitation of uranium mines (Imouraren), gold or other mineral products will lead to the installation of several industrial units (about half a dozen units is envisaged by 2015).

The installed capacity will consequently be quickly exceeded. This situation will induce a mineral coal capacity building policy. An ERT option in this area is the use of coal-fired plants considered to be 'clean' where modules of 50, 100 and 125 MW exist at very competitive prices.

III.3.2 Production of petroleum products

All the petroleum products consumed in Niger are imported basically from Nigeria and the international market.

However, the country has significant proved oil reserves of about 350 million tons at the extreme East of the country (Agadem). Considerable quantities of gas were also proved. The development of these resources is envisaged in the EPD with three good tests in 2006 and a probable production by 2009-2010.

Emissions from this subsector will consequently be enhanced. An analysis of ERT potentials in the area is to be envisaged with the currently existing progress in the field of oil production. Oil exploitation was lunched in 2008 with the laying of the foundation stone of a refining unit of 20 000 barrels per day and the exportation of excess of productions.

III.3.3 Exploitation of Uranium

In Niger, the exploitation of uranium is done basically for exportation in the form of Yellow Cake. This industry experienced increasing interest from 2007 with the renegotiation of prices with its major client. Agreements signed early 2008 considered also an increase in production (rising from 2 670 tons in 2005 to almost 10 000 tons by 2012) which will make Niger the second world producer of this mineral.

There is provision in the Energy Policy Declaration (EPD) and the SDRP for an improvement of the value added of this industry without specifying in which form. With the prospects of establishing several nuclear power stations in Africa, (Libya, Algeria, Nigeria, etc.), the Common Energy Policy of UEMOA and ECOWAS, the West African electrical grid interconnection policy, etc. it is possible to plan the development of this mineral for energy production both at national level and for sub-regional integration.

Given that this option has a very GHG emission control potential, the major obstacles for this option are naturally the political will, investment costs and technical capacities of the human resources available on the subject.

III.3.4 Water industry

The target set for 2015 is the coverage of 80% of drinking water needs in rural areas and 100% in urban areas through the extension of the urban networks and the construction and/or rehabilitation of 1 000 mini-DWS per annum in rural areas. There are also plans to equip these facilities with modern draining systems powered by modern energy services (MES). Thus, there are plans to set up 1 432 mini-DWS in villages of 1000-2000 inhabitants in 2012 and over 7 000 mini-DWS by 2015.

The dominant technologies in this area until now are: (i) PV solar water pumps with a power output of 600 Wc per facility in villages for water needs of 30 to 40 cubic meters per day, (ii) diesel heat pumps of 5 to 6 kW for these same villages or connection to the electrical grid where it exists.

For urban centers whose capacity exceeds 40 cubic meters per day, making use of solar technology was not considered as an option in Niger. For villages with 250 to 1000 inhabitants, modern water supply points were installed (cemented well, boreholes, etc.) equipped with human powered pumps. There are also ERT possibilities including wind pumping or small capacity solar units.

The obstacles are the costs, maintenance and availability of skills. Another peculiarity of Niger is the water supply in grazing areas. The current policy focuses on pastoral cemented well and boreholes of the same type. In addition to the ERTs associated to this type of work, the rehabilitation of some traditional wells existing rural areas could be envisaged, notably for villages and camps with less than 250 inhabitants so typical of Niger's society. Modern techniques will make it possible to save 4 to 5 tons of fuel wood for each well maintained traditionally and per annum. These techniques have already been tested by several NGOs and Development Associations in pastoral areas for many years.

III.3.5 Promotion of Income Generating Activities by establishing Multifunctional Platforms

The establishment of Multifunctional Platforms consists of setting up an energy unit likely to operate a grain mill, a hulling machine, an alternator and a battery charger to facilitate women's domestic work and provide them with the opportunity to undertake income generating activities while enabling rural households to have minimal electrification.

This technology is also classified among those that facilitate rural households' access to Modern Energy Services (MES) by SNASEM following the successful experiences of the Special Program of the President of the Republic. It is expected that there will be a rise from 3 500 units in 2007 to 12 500 units by 2012 and 14 000 units by 2015. Dominant units currently operate on diesel (5 to 6 kW or 10 HP) which represents a potential source of high CO_2 emissions.

Existing alternative ERTs are electrical units in electrified localities with the vast rural electrification program mentioned or those operating independently. In this case, PV solar units of 5 to 6 kWc will be used. There are also possibilities of using wind or biogas energy. For these alternative technologies, costs (solar), deposit (wind) or the raw material (biogas) are the major obstacles to which one may add technical competence which is lacking.

III.4 OTHER POTENTIAL SECTORS TO AVOID CARBON DIOXIDE EMISSIONS

Other potential sectors to avoid carbon dioxide emissions related to the energy sector are: (i) manufacturing and construction industries, (ii) agriculture, fishery and fishing activities, (ii) Mines (gold washing and exploitation of uranium and coal). Emissions from these sectors are presently marginal but may develop further considering the targeted ambitions in the various strategic frameworks by the year 2015. ERT possibilities in these sectors may be summarized as follows:

III.4.1 Manufacturing and construction industries

There are plans to increase agro-industries particularly slaughterhouses, hides and skins and agricultural by-products. The viability of such industries depends, to a large extent, on the source of energy and its cost.

Consequently, industrial units out of the electrical grid are hardly sustainable. It is thus possible to expect few risks in their development out of the electrical grid in the various electrical energy supply scenarios in the country.

III.4.2 Agriculture, Fishing Activities and Fish Farming

The energy consumption of this sector has experienced a substantial lift with the Modernization Program of this sector in recent years.

Emissions result from two sources: (i) mobile through the extension of agricultural tractors and (ii) fixed through the promotion of irrigated farming.

The mechanization of ploughing is limited in Niger and its development will not be quite promising in view of the projection of the country's various strategies. However, irrigated farming is highly envisaged with targets of about 270 000 ha by 2015 compared with less than 50 000 ha today. At least 50% of this land area is envisaged in the form of small size private farms.

Experiences drawn from programs such as ANPIP enabled the extension of over 30 000 individual petrol pumps in the 1990s and in 2000. This resulted in a substantial rise in emissions in this sector. ERT possibilities in this area are related to solar PV, wind energy or connection to the power system.

The major constraints are the costs and maintenance operations. With the building of the Kandadji dam, the navigability of the river will be certain, which will increase emissions caused by fishing and possibly fish farming. Measures should also be envisaged here on the most appropriate means of navigation. Niger has very little experience in this area.

To conclude this chapter, one may say that the strategic development options displayed in SDRP, SDR, DPE and SNASEM as well as the quantitative targets are quite ambitious and possible. The ultimate aim is the economic and social development while conserving the environment.

The achievement of these objectives is a national priority for a country with a low human development index which led to a high mobilization of the international community.

The potentials offered by the country's resources make the issue of technology transfer crucial in the energy sector. Fortunately for all the possible ERT alternatives, the country is endowed with the resources necessary. The major challenge is their correct assessment and a consequent capacity building program to tackle the situation.

IV. VULNERABILITY TO CLIMATE CHANGE

Vulnerability refers to the incapacity of a system to address the negative effects of climate change. It is a function of climatic variations, the system's degree of sensitivity to these variations and its adaptation capacity. Many factors therefore count in its assessment. This involves an accumulation of uncertainties from various origins. Information relating to the incidence of climate change in Niger is still limited due to the little amount of data available and the often incomplete nature of topics being tackled.

Although studies on incidence do not systematically focus on climate change scenarios, it is essential to have general information on projections on climate evolution adopted by the country. This is the objective of the first part of this chapter, which presents results of regional climatic simulations realized in Niger. These results deal with two often used emission scenarios (IPCC's A2 and B2). They are based on a relatively wide set of climatic simulations and thus allow a quite sound inclusion of uncertainties. It is however important to bear in mind that these two scenarios do not include the complete range of socioeconomic scenarios and do not integrate climate change mitigation policies. This chapter later presents information available on the impacts in the areas identified: agriculture, livestock, water resources, and human health. It describes existing adaptation measures, as well as those envisaged with a more or less certain degree of predictability. The next part in this chapter proposes a summary of potential impacts as well as a first attempt to assess the corresponding vulnerability. It should be considered as a preliminary and indicative summary, because it is based on available elements, which are difficult to be summarized and which are yet so limited. Economic impacts, for which data available is still patchy, are not tackled in this chapter. Mitigation measures could have complex economic consequences, notably in terms of cost, as well as potential inconveniences in some sectors and positive side effects. These measures are not directly related to the incidence of climate change proper, and their study would not lead to a better understanding.

IV.1 VARIABILITY OF CURRENT CLIMATE

IV.1.1 Analysis of climatic data

Data used was chosen in a way that no missing data appears in the 1961-2000 series. Synoptic meteorological stations meeting this criterion are: Agadez, Birni N'Konni, Maradi, Niamey, Tahoua, Tillabery and Zinder. The agreed climatic parameters are: rainfall in June-July-August-September (JJAS), maximum temperatures in JJAS, minimum temperatures in January-February-March (JFM), wind speed in JFM, maximum relative humidity (RH) in JJAS and minimum RH in JFM at Konni, the only station presenting consistent data after their upgrading by the National Meteorology.

The choice of the periods under review JJAS and JFM could be explained, for the first, by the fact that over 80% of annual rainfall occurs at this period and the bulk of atmospheric filth from the ground is produced during the second period (Ben Mohamed, 2003).

With regards to data quality, statistical tests were used to assess it. The major feature to be verified is the unpredictability of a set of data. A set is said to be random when all the observations are from the same population and are all independent from one another. In practice the set is simply random if it is not persistent, if it does not involve trends and if there is a stability of the dispersion of their means close to their average.

Tests on the persistence, trends, dispersion, as well as a Fischer test were carried out on the sets of data previously mentioned. The results of these tests appear on the following table:

Table 42: Persistence, trend, dispersion tests, as well as the Fischer test on the sets of data previously mentioned

Pers	JJAS rainfall					Tmax JJAS					Tmin JFM					VV JFM				
Longitude, Latitude, Altitude	CV		Tend	Disp	Fischer	CV	Pers	Tend	Disp	Fischer	CV	Pers	Tend	Disp	Fischer	CV	Pers	Tend	Disp	Fischer
Tillabery (1 27E, 14 12N, 209m)	30%	1,2	-1,3	-1,7	5,00	3%	1,7	3,0	-0,5	1,11	5%	1,7	2,3	-1,6	2,66	18%	-0,4	-1,6	-0,9	5,12
Niamey Aero (2 10E, 13 29N, 221m)	27%	0,8	-1,2	-0,4	3,12	3%	1,8	2,9	-1,8	3,02	5%	1,6	2,7	0,6	0,31	31%	4,4	4,5	0,04	0,57
Birnin'Konni (5 17E, 13 48N, 272m)	23%	2	-0,2	0,4	4,53	6%	3,5	-2,7	-3,8	12,16	5%	1,7	3,4	-0,8	1,44	21%	3,1	-2,8	1,3	5,40
Tahoua (5 15E, 14 54N, 385m)	28%	1,7	-1,3	-0,5	3,21	3%	1,4	1,2	-0,5	1,24	5%	-0,1	0,9	-0,3	1,76	23%	3,4	2,6	1,2	0,10
Maradi Aero (7 5E, 13 28N, 368m)	28%	2,5	-2,1	-3,0	9,49	2%	1,3	2,2	-1,1	1,90	6%	2,3	4,1	-0,4	0,98	22%	4,8	5,10	0,2	0,45
Agades (7 59E, 16 58N, 498m)	40%	1,8	0,1	1,5	0,59	1%	-0,6	2,2	0,9	1,36	7%	2,6	3,8	0,3	0,40	27%	4,8	5,1	4,9	0,00
Zinder Aero (8 59E, 13 47N, 451m)	26%	-0,3	-1,7	1,0	3,81	3%	1,5	3,5	-1,2	2,01	5%	-0,3	2,3	-0,8	2,32	19%	4,0	3,4	-2,4	4,29

It could be deduced from the review of this table that:

- For the period of time under consideration, the series may be considered as simply random, the Fischer test giving a coefficient below the critical value of 12.6. One could note that the results are different if one considers the period of time between 1950-2000 during which the declining trend of rainfall in relation with droughts appears clearly;
- the very high variability of rainfall in JJAS and wind in JFM, compared with that of temperatures translate indeed the difficulty of their predictability in this region.

IV.1.2 Evolution of climatic parameters

We use a simple and sample index known as reduced anomaly to bring out periods of climate extremes. For this study, were presented trends of the averages of the seven (07) stations of reduced anomalies of rainfall JJAS, maximum temperatures JJAS, minimum temperatures JFM, wind speed JFM and maximum relative humidity JJAS and minimum RH JFM at Birni N'Konni.

Figure 16 below presents this trend for maximum rainfall and temperatures in JJAS. The review of this figure brings out two facts, namely:

- the decrease in rainfall characterizing the drought of the years 1970-980 in the Sahel;
- the high correlation between rainfall and maximum temperatures in JJAS, having been indicated before for the period 1950-2004 (Ben Mohamed, 2007). Concerning the present case, the explained percentage of the variations of one of the variables by the variations of the other variable reaches 67%.

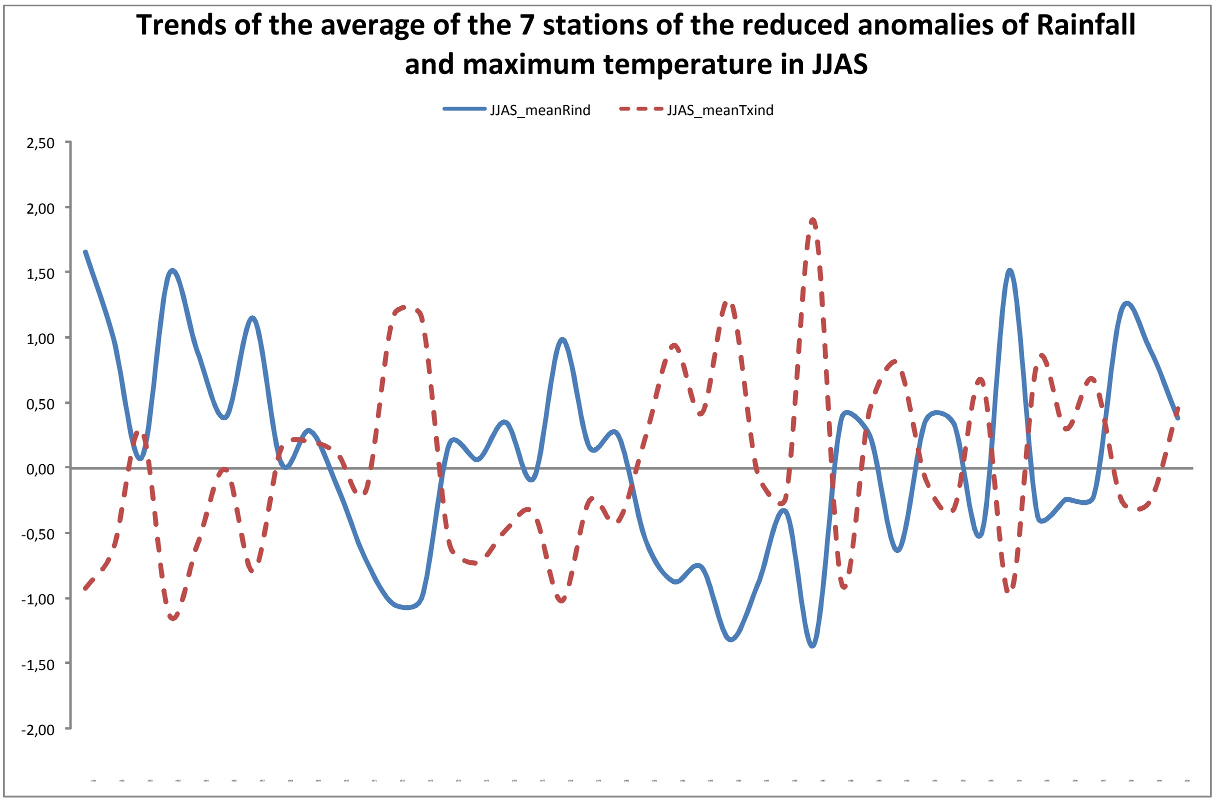

Figure 16: Trends of rainfall and Max temp in JJAS in Niger between 1961 and 2000

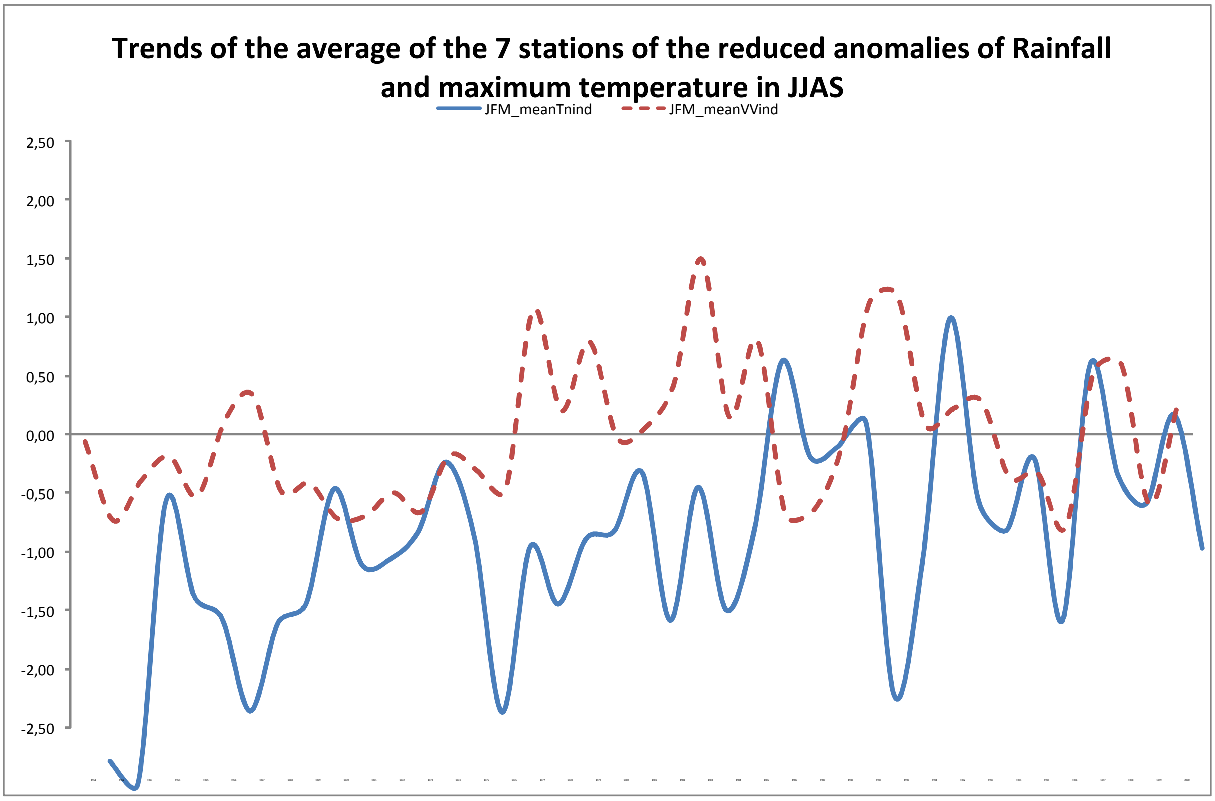

Figure 17: Minimum temperature trends and wind speed in JFM in Niger between 1961 and 2000

Figure 17 above presents the trends of minimum temperatures in JFM and wind speed at 2 m. A review of this figure once again brings out two facts, namely:

- the upward trends of minimum temperatures in JFM, which is a sign of some climatic warming in this region, a phenomenon already illustrated in other occasions (Issa Lellé, 2001);

- the evolution of wind speed does not show a clearly distinct trend for the simple reason that wind speed depends on oscillations from North Atlantic which also has a high multiyear variability.

The figure below presents the trends of maximum humidity in JJAS and minimum in JFM at Birni N'Konni, for reasons previously stated:

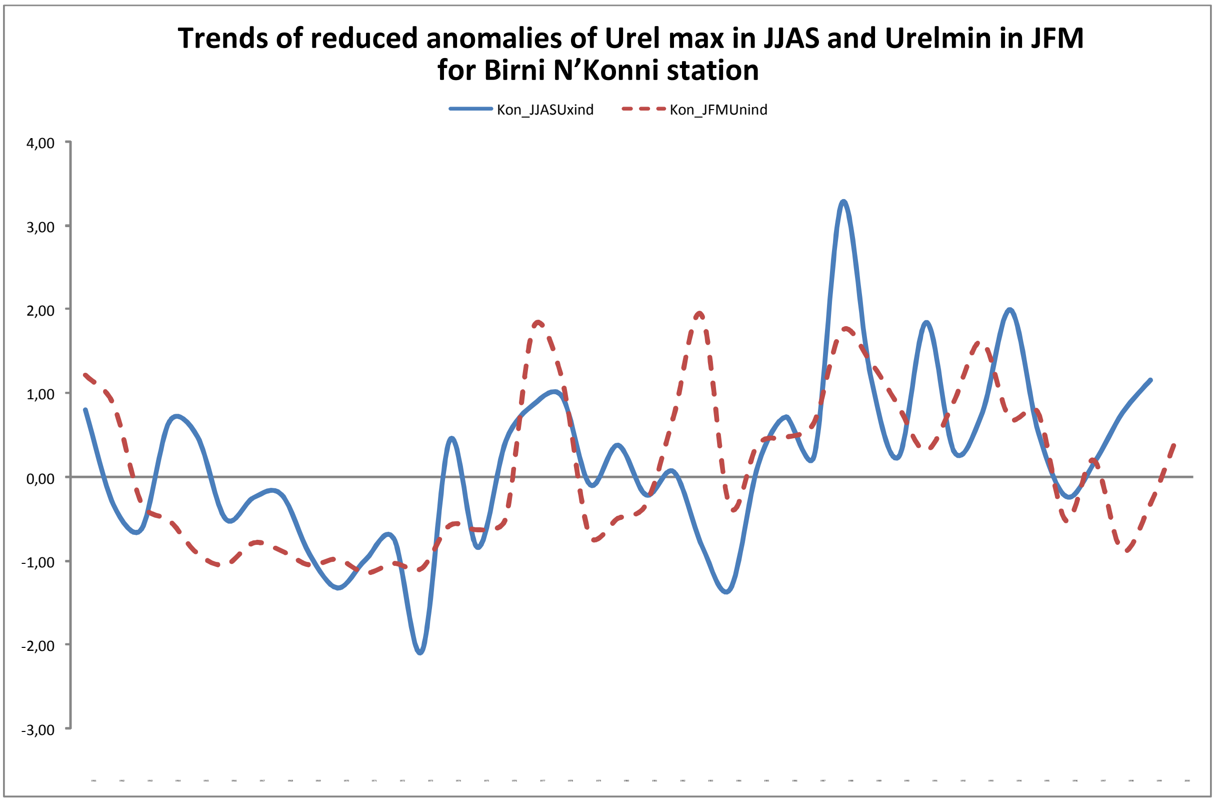

Figure 18: Trend of minimum Urel in JFM and maximum in JJAS at Birni N'Konni 1961 and 2000

At the level of maximum curve, we notice the concomitant decline with high drought periods that the Sahel experienced recently and which are linked to the abnormalities of general circulation caused by ocean warming.

The variability observed from the minima should have also resulted in anomalies in general circulation. We notice nonetheless that major peaks appear during non epidemic meningitis years.

IV.2 CLIMATIC PROJECTIONS AND FUTURE IMPACTS: REGIONAL CLIMATIC SCENARIOS, MAJOR VULNERABILITIES

IV.2.1 Introduction

Projections have been made for period 2020-2049 with respect to the baseline reference period of 1961-1990, in accordance with IPCC's recommendations.

Two General Circulation Models (GCM) outputs were used for three Greenhouse effect gas emissions; outputs of HadCM3 model (Hadley Centre for Climate Prediction and Research) for scenarios A2 and B2 and outputs of model CGCM3 (Canadian Centre for Climate Modeling and Analysis) for scenarios A2 and B1. Two models of change of statistical scale had initially been used: SDSM[12] (Statistical Downscaling Model) with outputs of the HadCM3 model and LARS-WG[13] with outputs of the CGCM3 model. However, only the results of the first were agreed.

[12] https://co-public.lboro.ac.uk/cocwd/SDSM/
[13] http://www.lars.bbsrc.ac.uk/model/larswg.html

Daily outputs of HadCM3 Model, standardized for use with SDSM, were obtained for scenarios A2 and B2, for the period between 1961-2100. This data is available on the website of the Canadian Climate Impacts Scenarios Project (CICS[14]). Daily outputs of the CMCG3 model were used for scenarios A2 and B1 over the same period. The three scenarios used for Niger were imposed by GCM models and are A2, B1 and B2.

The model agreed to generate in detail the local climate in this study is the Statistical Downscaling Model (SDSM, Wilby, *et al.* 2001). It is a regression model based on high scale climate information (predictors) from NCEP (National Center for Environmental Prediction) reanalyzed data as well as daily data from the observed variable (predicting) of a station during the baseline reference period from 1961 to 1990.

The model is sized with predictors chosen to explain as much as possible the variability of local observations and later validated. The model is then used to determine future local climatic conditions with predictors from GCM scenarios over the chosen future period. The process is explained in detail in the SDSM operating manual.

Other global model outputs were used to have a synthetic vision of expected projections for relative variations of average rainfall and air temperatures by 2020-2049 as compared with the baseline reference period of 1961-1990. These are MPI-ECHAM5, CSIRO-MK3, GFDL-CGCM2, MRI-CGM2 model outputs.

IV.2.2 Performance of IPCC climatic models in Niger

The climate simulation model outputs should always be compared with the observations to stick to their performance. In general, this amounts to comparing the annual rainfall signal with those of air temperature. Averages of rainfall and air temperature from observations of major synoptic stations of the country in the part located below latitude 16°N were carried out this way for Niger from 1961-1990, to eliminate stations located in the Saharan desert.

Figures 19 and 20 on the next page present the results obtained for UKMO-HadCM3, MPI-ECHAM5, CSIRO-MK3, GFDL-CM2, and MRI-CGCM2 models.

From a first glance at the following figures, there appears to be low models in the correct reproduction of the annual cycle both for rainfall and temperature. For rainfall, the signal amplitude could be acceptable; unfortunately discrepancies in the position of the maximum definitely translate a problem of convection parametering in this area where rainfall distribution is strictly unimodal, which immediately amounts to a rejection of the models indicated.

With respect to air temperature whose annual cycle is illustrated by figure 18, this time we observe a reproduction of the bimodal nature of this parameter with once again serious discrepancies in the positions of maxima. This time the amplitudes are less satisfactory than in the previous.

[14] http://www.cics.uvic.ca/scenarios/index.cgi?Scenarios

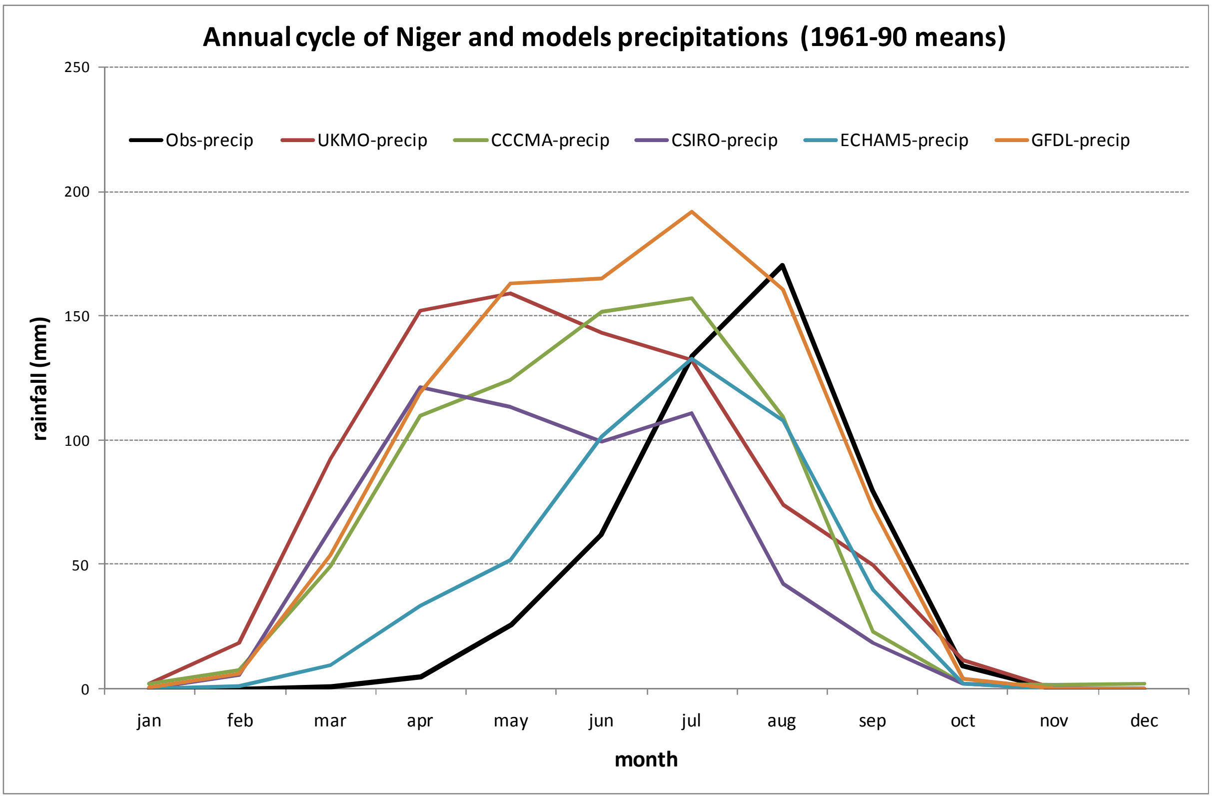

Figure 19: Annual rainfall cycle observed resulting from the models indicated

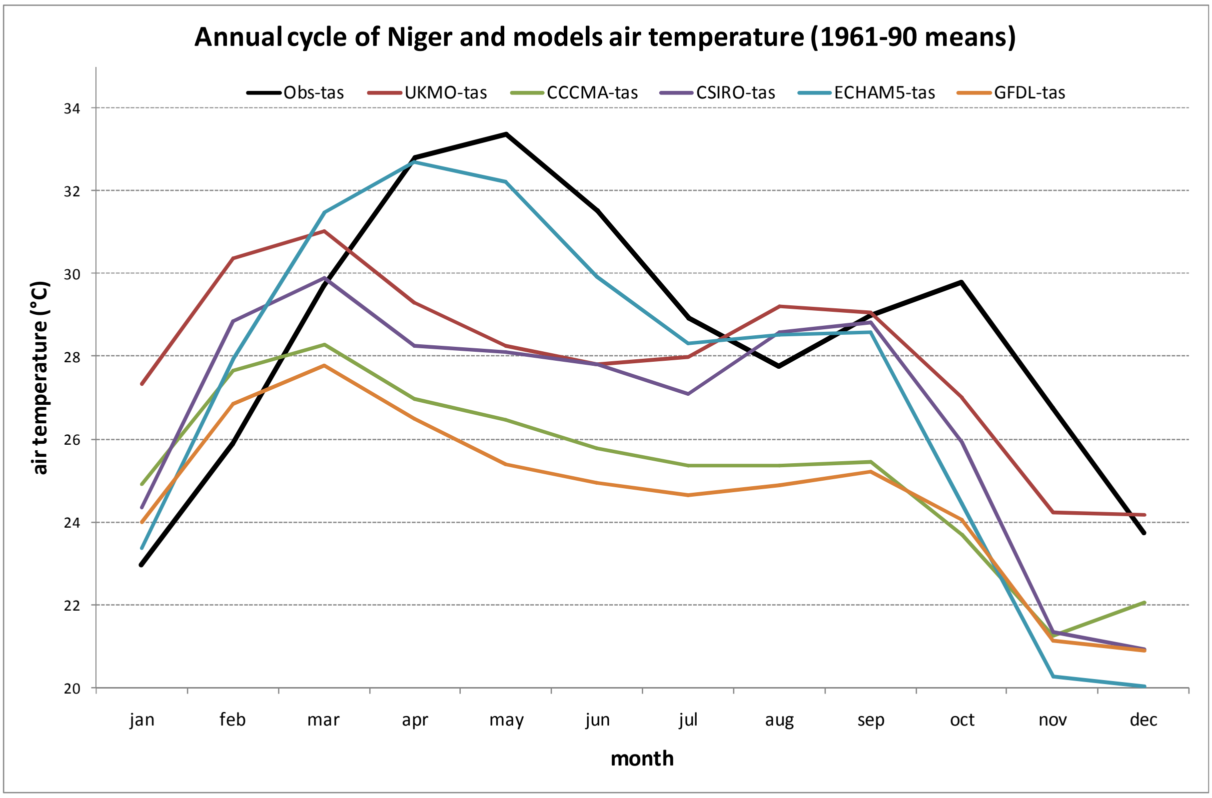

Figure 20: Annual air temperature cycle observed and resulting from the models indicated

It follows from the review of these two figures that the performance of climate models above this area is still unsatisfactory, even when they only manage to reproduce the bimodal nature of temperature. This is one of the reasons why it is necessary to take model outputs for this area with all precaution, because an obvious research effort still has to be made in this direction.

IV.2.3 Future scenarios for Niger

IV.2.3.1 SDSM model

Projections made for temperatures show that in spite of a large variability, all models agree to predict an average increase in maximum temperatures by 2020-2049. The increase in the annual average of maximum temperatures reaches 2.3 °C according to scenario B2 and it goes up to 2.6 °C according to scenario A2 for the period 2020-2049. The highest rises concern Agadez, Mainé, Konni and Maradi stations.

Stations which will experience less of this rise are Niamey and Gaya stations, with at the same time a rise likely to reach 1.5 °C. It could be observed from all stations that this rise in daily maximum temperatures is least in the months of June, July, August and September corresponding to the rainy season. Rainfall forecasts show a slight increase of rainfall by 2020-2049 for most stations and a late start of the rainy season. There is an expected high increase in rainfall at the Tillabéry station. A modest decline will be observed at the Gaya, Niamey and Mardi stations.

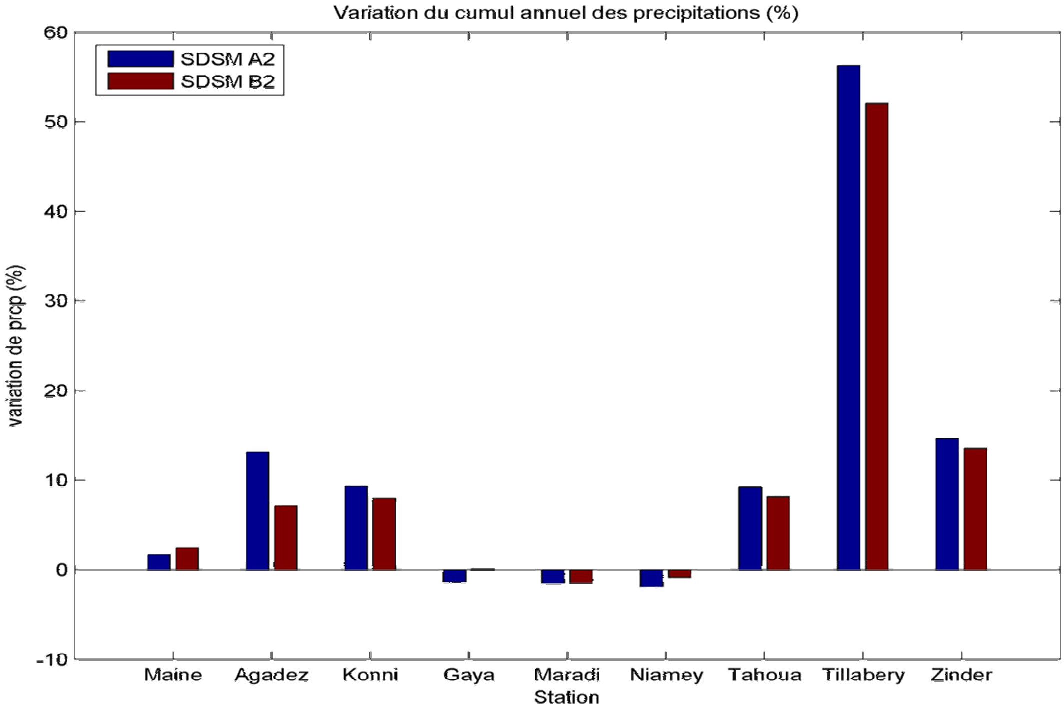

Figure 21: Relative variations of annual rainfall in all stations with regard to the period 1961-1990

This expected increase in rainfall in the Sahel is substantiated by several recent studies (Reindert *et al*, 2005). The recent IPCC report (IPCC 2007), shows that results of models on rainfall changes in the Sahel are contradictory. The results presented here are only those of the HadCM3 model disaggregated with SDSM.

Extreme weather events such as intense heat or heavy rainfall may have tremendous consequences on humans, plants, animals or infrastructures. In this study, the value of 99^{th} centile of maximum temperatures and daily rainfall were agreed as extreme events threshold.

Extreme events of maximum temperatures and rainfall are analyzed for all the stations over the baseline reference period of 1961-1990 and over the period 2020-2049 according to scenarios A2 and B2.

It clearly appears on table 44 that the 99^{th} centile of rainfall will experience a slight increase in all stations, apart from Tillabéry station where the increase will be high. This means that there will be an intensification of heavy rains, with all possible consequences on infrastructure.

Table 43: Summary of changes of extreme rainy events for all stations

	99th centile of rainfall (mm)	Variation A2 (mm)	Variation B2 (mm)
Tillabéry	63.56	46.43	46.10
Maine	70.59	0.62	1.09
Agadez	33.47	0.76	0.80
Konni	54.53	1.11	0.86
Gaya	65.01	0.50	0.77
Maradi	64.62	1.21	1.41
Niamey	63.19	0.82	1.01
Tahoua	48.84	1.24	1.38
Zinder	63.21	1.66	1.77

A review of the following table also shows an increase in extreme marginal temperatures from 0.8 to 3.3 °C. This result was foreseeable as average maximum temperatures are likely to increase in the same magnitude.

Table 44: Summary of extreme changes of daily maximum temperature for all stations

	99^{th} centile of max temp. (°C)	Variation A2 (°C)	Variation B2 (°C)
Tillabéry	44.2	1.9	1.7
Maine	43.5	2.1	2.0
Agadez	43.7	0.9	0.8
Konni	43.4	2.2	1.9
Gaya	42.6	1.6	1.3
Maradi	42.5	3.3	2.5
Niamey	43.4	0.8	0.9
Tahoua	43.6	2.5	2.4
Zinder	42.5	2.3	2.1

For future studies on climate change, it will be advisable to also use the change of scale with a regional model such as PRECIS or RegCM as a supplement to the statistical methods. We can also recommend the use of a wide range of climate change scenarios bearing in mind that it will require much more time and a minimum of calculating material and work stations for regional models and data storage peripherals.

IV.2.3.2 MPI-ECHAM5, CSIRO-MK3, GFDL-CM2, MRI-CGCM2 Models

Model outputs are provided by IPCC, through its data distribution center (IPCC - CDDC). Data is available at monthly base unlike in the previous model, however with a resolution of 1°x1°. The processing was done using the software known as Grid Analysis and Display System (GRADS v.2). Results are produced in the form of relative variations of average rainfall in JJAS and annual average temperatures of the period 2020-2049 in relation to the baseline reference period between1961-1990 (figures 22 and 23 of the next page).

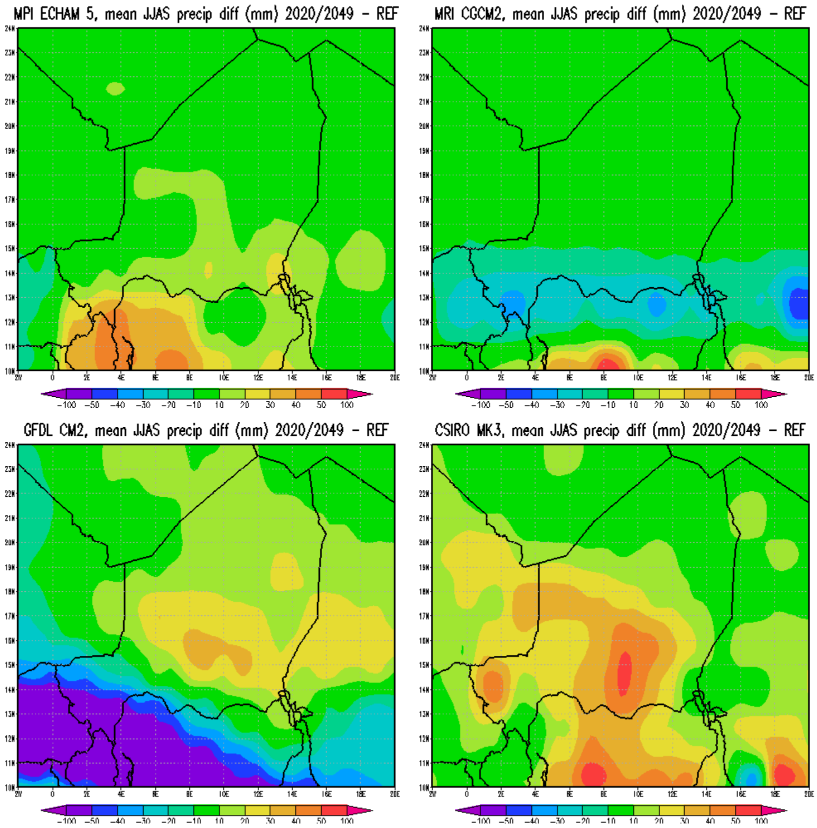

Figure 22: Relative variations of rainfall in JJAS in Niger from the models indicated

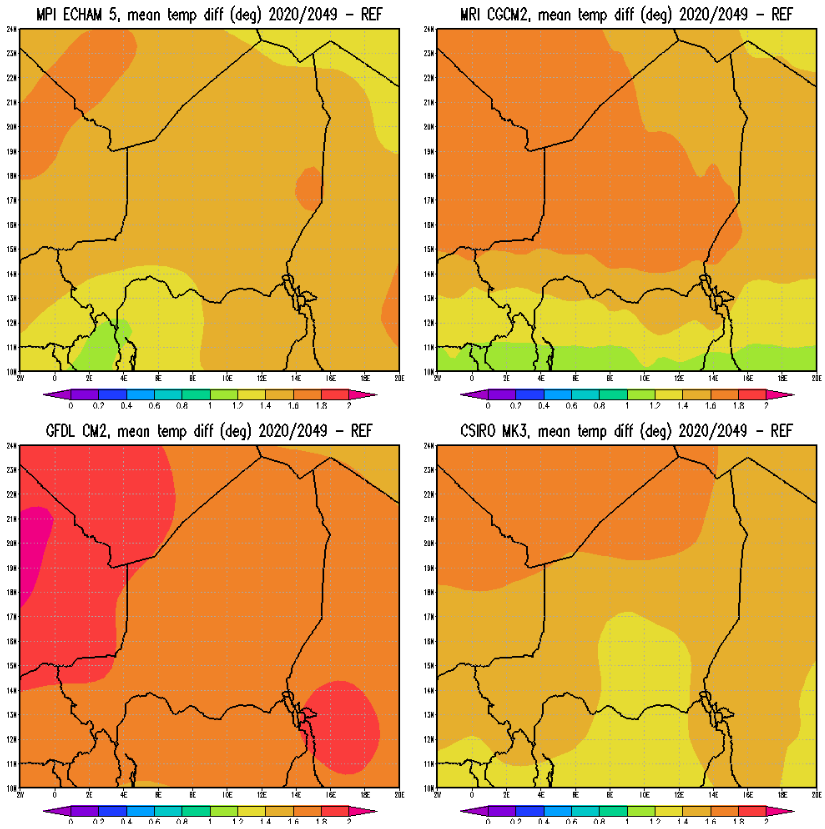

Figure 23: Relative variations of annual average temperatures from the models indicated

Figure 22 presents the expected variations of average rainfall in JJAS for the period 2020-2049 in relation to the baseline reference period between 1961 and 1990. These are disaggregated outputs of these models. Two models out of four (MPI ECHAM5, CSIRO K3) allow for an increase in rainfall in

Niger while the two others (GFDL CM2, MRI CGCM2) allow for a decline by 2020-2049. These models appear on the list adopted by IPCC. They highlight the uncertainty which characterizes rainfall variations predicted by Global Climate Models (IPCC, 2007), an uncertainty translating the disagreement of the said models to the signs of change predicted for the area including Niger.

Figure 23 (on the previous page presents the forecasts of variations of annual averages of air temperature in Niger by 2020-2049). The four models are unanimous in forecasting rises in these annual average temperatures from 1 °C to 1.6 °C in Niger, by 2020-2049. It should be borne in mind that these average values are annual, and that seasonal variations may be more significant.

IV.3 CONSIDERATION OF SCENARIOS TO ASSESS IMPACT ON AGRICULTURE: MILLET GROWTH AND ITS PRODUCTION IN NIGER

This assessment is based on three studies carried out, one with a plant growth model, and the other two on purely statistical bases.

a) The first study (Salack *et al*, 2008) used historical data covering the period 1961-1990 from 12 synoptic stations of the Sudano-Sahelian area of Niger. With regards to climate change scenarios, we resorted to those of HadCM3 model corresponding to emission scenarios A2a and B2a extracted from seven lattices covering the 12 stations mentioned above. Concerning the plant growth model, the one used is dynamic growth SARRAH model, simulating crop development and yield. It was possible to thus estimate the impacts of climate scenarios on the sowing date, the length of the growth cycle, the production of biomass and the crops yield (Souna III) and suggest adaptation measures at the field level for better making. Daily outputs were later analyzed to obtain average increases in temperatures and rainfall by the years 2020 and 2050. The values obtained vary between 0.7 and 1.85°C for temperatures and 3.44 to 8.34% for rainfall variations by the year 2050. The use of the SARRAH model for the simulation of millet yield is justified because it was calibrated and validated for this crop (Souna III) which is found throughout the Sudano-Sahelian area.

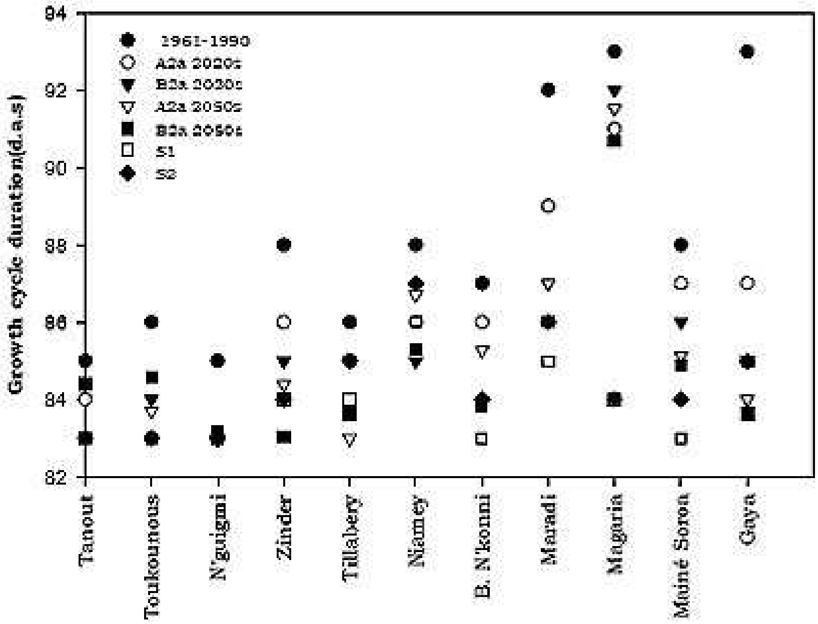

Figure 24: Modifications of the growth cycle of millet in different climatic scenarios

Sowing date is generated optionally by using a limit function approximating the response of the farmer. The agreed yardstick was 20 mm of rain followed by 20 days during which the development of the crop is monitored, and the seedling was considered as a failure if after 10 days out of these 20, the evapo-transpiration (ETP) relating to the crop was below 30%. Results obtained by these authors state a reduction of the growth cycle from 2 to 3 days by the year 2002 and from 4 to 5 days by the year 2050. The following figure shows the variability at local level for cycle millet from 82 to 92 days.

The decline in yield was 4.6% in scenarios A2a and B2a. We noted little difference between the two time horizons for this decline and for both scenarios.

Thus, with the scenarios considered, one could expect that millet would not be too vulnerable to heating during the rainy season, for the scenarios considered.

b) The second study was based on purely statistical considerations (Ben Mohamed et al, 2002). This study concludes that millet yield by the year 2025 at a 13% decline, as a consequence of a temperature rise in July-August-September. It should be recalled that rainfall is thoroughly correlated with maximum temperatures of the same period which will impact rain-fed crops such as millet.

c) The third study (Seidou *et al*, 2006) focuses on the statistical modeling of climate –cereal yield relation for Niger, funded by the Canadian International Development Agency (CIDA) within the context of the project to Support Adaptation capacities to Climate Change in Sahel Countries. According to this study based on a logistic regression model, up to 42% of millet yield variability in Niger may be due to rainfall.

In conclusion, the studies presented here properly confirm the conclusions of the 4th report IPCC concerning a decline in the yield of cereal crops as a consequence of temperature rise in tropical regions.

IV.4 SECTORS VULNERABILITIES

IV.4.1 Exposure units and time scale

IV.4.1.1 Agriculture

The area under study is the green belt of Niger whose total annual average rainfall (1971-2000) is above 200 mm.

With regards to the exposure units, the sampling focused on the following regions: Dosso (2.7% of national territory), Maradi (20.4% of the country's population) and Zinder (12.30% of the country's land area), regions which, in terms of agriculture, are the major areas of cereal production in the country. These regions also have many climate data over many decades.

Specific geographical areas in Niger were not taken into account but nine (9) synoptic stations for climatologic records and all livestock as regards cattle, were considered. Data concerning rainfall records from 1961 to 2005 of synoptic stations of the Direction of National Meteorology namely: Agadez, Birni N'Konni, Gaya, Maïné Soroa, Maradi, Niamey, Tahoua, Tillabéry and Zinder.

IV.4.1.2. Livestock production

Table 45: Exposure units per specie from 1961 to 2005

Specie	TCU strength	
	Average in 44 years	Standard deviation in 44 years
Cattle	2 444 794	562 783
Sheep	385 533	183 727
Goats	644 437	158 110
Camels	567 514	384 057
Total in TCU	**4 042 279**	**1 009 746**

Exposure units are the number of the various animal species in terms of number of individuals and total cattle base converted in Tropical Cattle Unit (TCU) which corresponds to a unit of cattle with body weight of 250 kg whose daily consumption in solid matter is 6.25 kg. The conversion is done as follows: one cattle = 0.8 TCU; one sheep = 0.1 TCU; one goat = 0.1 TCU and one camel = 1 TCU.

IV.4.1.3 Water resources

The choice of water resource units subjected to climatic stimuli is based on:

- the availability of long data series;
- the sensitivity of the water resource system to climatic stimuli;

- the socio-economic importance of the system.

Against the backdrop of these principles, the agreed exposure units are:
- surface water;
- ground water.

IV.4.1.4 Health

Choice criteria of exposure units concern the characteristics of the disease itself and the geographical area.

As far as the disease is concerned, it should first of all be a public health problem, climate sensitive and ravaging over a given area and quite a considerable period. Finally, we should have data on a relatively long series.

Geographical areas or regions chosen should have data on diseases which ravage in an endo-endemic manner and have a considerable socio-economic impact. These are the health districts of Maradi Council, Zinder Council, Agadez Council and Tillabéry for the following three diseases: malaria, meningitis, and measles.

IV.4.1.5 Time scale

We considered the following time horizons:
- the baseline reference period: 1961-1990
- the period under study: 1961-2005
- climate change projection horizon: 2020 to 2049

V.4.2 Current vulnerability of the sectors

IV.4.2.1 Agriculture

From surplus agricultural production up to the early 70s, by the late 80s only 86% of food needs met in Niger. Nowadays the country has become structurally deficient mainly because of drought. This deficit is linked to the decline in rainfall confirmed by DMN for the past three decades. Indeed, the study on the vulnerability of the agricultural sector highlighted that the evolution of millet, sorghum and cowpea cultivation yields is subjected to a high inter-annual variability linked to many factors including variations of the rainfall regime (Seidou et *al*. 2006). Floods also have a negative influence on agriculture. In 1998 for instance, 588 ha of rice fields, 8 608 ha millet fields and 203 orchards were damaged in Niger. The socioeconomic impact of climatic factors on agriculture is characterized by the decline in farm yields with the following consequences, among others:
- food shortage resulting in a permanent food insecurity;
- exacerbation of land conflicts which arevery often bloody;
- rural exodus leading to the establishment in urban areas of communities vulnerable to delinquency, begging, robbery and crime;
- increase in rural poverty;
- reduction in agricultural input in GDP.

V.4.2.2 Livestock production

The various results of the study on the vulnerability and adaptation of the livestock sector to climate change illustrated the influence of climatic factors particularly rainfall and temperature on livestock. As a matter of fact, in 1990, the total number of national cattle fell down as compared to their 1972 value. As illustration, during the 1973 drought, the total number of national cattle decreased by 40% as compared with their 1972 value. There is a correlation between the total number of cattle, as for example in 1990, the total number of livestock increased by about 80% as compared with their 1989 value notably as a result of rainfall fluctuations which have an impact on forage crop production. Among the different species, it is necessary to emphasize that camels are less vulnerable to climate change.

The socioeconomic impact of climate factors particularly during recurrent periods on the livestock sector is characterized by:

- a decline in the incomes of rural dwellers;
- important modifications of the composition of herds through a progressive replacement of bovines by small ruminants and camels;
- malnutrition of the population;
- the conversion of a significant number of nomadic breeders into sedentary thus reducing the cultivable areas;
- imbalanced of trade balance (external input of over 6 000 tons of milk per annum that is over CFA F six (6) billion);
- reduction in agricultural input in GDP.

IV.4.2.3 Health

The results obtained by the study on the vulnerability and adaptation of the health sector relatively to the occurrence of diseases such as malaria, meningitis and measles reveal sound correlations between meteorological and health parameters.

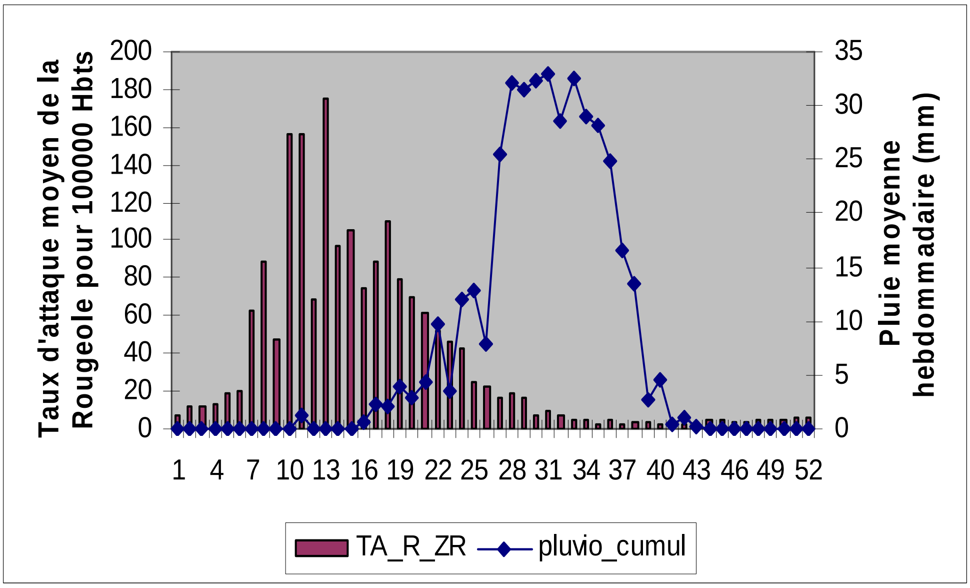

Figure 25: Influence of rainfall on the weekly incidence of measles in Zinder

In fact, in all the regions studied, it was established that extreme temperatures influence the seasonal or quarterly distribution of cases or rates of occurrence of these diseases. For the case of malaria, the first quarter characterized by the lowest temperatures and the second quarter corresponding to the hottest quarter experience the lowest rates of attack of the year. Rainfall is also a climatic parameter which influences the incidence of the rate of malaria attack. Indeed, the same study shows that the highest rates of malaria attack were recorded in the third and fourth quarters corresponding to the rainy season. The influence of extreme temperatures on the rate of malaria attack is translated by low rates during the first two quarters (January, February, March, April, May, June) during which temperatures are highest.

Measles as well as meningitis mainly ravage during the dry and hot period. During this period, the rate grows up to a certain period related to extreme temperatures. The rate of attack of meningitis reduces with the arrival and the evolution of rainfall accumulation.

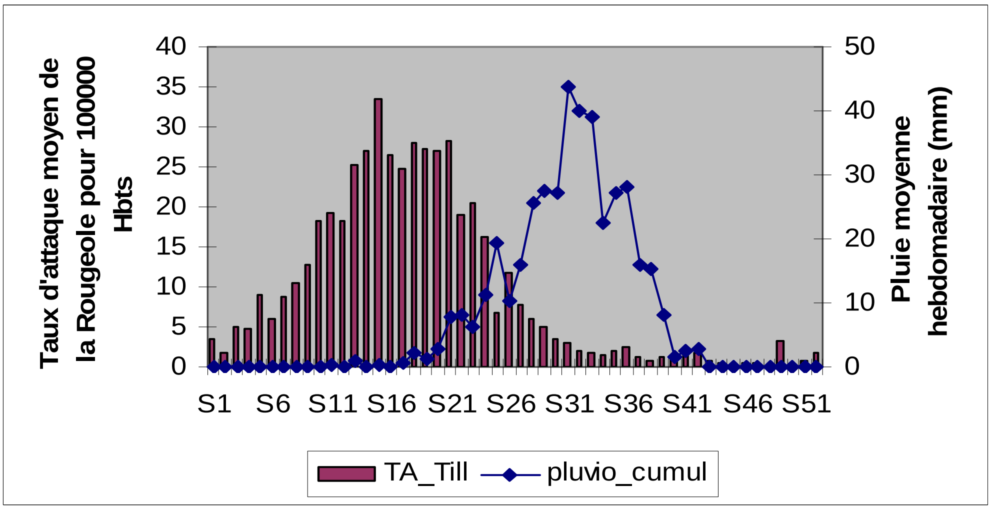

Figure 26: Influence of rainfall on the weekly incidence of Measles in Tillabery

IV.4.2.4 Water resources

The analysis of rainfall anomalies in the 59 stations distributed over the national territory (DMN, 2006) shows a decrease of rainfall since the last three (3) decades, as illustrated on figure 26.

The corresponding rainfall deficit is in average of 20% but may reach higher values at 30% in some regions.

Recent studies conducted in the entire West African region (Servat et al. 1998) show that the decline in rainfall is basically as a result the reduction of the number of rainy events. In addition, the analysis of rainfall time-series shows a definite trend of isohyet slide southwards

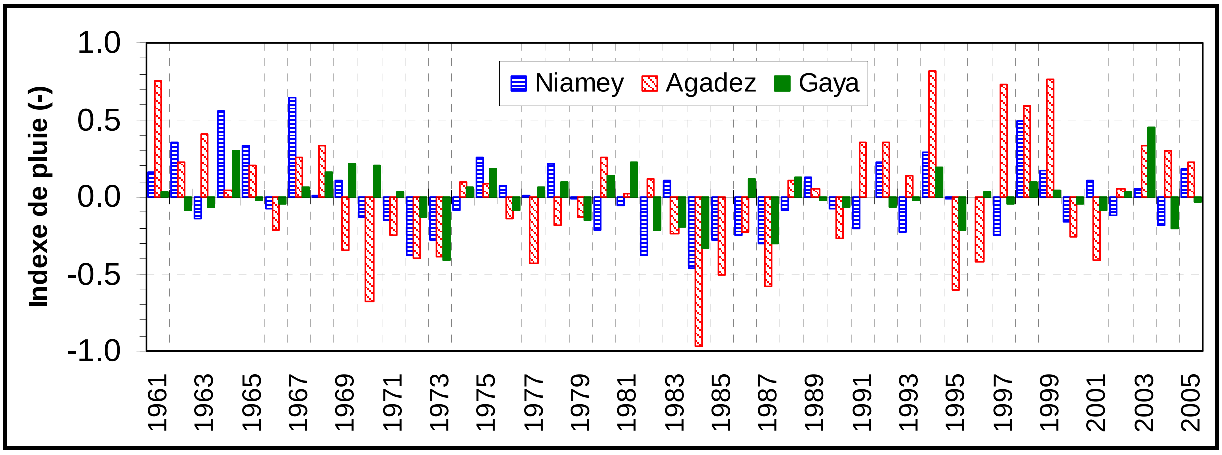

Figure 27: Rainfall anomalies at Niamey, Agadez and Gaya stations.

IV.4.2.4.1 Surface water

Hydrometrical observations show that consequences on water flows and the decline in rainfall observed over three (3) decades are: (i) a significant variation of annual average flows, concomitant with that of rainfall from 1970 for the major part of rivers and notably the Niger River; (ii) a widespread decline in flows from rivers.

The decline in the Niger River flows in Niamey (the next figure) for instance is more significant than that of rainfall of 40 to 60% since the early 1970s compared with 20 to 30% for rainfall at the Niamey station. This decline is however less obvious in tributary basins of the river's right bank.

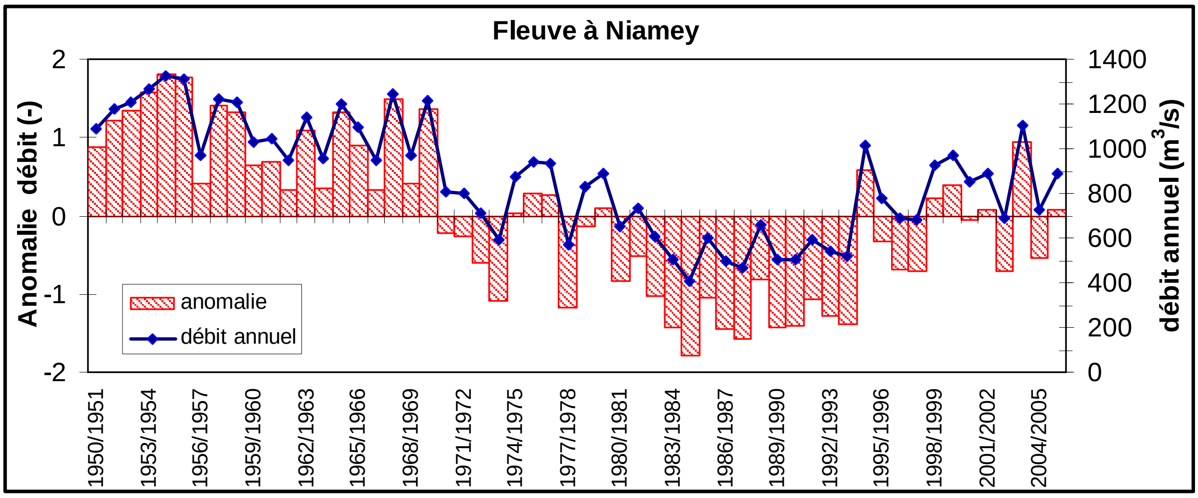

Figure 28: Annual abnormalities and flow of the Niger River in Niamey (1950-2005)

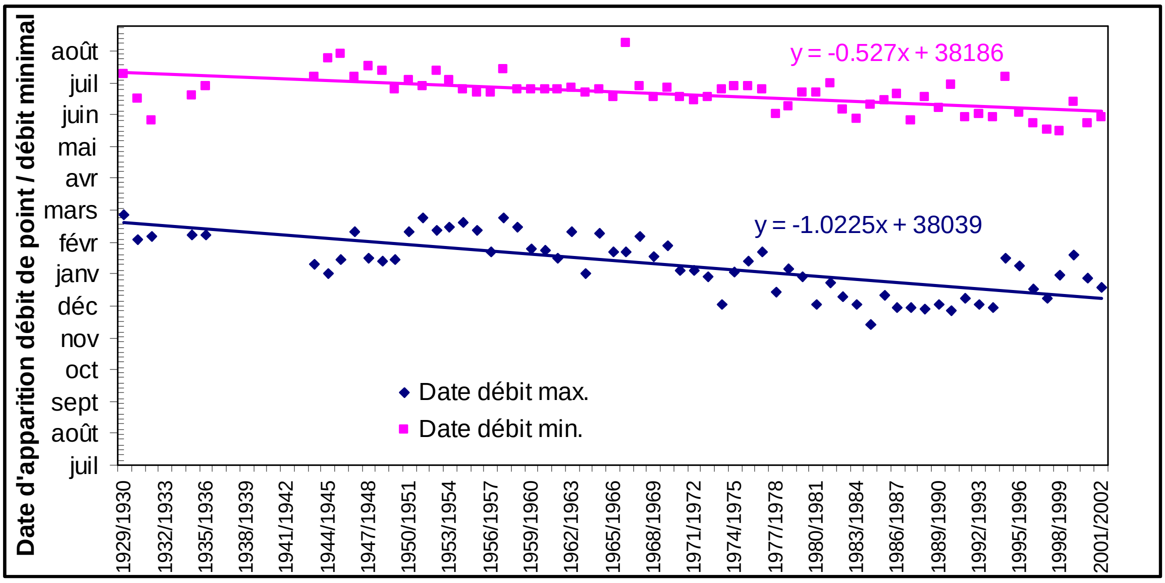

Figure 29: Changing of dates of appearance of peak flows (Guinean flood) and minimal flow from the Niger River at Niamey

The analysis of the hydrograph from the Niger River in Niamey also shows (figure 29) that:

- the peak flow of the Guinean flood arrives increasingly earlier, from February/March in the 50s, to December/January in the previous decades;
- recession is also increasingly faster, the minimal flow which formerly took place in June/July, is recorded from the month of May during the last decade.

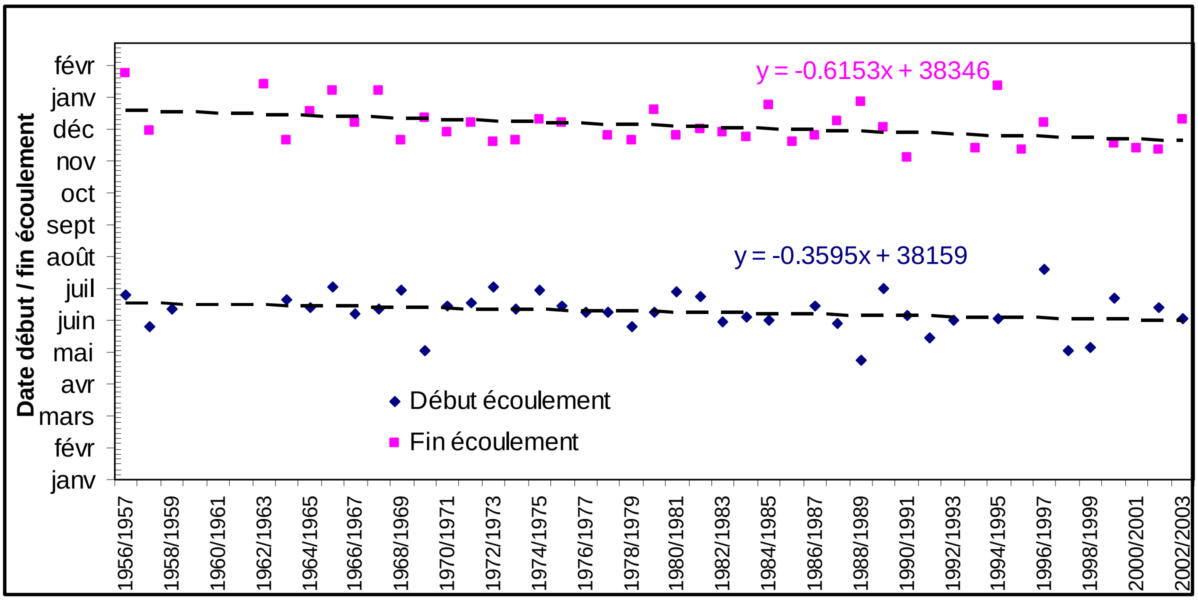

Figure 30: Changing of start and end dates of flows from Sirba to Garbé-Kourou

On right bank tributaries such as Sirba, the same analysis targeted at the appearance (start) and the end of flows (figure below) shows that:

- flows from Sirba increasingly take place earlier, from May/June in the late 1950s, to June/July in the early years of 2000;
- recession also takes place increasingly earlier, from December/January in the late 1950s, to November/December in the early years of 2000.

Like the River Niger, Sirba thus presents a general displacement of its flow regime, which is not without consequences on the availability of the resources.

IV.4.2.4.2 Ground water

The vulnerability of ground water resources to climate change and variability lies on the quantitative and qualitative levels. With regards to the quantitative level, it is the variation of the water table piezometric level whose decline suggests a reduction of the availability of the resource. Concerning the qualitative level, the variation of ground water quality is linked to the modification of mineral properties of water.

The water tables of Continental Intercalary/Hamadien are fed by infiltration from rain water in the free water table part of Continental Hamadien (Maradi region). The renewal of these waters is low and the fossil nature of the resource limits its vulnerability. The water table of CT3 is basically fed by infiltration of flood water from *koris* and gullies. This high dependence on flows makes the CT3 water table a resource particularly vulnerable to climate stimuli. The Manga Pliocene aquifer is considered as fossil as a result of a very low renewal and recharge. It is thus potentially less vulnerable to climate changes and variability. However, the Manga extended aquifer fed by infiltration in the bed of the Komadougou, pools and oasis basins undergo significant seasonal and inter-annual fluctuations which show its vulnerability to climatic stimuli. However, the absence of long lasting piezometric records does not make it possible to clearly bring out the evolution of the resources.

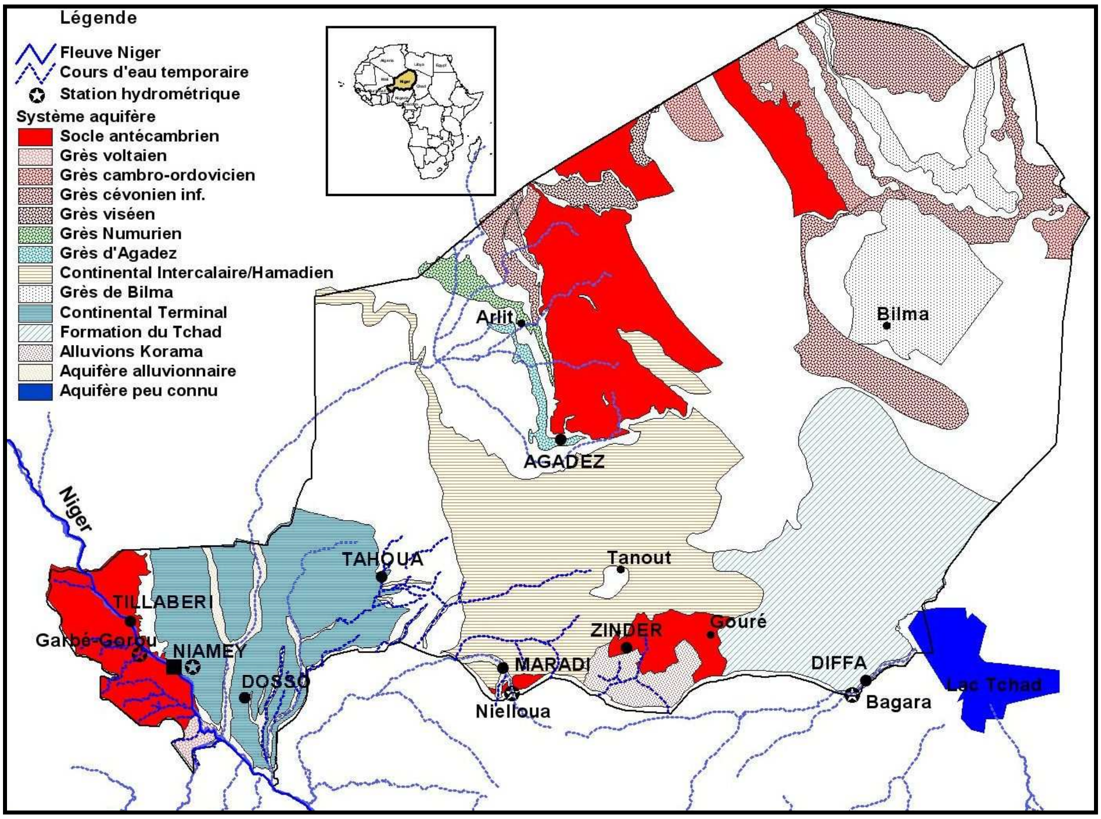

Figure 31: Map of ground water resources in Niger

Alluvial aquifers are very vulnerable to changes and to climatic variability because they are associated with rivers. Moreover, its shallow nature makes this resource the target of often significant water collection for irrigation and drinking water. To this one could add the sensitivity of flows to human actions modifying the state and conditions of surface water in tributaries.

IV.5 FUTURE VULNERABILITY TO CLIMATE CHANGE

IV.5.1 Agriculture

It emerges from the analysis of the different climatic projections made in the regions studied that food security is far from being provided in the future. There is a visible gap between the food needs of a fast growing population and probable agricultural production.

Under the influence of population pressure, the gap could in the long term have an exponential trend (resulting in a demand/probable production balance sheet) which will always be negative in spite of the sensitive growth of millet, sorghum and cowpea production.

The major impact of rainfall decline will be soil degradation, decline in agricultural production and chronic distribution of food supply. There is also an expected continuous large scale movement of populations, an increase in diseases and an important loss in terms of biodiversity.

IV.5.2 Livestock production

In spite of the unfavorable climatic trends, the development of cattle from 2005 to 2035 tends to grow significantly; this does not take into account possible epizootic diseases which could disrupt the trend thus projected.

In the light of unfavorable climatic conditions which stand out on the horizon, the socio-economic consequences could be dramatic. In fact, as the decrease of rains encourages the decline in productivity, men and animals will tend to migrate towards more productive areas thus exacerbating conflicts between farmers and breeders.

Livestock dangers could lead breeders to switch to other types of activities leading to changes in habits and customs. At the macroeconomic level, the livestock sector which is the second mainstay of the national economy would no longer contribute considerably as in the past to the country's gross domestic product balance of trade.

IV.5.3 Forestry

If the evolution of forest area based on man-made factors and the climate effects related to climate changes noticed from 1970 to 2000 remain, the projection by 2025 based on parameters calculated for the year 2000 (baseline reference year), shows that the forest degradation process will increase. In the absence of a sustained and consolidated effort of reforestation and forest management and/or substitution with other alternative sources, by the year 2025, the needs of a population of 23 million inhabitants would be about 24 million steres.

Species which in the past were less preferred for firewood will be used by the disadvantaged rural populations in lands where agroforestry parks would have disappeared.

IV.5.4 Health

IV.5.4.1 Malaria

A review of the results of projections described clearly shows an increase in minimum and maximum monthly temperatures over all of our stations. These results are in perfect agreement with the conclusions of IPCC's 4th evaluation report.

These increases will also be noticeable by 2020-2049 for Zinder, Maradi, Tillabery and Agadez stations with scenarios A2 and B2. In these localities where studies on malaria are not conducted, the rise in temperatures during the wet season (December to February) could result in quite a high transmission by creating more favorable thermal conditions for the transmission cycle notably the sporogonic cycle of the parasite and the survival of the vector (MARA /ARMA, 1998).

In fact, it should be recalled that the development of the parasite stops at 16 °C, but the transmission which is below 18 °C is less probable not only because, at this temperature, very few adult mosquitoes survive the 56 days necessary for the sporogony, but also because the abundance of mosquitoes is limited by a long larval period. At 22 °C, the sporogony is achieved in less than three weeks and the proportion of mosquitoes surviving at this period (15%) is quite significant for the transmission cycle to take place. Thus, a temperature below 18 °C was considered as unfavorable, and temperature above 22 °C as entirely favorable for the transmission.

The higher temperature limit is basically determined by the survival of the vector, since temperatures above 32 °C are linked to a major renewal of generations, weak individuals and a high mortality rate (Le Sueur, 1991, Maharaj, 1995).

Thermal death takes place at 40 °C. However, at some very hot periods an increase in temperatures could also considerably reduce the transmission cycle.

In this work, for problems linked to the availability and quality of health data on this scale, correlations were not studied. It is most likely that for stations in the East where minimum temperatures are quite low (Zinder, Agadez, Maradi), an increase in minimum temperature during the wet season will increase the rate of malaria attack. To illustrate this, at Tillabery, the rate of malaria attack is quite high due to the fact that the country's highest minimum temperatures are most often recorded in this locality. However, the rate of malaria attack might reduce considerably during the hot period because the increase in temperature where it is already high will eliminate transmissions and could cause the death of mosquitoes. Moreover, annual rainfall will rise in Zinder, Tillabery and Agadez by 2020-2049.

If appropriate adaptation measures are not taken, morbidity and the rate of malaria attack will increase as well as subsequent mortality. At Maradi, there will be a slight rise in annual rainfall, which does not favor an aggravation of malaria cases. With regard tos rainfall, the 4th IPCC report is rather moderate for tropical regions or low latitudes. Models are not unanimous even if generally speaking it is a downward trend which will be the most credible according to their conclusion. It should nonetheless be borne in mind that rainfall in our latitudes is characterized by a high variability of distribution in space and time

IV.5.4.2 Meningitis

Except for Maradi, by 2020-2049, rainfall will show a rise in the months of July, August, September and an annual rise. This situation combined with temperature rise could extend the dry period and will thus increase the rate of meningitis attack. As shown from the analysis of the first correlation results, meningitis thrives during the dry period with a low humidity rate and an absence of rain. Temperature rise during 'wet' seasons may also be to the advantage of a high rise in the attack rate of this disease in the absence of a high humidity rate. However, at Tillabery, the season could stretch out over a long period and reduce the dry season and thus reduce the occurrence and rate of attack of meningitis in this region.

IV.5.4.3 Measles

At Tillabery, by 2020-2049, there will be an increase in temperature and most especially a considerable increase in rainfall. If this increase is translated by an extension of the rainy season, which seems to be the case, there will then be a reduction of the period of intense measles activity with rains which will begin from April. This means that the late start of the rainy season will not concern Tillabery. These conditions encourage a reduction of attacks from measles in this locality even if the changes which will take place in the other non-rainy periods of the year, notably temperature rise, could have a reverse effect.

This is also valid to a lesser extent at Zinder and Agadez. However, at Maradi, rains will reduce. This reduction could cause an extension of the period conducive for the development of measles.

IV.5.5 Water resources

Complex or simplified climate models (General Circulation Model, Regional Models) based on physical mechanisms are the major instruments to project future climate trends.

IV.5.5.1 Rainfall

In spite of considerable uncertainties, climate models make it possible to satisfactorily simulate future rainfall trends at global level.
However, at sub-regional, national or local level, the visible variability of rainfall and the so dispersed observation network make future climate change forecasts difficult and uncertain.

Trends announced for the West African zone by simplified models point to the following rainfall modifications at national level:

- a greater variability of rainfall from 0.5 to 40% in the sub region, with an average of 10 to 20% by the year 2025;
- the continuation of isohyets shift southwards already begun in the late 60s will persist in line with rainfall decline;
- a reinforcement of the hydrological cycle with the appearance of climate phenomena unknown in the past in the country;
- a rise in the frequency of high rainfall and droughts episodes, but with uncertainties on the zones concerned and the periods.

IV.5.5.2 Surface water

Future impacts of climate change on surface water resources result from the announced disruption of rainfall. The following are the most probable:

- the observed decline in the flow of the Niger River;
- the increase in flows in endoreic micro-catchments and tributaries of the river's right bank;
- the displacement process of the Niger River's hydrological regime and the major tributaries of the right bank could continue with peak flows from the Guinean flood to Niamey which will be shifted from February/March to December/January, or even November/December in

the most unfavorable SRES scenario cases;

- the scope and frequency of floods will increase notably in the Southern band of the country. This increase will result from the expected rise in the frequency of episodes of heavy rainfall, even if the effect of a given variation of rainfalls depends on the surface conditions and other characteristics of the tributary;
- evaporation will increase in line with temperature rise, which could reduce water volumes in our dams and water reservoirs even where rainfall increases or changes so little.

IV5.5.3 Ground water

The impact of climate change on ground water resources not only depends on changes in volume, the period and quality of flow and recharge, but also on the characteristics of the aquifer system, pressures to which it is subjected, the trend of its management and adaptation measures taken. Against the backdrop of climate change impacts on rainfall and flows, the possible impacts on ground water are:

- the decline in the recharge of the water tables and consequently their piezometric levels, notably ground and alluvial water, as a result of the reduction in rainfall and flows. This vulnerability will be increased by human pressure linked to water collection. It is less likely that announced climate changes should have major effects on municipal and industrial demand. It could however strongly affect water collection for irrigation purposes. Water collection for irrigation, further determined by weather, could thus increase or reduce according to rainfall trends: higher temperatures will tend to increase demand, as a result of a higher rate of evaporation;
- the increase in the recharge of water tables and the piezometric level rise in endoreic basins where flows could increase;
- a very significant reduction in the recharge of aquifers of large sedimentary basins;
- the reduction or increase in water table input to streams according to the increase or decline of the recharge;
- the increase or reduction of ground water resources in line with recharge trends;
- the deterioration of the quality of water in relation with the increase or decline of water table recharge. The increase in flows in deforested areas promotes soil leaching and the concentration of polluting elements towards low-pressure areas favorable to recharge.

V. ADAPTATION TO CLIMATE CHANGE

V.1 ADAPTATION ASSESSMENT

Adaptation assessment is considered as the assessment of the capacity of particular systems and groups to adapt to specific types of risks. In this document, there is no assessment per say, but an analysis of current and future vulnerability to climate change so as to propose adaptation strategies. The system is seen here as an economic sector in relation with the population. The risks on their part are defined physically for instance a drought, a storm or very precipitation. Two approaches were used to propose adaptation strategies.

The first approach is the one which served in the preparation of the National Action Program for Adaptation to Climate Change (NAPA) in Niger. Indeed, in the preparation of NAPA, a survey was conducted to determine the climate change and variability observed. For example, the analysis of established reduced rainfall anomalies based on rainfall data from 59 stations, from 1961 to 2004, shows a downward trend of rainfall over the last three decades. It is from lessons learnt from this survey and some indicators developed with the participation of local stakeholders to identify factors which facilitate and limit their own adaptation, that many adaptation strategies were proposed.

The second approach is based essentially on the deduction of the consequences on some socioeconomic indicators of the results of climate change projections made during the study on future vulnerability. These indicators were identified thanks to a judgment of experts and taking into account the priority needs of local communities. Adaptation measures were later proposed taking into account the links between these indicators and some climate parameters as well as socioeconomic, political and environmental conditions described in terms of current vulnerability and existing adaptation.

V.2 ADAPTATION STRATEGIES AND MEASURES

Table 47 of the following page gives in detail the list of on-going adaptation measures or strategies advocated.

Table 46: Proposed adaptation measures

Sector	Adaptation strategies
Agriculture	• improvement through research of the genetic resistance to the desiccation of cereal varieties and improvement of farming techniques • effective protection of crops against harmful organisms • diversification and intensification of irrigated farms • support to the promotion of sub-urban vegetable farming • promotion of Income Generating Activities and the Development of Credit Unions
Water resources	• knowledge and control of water resources • improvement of the coverage of the populations' water needs and their living environment • support to all production sectors while seeking a better adequacy between costs of investments, maintenance and operation of water infrastructure • full participation of the populations in the design and execution of water works • protection of water resources and water ecosystems • development of water resources through a better organization of value chains • adequacy between water supply (for domestic, industrial, agricultural use...) and the treatment of residual water • adequacy between facilities disrupting water regimes
Livestock	• support to traditional breeding through the development of pastoral facilities and securement capacities in grazing areas • increase the productivity of livestock by improving the genetic potential and the development of agriculture/livestock integration • support to village poultry farming • recovery of the live or dead stock value chain • support to the organization of the livestock value professionals • support to the privatization of the zoo-veterinary profession • fight against epizootics and setting up health intelligence • promotion of dairies and support to sub-urban livestock production • support to veterinary and zoo technical research • promotion of unconventional livestock production • support to the implementation of the action plan for the recovery of livestock production in Niger and attendant measures

Transport	• setting up a Road Data Bank • inspection of the road network • setting up an institutional framework to govern the importation of vehicles • institution of a regular control of greenhouse gas emissions released by imported vehicles
Health	• handling of endemo-epidemic climate sensitive disease cases • promotion of epidemic prevention and control measures • building the capacities of the mechanism to collect data necessary for decision-making with a view to managing climate-sensitive disease epidemics • introduction of an adequate research-action system likely to enable rapid and efficient decision-making • setting up and continuous reinforcement of an adequate biological monitoring system • adequate and free handling of meningitis cases • sensitization of the populations for the protection and prevention against climate-sensitive diseases • coordination of decisions and actions to epidemics at all levels • setting up high-performance vaccination strategies • setting up a communication and social mobilization system in the event of epidemics • systematic vaccination

As it could be noticed, these measures focus on:

- the promotion of alternative non agricultural jobs in rural areas.
- the extension of irrigation;
- the integrated management of land, water and other resources for their preservation and their sustainable and equitable use;
- education and training because the introduction of issues relating to climate change at different levels of education is a continuous process which may help in building the capacity of stakeholders in sustaining adaptation in the future and to develop appropriate research activities as well as a wider sensitization of citizens;
- sensitization campaigns of the public because such campaigns may increase awareness and disseminate information so as to enhance public awareness and the involvement of a wide range of stakeholders. These campaigns may also be an opportunity for decision-makers in charge of adaptation to better perceive and understand the public's point of view on climate change and adaptation;
- reflection on public policies likely to encourage and support adaptation of individuals and the private sector, particularly through the restoration of incentive tax measures or subsidies;
- the development of efficient early warning systems, particularly for extreme events such as droughts and floods;
- the development of science, research and development and technological innovations to enable responses to be provided to climate change in general, and also responses specific to vulnerability to climate change, including the economic assessment of adaptation in general and technological adaptation in particular;
- the establishment and reinforcement of monitoring, observation and communication systems (parameters linked to weather, other indicators and impacts of climate change, etc.) to enable policy-makers to readjust their adaptation strategy based on confirmed climate change;
- the promotion of alternative non-agricultural jobs in rural areas.



V.3 SHORTCOMINGS AND CONSTRAINTS

They may be classified into three levels: human, material/technical and financial.

V.3.1 At the human level

They are mainly: (i) the low development of teaching, training and research on climate change notably with respect to vulnerability and adaptation aspects; (ii) the absence of an adequate real national expertise mastering the tools and methodologies for an appropriate evaluation of vulnerability and adaptation to climate change; (iii) inadequate scientific training on some aspects such as vulnerability, adaptation and mitigation of climate impact; (iv) national stakeholders' lack of understanding of the issues and the challenges of climate change; (v) poor skills in documentation and archiving.

V.3.2 At the material and technical level

They are mainly:

- the absence of systematic national research and observation institutions in the area of water sciences (meteorological, hydrological services…);

- the absence of an accessible and structured national database (hydrological, hydro-geological, forest inventory…) for a better assessment of vulnerability and adaptation;
- thinness and diversity of methods of documentation and archiving of data and information considering the high number of structures holding data;
- absence of long term surveillance and monitoring units of climate parameters;
- absence of a specific coherent model and a very sound resolution for the assessment of vulnerability and adaptation applicable to all sectors;
- the absence of efficient systems of climatic and hydrologic projections;
- inexistence of a national calculation center specialized in research on climate change;
- inadequate material resources for collection, archiving, analysis and communication (SIG, TIC…) in most national data producing services.

V.3.3 At the financial level

They are mainly: (i) low financial capacity of institutions producing and holding data in the area for their collection, archiving, analysis…; (ii) absence of financial resources for the purchase and acquisition of some data necessary for the assessment of vulnerability and adaptation; (iii) inadequate financial resources to build capacities and build on a sustainable assessment system for vulnerability and adaptation; (iv) low fund raising to support programs and adaptation strategies.

V.4 SENSITIZATION PROGRAM FOR STAKEHOLDERS ON THE IMPACT CLIMATE CHANGE

Table 47 below summarizes the various tools likely to enable an adequate public awareness on climate change in Niger.

Table 47: Adequate public sensitization tools on climate change

Themes	Activities	Target Public	Tools
Knowledge of the Kyoto Convention, Protocol	Development of the documentation on the theme, production of a documentary film.	Policy makers, parliamentarians, local elected representatives, NGOs/DAs, technical executives, private operators and local councils	Concept document Radio/TV programs, fora Workshops/seminar
Knowledge and popularization of adverse impacts on vulnerable sectors	- preparation of thematic brochures in national languages, - production of films, documentaries, radio/TV programs	Policy makers, parliamentarians, local elected representatives, NGOs/DAs Technical executives, private operators and local councils	Thematic brochures in French and national languages, radio/TV programs workshop/seminar, for a
Training and retraining of technical executives and other players	- Identification of training needs, - preparation of training modules.	Central, regional, divisional, and council executives and NGOs/DAs	Workshops /seminars
Sensitization of school children and academia on the CC phenomenon	- design of posters, booklets and documentary films	Pupils, students, supervisors	Posters, documentary films, presentations, conferences/ discussions

VI. INSTITUTIONAL ARRANGEMENT ON CLIMATE CHANGE, PRIORITY NEEDS, FUNDING NEEDS

VI.1 MEASURES ADOPTED AND PLANNED TO IMPLEMENT THE CONVENTION

Following the signing of the United Nations Framework Convention on Climate Change (UNFCCC) on June 12th, 1992 and its ratification on July 25th, 1995, Niger has developed a National Environmental Plan for Sustainable Development (PNEDD) which is the inspiration framework of all policies on the environment and sustainable development, the implementation of which is coordinated by the National Environmental Council for Sustainable Development (CNEDD). Established in January 1996 and placed under the control of the Prime Minister's Office, the CNEDD coordinates six (06) PNEDD's priority programs including the Climate Change and Variability Program (PCVC).

To this end, specialized technical Commissions including the National Technical Commission on Climate Change and Variability (CTCVC) were set up to support the implementation of the PNEDD. This is how the CTCVC was established in 1997; it comprises representatives from public services and parastatals, non-governmental organizations, research and training institutions, the civil society and the private sector. Its aims is to support the Executive Secretariat of the National Environmental Council for Sustainable Development (ES/CNEDD), in the implementation of the Climate Change and Variability Program.

One of the major objectives of the PCVC is the implementation of provisions of the United Nations Framework Convention on Climate Change nationwide. It is under its supervision that Niger undertook the preparation of its first National Communication.

The self-assessment of this first communication led to a revision of the commission by adoption of Order 000050 PM/SE/CNEDD of 07 June 2006 modifying Order No 054/PM/CNEDD of 21 July 1997 on the establishment and duties of the CTCVC Commission. Moreover, within this commission, five (5) thematic task groups were established, namely: (i) Energy-Water-Road Infrastructure; (ii) Agriculture-Livestock; (iii) Forestry, Fisheries and Wetlands; (iv) Industrial Processes, Wastes and Health and (v) Clean Development Mechanism.

After the publication of its initial National Communication, Niger has undertaken a number of activities in the area of climatic change:

- the preparation, validation and adoption of the national strategy and action plan on climate change and variability with the support of UNDP/GEF;
- the organization of several information and sensitization workshops on climate change;
- the publication of five articles in newspapers and the preparation of a brochure on climate change ;
- the organization of several training and awareness raising workshops on the Clean Development Mechanism (CDM) for State services and the civil society. These training sessions led to the identification of nine (9) project ideas;
- the development of the National Action Program for Adaptation to Climate Change (NAPA) with the objective of contributing to mitigating the adverse effects of climate change on the most vulnerable populations, for sustainable development and poverty reduction in Niger;
- the implementation of the UNDP/GEF/RAF02-G31 project entitled "Capacity building to improve the quality of greenhouse gas inventories in West and Central Africa" which aims at building the capacities of beneficiary countries, so that they can improve the quality of activity data and emission coefficients used in their national GHG inventory;
- the implementation of the Initial National Communication Self-assessment Project whose objective was to identify the shortcomings and inadequacies linked to this Communication and propose improvements for the Second National Communication;
- the development and implementation of the National Self-assessment Project of Capacity Building (ANCR) in order to manage the global environment: this project's objective is to assess capacity building needs and to propose a strategy and action plan for the implementation of capacity building activities within the framework of conventions on

desertification control, biological diversity and climate change.

VI.2 PRIORITY NEEDS ON THE TRANSFER OF TECHNOLOGIES

In order to achieve sustainable development, adaptation measures should be sustained by an intensification strategy of technology transfer. It follows that technology transfer both for mitigation and for adaptation to climate change should take into account economic and social development priorities as defined by strategic frameworks such DSRP, SDR, PANA, DPE, SNASEM and other sub regional integration strategic documents. It should be noted that potentialities offered by the country's resources render the issue of Technology Transfer crucial, particularly in the energy sector. The major challenge remains their correct assessment as well as a consequent capacity building program to address the issue. To do this, fifteen (15) project ideas were defined. These projects concern both mitigation and adaptation to climate change. They also prefigure the consideration of climate change in national strategic frameworks.

Taking into account the greenhouse gas inventory presented in chapter III, it emerges that emphasis should be laid on avoiding of GHG emissions without the risk of hampering the country's economic and social development. Table 50 below presents the objectives and other relevant indications relating to the following strategic documents: SDRP, SDR, DPE, SNASEM, and Kandadji. It also defines the technological potentials both in achieving the targeted objectives and possibly alternatives likely to lead to climate change mitigation in terms of avoidance of greenhouse gas emission while enabling economic development to continue sustainably. At the end the review of the objectives of these various strategic frameworks, one may mention those showing an interest for the transfer of ERTs for the mitigation of greenhouse gas effects: (i) SDRP is the global reference framework including all the other sector-based strategic frameworks; (ii) SDR in some of these major cases; (ii) DPE, and SNASEM which complement this mechanism in terms of relevant indicators for energy needs and consequently the technological potential for sustainable development and; (iv) NAPA with the objective of meeting the immediate and urgent needs of the most vulnerable communities.

Table 48: Technological potentials according to strategic axis

Strategic documents	Overall objective	Specific objectives	Relevant indicators	Technological potential
SDRP_AXIS 5: Infrastructural development	Equip countries with economic infrastructure to boost growth and facilitate access to social services	Specific objectives of SDR, SNASEM, DPE and other sector strategic frameworks	Indicators in terms of drinking water coverage, IHC coverage, and equipment of irrigation areas	Solar PV is the most buoyant option considering national experience in the various drinking water supply and health sector. The irrigation sector is still dominated by the use of thermal pumping
SDRP_AXIS 2: Equitable access to basic social services	Promote universal access to social services and make the poor benefit sustainably from it.	Specific objectives of SNASEM, DPE and other sectoral strategic frameworks such Energy and Sustainable Program (PEnDD).	Indicators in terms of drinking water coverage, IHC, communication, education coverage and promotion of ICTs.	Solar PV technologies for the health, education, communication and drinking water supply sectors. Energy conservation and substitution of energy wood in the residential sector.
SDR_Program No 10: Preservation of the environment	Preserve the environment with a view to a healthy and sustainable exploitation	A wood economy is realized through the dissemination of alternative techniques	Indicators in the residential sector in terms of energy conservation and substitution of energy wood.	Technologies of improved energy efficiency stoves, promotion of solar cookers, and substitution of energy wood by LPG and mineral coal.
SDR_Program No 11: Fight against food insecurity	Provide food security through the development of irrigation	Irrigated surface areas shift from 85 000 ha to 160 000 ha by 2015	Indicators on food security in particular the ration of irrigated farming over national annual production. Portion of small-scale irrigation.	Irrigation dumping technologies. The possible options are electrical interconnection for larger land areas and promotion of PV solar pumping, wind pumping and use of biogas for small size areas (below 1 ha)
SDR_Program No 13: Land reclamation and reforestation	Reverse the generalized trend of soil degradation and vegetation cover	An economy of 7 000 000 tons of firewood is realized through the dissemination of adapted techniques.	Indicators on the access rate to substitution equipment in rural and urban areas as well as the promotion of fuel efficiency stoves.	Technologies of improved energy efficiency stoves, promotion of solar cookers, substitution of energy wood by LPG and mineral coal
Program No 14: Kandadji	Contribute to poverty reduction through the regeneration of the natural environment, the improvement of food security and the coverage of water and energy needs.	A hydroelectric power plant of a capacity of 125 MW is built with an associated transmission of line of 132 KV (167 km).	Indicators on national coverage on energy needs and percentage of national production over total of final consumption.	Hydroelectric energy technology

The national priorities listed below may be reconciled with the results of National GHG Inventory in the energy sector indicated in the table which follows as well as with mitigation studies.

Table 49: GHG Inventories in Niger (Energy sector)

Sub-sectors	**CO_2**	**CH_4**	**N_2O**	**NO_x**	**CO**	**CVONM**	**SO_2**
Power industries	275.85						1522.99
Manufacturing and construction industries	102.26						101.05
Transport	762.39						345.25
Trade and institutional	1.18						170.67
Residential	702.71						
Agriculture, fishery and fish-farming	45.78						
Others (mines)	1.78						
Total	1875.39	34.73	0.48	21.10	613.54	76.31	2139.96
Biomass	5590.09						
International bunker fuels	37.4						
Total in Eq-CO_2	1875.39	729.33	148.8				

It follows from the analysis of this table that the transport sub-sector is the first transmitter in the energy sector with 762.39 Gg of CO_2 followed by the Residential with 702.71 Gg of CO_2 and power industries with 275.85 Gg of CO_2.

Manufacturing and construction industries sub-sector as well as the agriculture sector are on the fourth and fifth position respectively.

However, by including emissions resulting from biomass burning for energy purposes, the residential sub-sector becomes the most transmitting sector.

One could say that priority sub-sectors for the promotion of ERTs for Niger are:

- the Residential sub-sector with a total emissions of 6 292.8 Gg of CO_2;
- the transport sub-sector with 762.39 Gg of CO_2;
- the energy industries sub-sector with 275.85 Gg of CO_2;
- the manufacturing and construction industries sub-sector: 102.26 Gg de CO_2;
- the Agriculture, Fishery and Fish Farming sub-sector with 45.78 Gg de CO_2.

The objectives backed by the figures displayed for these sub-sectors, by 2012 and 2015, by the different strategic frameworks of the country are summarized on the table on the next page.

The achievement of these quantitative objectives requires energy supply according to different options.

The option or combination of options chosen will depend on the increase or not of emissions by the country. The technological possibilities available and their costs (in millions CFA F) are presented in the table which follows.

Table 50: Available technological possibilities

	Year		
SECTORS	**2 006**	**2 012**	**2 015**
RESIDENTIAL			
Promotion of fossil-coal fireplace substitutes (households)	21 124	524 536	1 029 451
Promotion of LPG fireplace substitutes (households)	27 659	488 838	1 029 451
Access of rural households to electricity (households)			852 705
Access of urban households to electricity (households)	161 986	249 639	353 492
TRANSPORT			
Promotion of Intermediate Means of Transport (units)	0	50	30
Railway Interconnections (km of line)	0	2 000	0
Improvement of the vehicle fleet (units)	nd	nd	nd
ENERGY AND WATER INDUSTRIES			
Potable water supply points in rural areas (mini-PWSP)	502	1 432	7 162
Potable water supply points in urban areas (PWSP)	nd	nd	nd
Generation of hydroelectricity (MW))	0	130	0
Thermal generation of electricity (coal) (MW)	50	105	261
Oil exploration and production (drilling)	0	3	nd
Promotion of Multifunctional Platforms (PFM) and AGR Units (units)	3 520	12 518	13 909
MANUFACTURING AND CONSTRUCTION INDUSTRIES			
Agriculture and food Industries (units)	nd	nd	nd
Local Mining Industries (units)	nd	nd	nd
AGRICULTURE, FISHING AND FISH BREEDING			
Promotion of irrigation farming (ha)	14 000	27 000	270 000
OTHERS			
Mining Industries (coal and uranium) (units)	nd	nd	nd
Electrification of administrative services (communities)	10	155	194
Electrification of major rural centers (villages)	nd	275	nd

VI.3 ASSESSMENT OF THE CAPACITY BUILDING NEEDS ON OBSERVATION SYSTEMS

VI.3.1 Needs for capacity building on observation systems

One of the two main priorities of the Global Climate Observation System (GCOS) is the introduction of long-term systematic observation systems to support the regional and global climate change assessment studies. Consequently, the optimum needs of this system must be identified and defined.
Any capacity building action must as much as possible address the five main concerns that a systematic observation program must attain in order to focus on the specific problems that the UNFCCC is facing such as:

- Observing and defining the characteristics of the current climate, including its inherent variability and extreme events;
- Obtaining useful information on the detection of climate change, the determination of the rate of this change and participating in examining the causes;
- Providing observations for the determination of climate forcing caused by the change in concentration of green house gases and other man-made causes;
- Providing information for the validation of models as well as provide any assistance in future climate predictions;
- Contributing in the preparation of observations for understanding and quantifying the impacts of climate change on human activities and the natural system.

Concerning the constraints and shortcomings underscored, the priority actions to be taken in terms of capacity building may be summarized as follows:

- Providing financial assistance to the focal point of the meteorological department and its related services through institutional capacity building projects;
- Clarifying the roles of the various State structures;
- Providing the institutions and bodies in charge of implementing systematic research and observation programs with adequate technical and financial resources;
- Setting up a structure in charge of the exploitation of meteorological, climate and satellite data;
- Intensifying information and sensitization actions of all stakeholders and at all levels;
- Building the capacities of experts in areas of climate change scenarios and staff in charge of data collection institutions in order to ensure a good collection and archiving of data;
- Drawing up and implementing a long-term national strategy on data collection, analysis and archiving in order to enhance the preparation of Inventory of GHG;
- Setting up permanent monitoring and assessment policies and strategies.

Besides, meteorological and socio-economic data is indispensable in capacity building, as well as in the assimilation and management of knowledge necessary for the sustainable development of developing countries like Niger.

VI.3.2 Systematic observation plan

Niger technology transfer needs on the use of global observation data are vital.

Training, assistance and latest technological equipment will allow for the acquisition, treatment and exchange of data in real time.

Niger's national systematic observation plan must be the focal point and capacity building basis for the implementation or reinforcement of the following program:

VI.3.2.1 Upper-air observation Programs

Concerning meteorological observation under the implementation of the climate change systematic observation systems, three main upper-air observation programs were identified.

These programs must be part of the national plan aimed at defining the characteristics of present day climate and providing observations for the validation of models and assisting in the making of future climate predictions.

VI.3.2.1.1 Monitoring programs by stations of the national component of the RSBR

Considering the land area of Niger, any such network must comprise at least four stations in order to comply with Resolution 2/AR-1 (WMO) on the placing of radiosonde stations (RAOB) according to the horizontal resolution of 500 km.

This network which is part of the WWW global observation system will produce two observations daily (00 and 12 UT) and will provide an additional series of data on temperature, humidity, and wind, depending on the altitudes, in order to complement the basic climate observation data base (GUAN) at regional level.

Nowadays, this network is made up of the Agadez and Niamey stations, which are all operated by ASECNA within the framework of its routine activities. The two stations which may be set up as radiosonde stations and which are in line with the above-mentioned horizontal resolution are those in Bilma and Zinder.

VI.3.2.1.2 Monitoring programs by GUAN stations

The GUAN is a GCOS aerologic network comprising 150 stations selected from the RSBR upper-air stations of the WWW of the six WMO regions. This GUAN network was developed to serve as an appropriate framework for the constitution of a consistent and homogenous global fundamental measuring basis.

Once this data base is completed with other inputs and networks, it may be used to execute the various ranges of climate applications.

The GUAN is instead a scattered network which is aimed at detecting temperature change. It constitutes a

reference for the other set of data and for calculations in other models.
In Niger, the Niamey radiosonde station has been selected as part of the GUAN.

VI.3.2.1.3 Satellite and Aircraft Monitoring Programs

Satellites provide a global coverage of aerologic data which complements those provided by the stations of the RSBR national component.

However, it should be noted that data recorded by a satellite is not independent, the satellite vertical resolution recovery is quite low compared with what is required and the error margin is wider than those at the level of the radiosonde. Consequently, satellite data is frequently adjusted; that is the reason why they cannot be immediately used for the detection of long-term climatic indicators.

A potentially significant development in the area of aerology is the development of a combined aerologic observation system which includes radio sounding, wing/altitude data obtained from satellites, wind data, temperature and aircraft humidity (AMDAR) as well as data from other systems under experimentation such as wind profilers. The efficiency of such a system may be globally satisfactory for the climate observation objectives.

The challenge is at the level of a sustainable implementation and maintenance of this type of system.

VI.3.2.2 Middle layer atmospheric temperature observation monitoring programs

Consistent, regular and unreduced temperature readings of the middle layer of the troposphere and the stratosphere are the basic and required data for the detection and quantification of the “fingerprint” of warming due to an increase in the concentration of greenhouse gases (Spencer and Christy, 1993).

The only available method today, which allows for the collection of this temperature data of the middle layer, is done by satellite through the monitoring microwave emissions from oxygen in the atmosphere. These types of monitoring started since 1979 from Microwave Sounding Units (MSU).

VI.3.2.3 Surface climate observation programs

Surface weather data, especially temperature are collected from CLIMAT messages which are subsequently exchanged every two days of the month for several years within the framework of the implementation of the WWW and for the purpose of climate observation.

In Niger, just like in many other countries, climatic data comes from three sources:

- **Climate observation program at RSBR stations**

The table on the next page shows the 15 stations of the RSBR national component produce CLIMAT data which is shared monthly on the RPT and is intended for climate needs. However, the regional and global coverage of CLIMAT is seriously suffering from non-production and especially exchange difficulties of CLIMAT.

- **Observation program in weather and rain stations**

In Niger, there is a network of eight weather stations that provide information on temperature, surface wind, rainfall, insulation, etc.

- **Climate observation program in GSN stations**

Like the GUAN for upper-air observation programs, the GCOS identified 1 000 stations of the national components of 6 RSBR, which are part of its surface reference for the monitoring of the surface, referred to as GSN. These stations complete the long series of good quality observation data.

The main objective of the GSN when it is backed by the other climate station networks (RSBR, climate, agro) is to provide a surface fundamental data base for climate study and analysis at regional and national levels. In Niger, the GSN comprises four stations: Bilma, Agadez, Tahoua, and Mainé Soroa.

Table 51: Implementation status of national synoptic network

Station	Opening Date	Surface observation program. Upper-air observation program.	Status at the level of GCOS	Means of collection E = emission; R = reception	Reception at international centers; October 2000
BILMA 61017	1926	Eight sfc observations, two PILOT soundings, 2 employees and the CLIMAT head.	GSN	BLU: E-R; E = 3; R = 4; PCD = hs	95%
AGADEZ 61024	1926	06, 09, 12, 15, 18, TEMP at 12 TU, 2 PILOT 5 employees and the CLIMAT head	GSN	BLU: E-R; E = 3; R = 4; PCD = good	73%
TILLABER Y61036	1931	Eight sfc observations, two employees and the CLIMAT head		BLU: E-R; E = 4; R = 4; PCD = good	95%
TAHOUA 61043	1939	Eight sfc observations, 2 employees and the CLIMAT head	GSN	BLU: E-R; E = 3; R = 3; PCD = good	97%
GOURE 61045	1957	Eight sfc observations, 2 employees and the CLIMAT head		BLU: E-R; E = 3; R = 4; PCD = no	98%
NGUIGMI 61049	1931	Eight sfc observations, 2 employees and the CLIMAT head		BLU: E-R; E = 2-3; R = 2; PCD = good	85%
NIAMEY 61052	1944	Eight sfc observations TEMP at 00&12, 4PILOT 14 employees and the CLIMAT head	GUAN	BLU; MDD: LS	98%
KONNI 61075	1933	Eight sfc observations, two PILOT soundings, 3 employees the CLIMAT head		BLU: E-R; E = 4; R = 4; PCD = good	97%
MARADI 61080	1939	Eight sfc observations two PILOT soundings, 3 employees and the CLIMAT head		BLU: E-R; E = 5; R = 4; PCD = good	100%
DIFFA 61085	1957	Eight sfc observations, 2 employees and the CLIMAT head		BLU: E-R; E = 1-2; R = 3; PCD = good	27%
ZINDER 61090	1905	Eight sfc observations, two PILOT soundings, 3 employees the CLIMAT head		BLU: E-R; E = 4; R = 4; PCD = good	93%
MAGARIA 61091	1958	Eight sfc observations, 2 employees and the CLIMAT head		BLU: E-R; E = 3; R = 3; PCD = good	82%
MAINE 61096	1939	Eight sfc observations, 2 employees and the CLIMAT head	GSN	BLU: E-R; E = 0-1; R = 4; PCD = good	92%
GAYA 61099		Eight sfc observations, 2 employees and the CLIMAT head		BLU: E-R; E = 3; R = 3; PCD = good	100%
DOSSO					

VI.3.2.4 Clouds and rainfall observation programs

VI.3.2.4.1 Clouds Observation

Clouds constitute an indispensable element for the characterization of the weather and climate and they also play a very important role in the evaluation of the radiation balance of the atmosphere and the water cycle. Presently, some measurements especially temperature, movement and water vapor content are measured using surface systems and satellites.

The Global Climate Research Program incorporated into its activities the international cloud climatology project through satellite, which is based on satellite images. This project may enhance its outputs once cloud observation from ground systems will be incorporated into it.

VI.3.2.4.2 Rainfall Observation

Rainfall observation is considered one of the most important climatic variable that affects human life and natural resources. The currently used measurement systems include the rain gauge, radars; recently research instruments using satellite-assisted techniques have been developed. These instruments have been identified and have proven to be very useful above the ocean in tropical regions in the provision of data. These satellite measurements that are conducted at a global scale and the resulting outputs of these analyses should create a discussion forum between the treatment centre such as the Global Climate Rainfall Centre as well as local and international users. It would be in the interest of Niger to actively participate in the activities of this centre.

VI.3.2.5 Atmospheric composition and chemistry

VI.3.2.5.1 Global Atmosphere Watch

The Global Atmosphere Watch (GAW) is a WMO international program for the collection, distribution and archiving of observation data on the atmospheric components. These archived data are those that have passed through the control test.

The GAW global network comprises about twenty stations that measure the concentration of a certain number of greenhouse gases including that of the ozone layer. If it is fully implemented, it would be the main contribution of GCOS.

Current plans should focus on increasing the number of operational programs in stations and on the expression of the atmospheric aerosol observation needs. In Niger, the creation of GAW stations would be a substantial contribution in the improvement of the sub-regional branch of the global network.

VI.3.2.5.2 Observation programs of greenhouse gas concentrations

Some atmospheric constituents were identified as being greenhouse gases. Others have a longer fixation time and are relatively quite mixed in the atmosphere (i.e. carbon dioxide, methane). Many of them present very variable distributions in time and space (i.e. water vapor, CFC, ozone).

The observation of these latter constituents requires the establishment of a comprehensive program which should include collections in three dimensions using surface observation systems, aircrafts and satellite technology.

Measurement programs in low altitude strata are always at the research stage although instruments aboard satellites were placed to provide information on horizontal and vertical distribution. Presently, the only instruments having time recording over the entire length of time are those measuring the total ozone column.

VI.3.2.5.3 Ozone observation programs

Ozone, in addition to its properties of being a significant greenhouse gas, had a large absorption power in ultraviolet wavelengths. This is how it succeeds in intercepting the harmful ultraviolet radiation of the sun in the stratosphere. The problem of reduction of atmospheric ozone was taken into account by the Montreal Protocol which had the mandate of limiting the use of CFC. For climate issues, troposphere ozone is very significant but it is not adequately measured for now. There are instruments which measure the profiles, but are less frequently used on some sites. GAW stations conduct ozone measurement but the geographical coverage and the network's capacity need to be extended.

VI.3.2.5.4 Aerosol measurement programs

The second report of IPCC (1996) recognizes the important role that atmospheric aerosols play in the induction of regional climate variations. Till now, there is no consistent strategy in aerosol observation. Some observations were made by infra-red imaging devices. The goal of GAW is to observe the direct and indirect effects of aerosols on the weather through interpretations based on results of studies on the treatment of such data in addition to models on radiative transfers which are not available for now. It is essential to develop a composite system which integrates surface observations of sixty already existing sites and satellite observations to develop an essential foundation for aerosol climatology.

In conclusion, it should be remembered that Niger's capacity to predict and target dangers in high water or flood situations is still inadequate although the country has fairly distributed hydrological and hydro-geological observation systems. These networks made it possible to collect hydrometrical data during variable periods according to stations and the nature of data. The oldest hydrometrical reports (instant coast of water levels, flow) date back to the start of the century while the monitoring of ground water resources only started in the early 80s.

General observation networks are managed by the Direction of Water Resources of the Ministry of Water Resources, The data was validated before being archived and published in different media. Data is accessible to all users as part of regional and international exchange of data.

It should however be noted that the support of development partners in the exploitation of networks has always been a determining factor because the State's budget allocation is insufficient or even inexistent. That is why, from the time this support reduced, observation networks were gradually abandoned and equipment deteriorated. In order to guarantee a sustainable management of water resources and to efficiently contribute to international programs on climate, we recommend the rehabilitation of basic hydrometric networks and short term support to the collection process.

From the foregoing, the observation in the two cases, that is in the area of research and systematic observation systems aimed at obtaining meteorological, atmospheric, climatologic, satellite, hydrologic and hydrogeologic data, is the absence of a National Plan on the Systematic Observation of Climate Change.

VI.4. CONSTRAINTS AND SHORTCOMINGS

For some years, meteorological, atmospheric, climatologic, satellite, hydrological observation systems, which are the basic elements essential for the study of global climate undergo a continuous degradation in Niger, considering the economic and financial difficulties that the country faces.

This situation resulted in the shrinking of the country's contribution to world weather observation and research programs.

The constraints of research and systematic observation linked to climate change may be summarized as follows:

- **At national level**
  - Insufficient quality and quantity of skilled human resources;
  - Economic and financial difficulties;
  - Absence or obsolete infrastructure necessary to conduct research;
  - Absence of inter-disciplinarity (research is so sector-based while issues on climate change focus on all socioeconomic sectors);
  - Inadequate consideration of the human dimension of climate change, often ignorance of socioeconomic and political aspects;

- Very high cost of meteorological equipment.

- **At regional level**
  - Absence of coherent and permanent synoptic observation networks across Africa;
  - absence of coherent, permanent and dense weather observations networks;
  - absence of reliable telecommunication network which will facilitate the exchange of data and will support forecast and early warning systems to be put in place to provide sustainable development;
  - absence of radar networks for areas exposed to poor weather, an indispensable tool for an early warning system. This mechanism will be completed by satellite data and surface observation supplying data on soil recycling. Thus, the essential ingredients of an efficient early warning system will be in place;
  - low integration of weather into the policy, strategies and development programs.

VI.5 PRIORITY NEEDS ON ADAPTATION

VI.5.1 Case of NAPA

The development objective of NAPA is to contribute to mitigate the adverse effects of climate change on the most vulnerable populations, in view of a sustainable development and the fight against poverty in Niger.

Consequently, the NAPA document gives an overview on the content of priority needs to undertake in order to meet the urgent and immediate needs and concerns for the purpose of adaptation to adverse effects of climate change.

VI.5.1.1 Selection and ranking of NAPA priority activities

As NAPA is a document that was validated at national level, there is cause to consider all its results here. For the selection of priority activities among an exhaustive list of potential activities and to maintain a readily manageable and meaningful process, the guidelines for the development of NAPA invite parties to consider four general criteria, namely:

- the level or gravity of adverse effects of climate change directly linked to vulnerability indicators;
- the reduction of poverty in order to increase adaptation capacity;
- synergy with other multilateral agreements in the area of the environment;
- cost-effectiveness ratio (financial consideration).

Regarding general criteria, five (05) criteria were used and they integrate, on the one hand, the achievement of SRP and results of the different consultations with local stakeholders particularly vulnerable groups and, on the other hand, Niger specific conditions on vulnerability to adverse effects of variability and climate change. These criteria are:

- the impact on groups and vulnerable resources;
- the impact on the economic growth rate of poor populations;
- the avoided losses for poor populations;
- the synergy multilateral environmental agreements, projects and programs;
- the cost.

The method used to classify and prioritize activities was the multi-criteria analysis (AMC) based on results of field missions conducted among vulnerable populations. All calculations were made using Excel software. The following table gives the list of priority options classified in order of importance.

Table 52: List of priority options and their rank in the NAPA classification

Name of option	Rank
Introduction of feed species in grazing areas	1
Promotion of Cattle Feed Banks	2
Rehabilitation of basins for the practice of irrigated farming	3
Diversification and intensification of irrigated farming	4
Promotion of vegetable farming, breeding and sub-urban activities	5
Promotion of IGA and development of credit unions	6
Water control	7
Dissemination and production of agro-meteorological information	8
Creation of cereal banks	9
Contribution to the fight against climate-sensitive diseases	10
Development of WSC /SDR actions for agricultural, forestry and pastoral purposes	11
Popularization of animal and plant species most suited to weather conditions	12
Protection of banks and rehabilitation of sandy pools	13
Technical, material and organizational capacity building of rural farmers	14

VI.5.1.2 Articulation of NAPA options in terms of technological options

Table 53: Technological options in NAPA

NAPA options	Development sector concerned	Type of technology	Availability	Observations
No 4 - Diversification and intensification of irrigated farming	Agriculture	Pumps for irrigation + Use of Urea Deep Placement - UDP Technology	Exists in the market; UDP technology finalized by IFDC	Study local production of some spare parts for pumps.
No 7 - Water control	Agriculture Water resources	Rain water reservoirs for irrigation Incorporation of CC in water projects; promote GIRE	President of the Republic's Special Program Modeling of works	The problem of securing this RE remains; Investments in PSPR should be considered
No 8 - Production and dissemination of agro-meteorological information	Agriculture	Radio & Internet - RANET	Technology developed by ACMAD	Coupling with community radios
No 9 - Creation of cereal banks	Agriculture	Improvement of cereal banks through the production of genetic material adapted to the most probable scenarios of CC	To be included in the mission of the UAM Biotechnology Laboratory	To be handled in the broader context of SDR
No 10 - Contribution to the fight against climate-sensitive diseases	Human health	Integration in urban planning and development of warning systems by RANET	Management of urban and sub-urban areas; ACMAD Technology	Integrate climate in the management of major endemic diseases
No 12 - Popularization of animal and plant species most suited to weather conditions	Agriculture and Livestock production	Seeds resistant to climate, the fight against parasites; artificial insemination promotion of races adapted to the most probable CC scenarios in an intensive animal production system.	INRAN and UAM	Enhancement of public research undertaken over some years in Niger

VI.6 NEEDS FOR FAST-TRACK DEVELOPMENT AND POVERTY REDUCTION STRATEGY AND RURAL DEVELOPPMENT STRATEGY

The objectives and other relevant indications relating to these two strategic documents are indicated on table 8 of page 13. It also defines the technological potentials for adaptation to climate change at the end of the review of objectives and strategies of SDRP and SDR having an interest for the transfer of ERT for adaptation to climate change.

VI.7 PROPOSED PILOT PROJECTS

A list of potential mitigation and adaptation projects to be developed in accordance with the priorities of national strategic frameworks is attached in the annex.

VI.8 SHORTCOMINGS, CONSTRAINTS, PRIORITY NEEDS IN EDUCATION, TRAINING AND PUBLIC AWARENESS

On the basis of the foregoing, it follows that many efforts have been made both by the Government and by technical and financial partners. These various initiatives were made through the organization of training workshops, conferences, broadcast interviews, dispatch of documents treating the issue, the publication of articles in some local newspapers and the preparation of newsletters. However, there are still shortcomings and constraints which hinder the effective implementation of the convention. Among them are the following:

- poor understanding of the concept of climate change by the stakeholders in charge of sensitization;
- inadequacy of sensitization media;
- high rate of illiteracy among the populations, which does not favor the understanding of these messages;
- inadequate expertise in climate change;
- inadequate means directed to education, training and sensitization actions of the public;
- relatively high cost of media services (newspapers, printing, radio, TV, etc.) for Information, Education and Communication (IEC) activities;
- low interest shown by the civil society to this Convention, given its complexity and too technical nature;
- low consideration of the issue of climate change in national development policies and strategies;
- low contribution of the funding mechanism of the convention in the development countries due to very long and complex procedures;
- inadequate national exchange, promotion and information dissemination mechanisms.

Taking into account the shortcomings and constraints mentioned above, education, training and sensitization needs of the public on climate change classified in order of priority are presented as follows:

- sensitization of political, economic and industrial decision makers with the aim of sensitizing national parliamentarians, members of government and executive of the administration as well as economic operators on climate change, the Kyoto convention and protocol: challenges and prospects, CDM: investment opportunities and prospects for national companies;
- education and training of the civil society and technical executive on the preparation procedures of projects in the area of climate change, and funding procedures;
- Clean Development Mechanism and adaptation strategies and mitigation measures;
- education, information and sensitization of producers on the effects of changes on their environment, the opportunities that the CDM offers, and adaptation strategies and mitigation measures;
- education and training of school children and scholars on the adverse effects of climate change on the environment, mitigation and adaptation measures and the CDM;
- setting up an information exchange operations center;
- revitalization of websites;

- setting up thematic networks on exchange and reflection;
- development and (or) reinforcement of exchange programs between parties.

In conclusion, within the framework of the implementation of the convention on climate change and in accordance with parties' obligations in educating, training and raising awareness of populations, institutional, legal frameworks have related programs within them. In this regard, many laws, ordinances and conventions at national, regional and sub-regional levels were ratified. They were supported by many initiatives and projects. In spite of the countless initiatives and projects, it follows that few initiatives have been developed for decision makers, the rural community and school children who are nevertheless the privileged targets. Actions are much geared towards technicians who unfortunately undergo undue difficulties due to lack of means to convey the skills they have. That is why shortcomings and constraints still exist which hinder the effective implementation of the convention. Under this prevailing situation, the major actions to be carried out will target:

- political and economic decision makers;
- representatives of the civil society and technical executives;
- producers;
- school children.

To do this, the program of action should target the following objectives:

- sensitization of political, economic and industrial decision makers with the purpose of: raising awareness on climate change, the Kyoto convention and protocol: challenges and prospects, CDM: investment opportunities and prospects for national companies;
- education and training of the civil society and technical executives on project preparation procedures on climate change and funding procedures, the Clean Development Mechanism, adaptation strategies and mitigation measures;
- education, information and awareness raising of producers on the effects of changes on the environment, the opportunities that the CDM offers, and the adaptation strategies and mitigation measures;
- education and training of school children and scholars on the negative effects of climate change on the environment, mitigation and adaptation measures and CDM;
- setting up an information sharing operations center;
- revitalization of websites;
- setting up thematic exchange and reflection networks;
- development and (or) reinforcement of exchange programs between the parties.

ANNEX: Pilot projects

A1. Technology transfer

Project No 1
Project title: Quantitative and Financial Assessment of Ecologically Rational Technologies in the implementation of *DSRP in Niger*
National priorities and macroeconomic scenario: DSRP
Objectives: Understand the incidence of technological options selected for energy supply by 2015 to address GHG emissions in the country and alternative measures to achieve sustainable development.
Contractor: PS/PRSP
Duration: 1 year
Methodology: A participatory approach following the suggestion made by stakeholders, consultants and participants to workshops for validating studies.
Cost: US$ 100,000
Project No 2
Project title: Survey of the Eco Development Potential of substitution of firewood with mineral coal in rural and urban areas
National priorities and macroeconomic scenario: PRSP, RDS, SNASEM
Objectives: To study emission factors of stoves using mineral coal and LPG stoves and GHG and potential for GHG mitigation in the residential zone in rural and urban areas in the Sahel
Contractors: MoME, CNES, private individuals, NGO
Duration: 1.5 year
Methodology: Research & development on cooking stoves to replace fuel wood, monitoring of a consumer panel, market penetration testing and assessment of benefits in terms of elimination of GHG emission.
Cost: US$ 100,000
Project No 3
Project title: Survey of the Eco Development Potential of substitution of firewood with biogas in rural and urban areas
National priorities and macroeconomic guidelines: DSRP, RDS, SNASEM
Objective: To launch two pilot projects aimed at replacing fuel wood with biogas from water hyacinth and cow dung.
Contractors: MoME, AMU, private individuals, NGO
Duration: 1.5 year

Methodology: Application of findings from biogas research conducted at UAM, to biogas production in rural areas where water hyacinth are near, and a centre for cattle multiplication
Cost: US$ 100,000
Project No 4
Project title: Promoting Renewable Energies for small scale irrigation and lighting in sub-urban areas
National priorities and macroeconomic scenario: PRSP, RDS and SNASEM
Objectives: to conduct an experiment aimed at disseminating irrigation and photovoltaic solar energy technologies
Contractors: MoA, MoME, CNES and Nigerien privates
Duration: 2 years
Methodology: Action-research on imports, marketing, monitoring, maintenance and assessment of existing technologies adapted to local needs.
Cost: US$ 200,000
Project No 5
Project title: *Research-development on stove and solar heater in urban and sub-urban areasn*
National priorities and macroeconomic guidelines: SNASEM
Objectives: to conduct research on development of solar energy stoves adapted to regular domestic uses in West African urban areas.
Contractor: CNES
Duration: 1.5 year
Methodology: Applied laboratory research and consumer panel, performance monitoring and assessment, marketing testing
Cost: US$ 100,000
Project No 6
Project title: Water *Extraction using wind energy in pastoral areas and villages with less than1000 inhabitants*
National priorities and macroeconomic scenario: PRSP, RSD
Objectives: To tap wind potential for water pumping system in order to achieve the MDGs in pastoral and rural areas.
Contractors: INRAN, AMU, CNEDD and MoH
Duration: 2 years

Methodology: Action-research by importing, manufacturing and testing wind technology for home-made pumps and testing of wind technology for water pumping in rural areas; monitoring and evaluation for dissemination.
Cost: US$ 300,000
Project No 7
Project: *Developping Access to ICTs and Community Radio functioning with solar PV*
National priorities and macroeconomic scenario: PRSP, RSD, NICI
Objective: To develop rural communication by facilitating access to ICTs and community radios through dissemination of photovoltaic solar energy sources
Contractors : MoC, HC/NTIC and CSC
Duration: 1.5 year
Methodology: Piloting of community telecenters and rural radios using solar photovoltaic under local initiative.
Cost: US$ 250,000
Project No 8
Project title: *Promoting Communities Centers with solar PV for non formal education and recreation*
National priorities and macroeconomic scenario: PRSP, PDDE
Objective: to facilitate access of disadvantaged groups, living in rural areas, to education and recreation centers through provision of photovoltaic solar energy
Contractors : PS/PRSP, D/PDDE
Duration: 2 years
Methodology: Establishment of village pilot cultural centers, equipped with TVs, videos, and literacy training and reading rooms that would serve as a study room for students preparing their exams; monitoring and evaluation for dissemination
Cost: US$ 150,000
Project No 9
Project title: Setting up of 3 Pilot centers to promote the use of agro meteorological information
National priorities and macroeconomic scenario: RSD
Objective: to increase farmers' access to agro-meteorological information (with RANET technology) so that they may use them during the rainy season.
Contractors: PS/RSD, ACMAD Center

Duration: 3 years
Methodology: to adapt the configuration of community radios so that they can connect with Internet; this will enable them to receive agro-meteorology reports and satellite pictures and other decision-making tools.
Cost: US$ 125,000
Project No 10
Project title: Capacity building for rural producers on the use of agro meteorological information to improve their adaptation capacity to climate change and variability
National priorities and macroeconomic scenario: RSD
Objective: to encourage farmers to use agro-meteorological information in their production activities, before making important decisions on the sowing dates, application of fertilizer, pesticides, etc. in order to avoid sowing again and to increase yields.
Contractors: DoNM, ACMAD, AGRHYMET
Duration: 3 years
Methodology: Organization of training workshops at the end of the dry season to enable farmers to participate in the collection of agro-meteorological data.
Cost: US$ 300,000
Project No 11
Project title: *Équiping freezers and health centers radio with solar PV in villages with population between 500 and 1000 inhabitants*
National priorities and macroeconomic scenario: PRSP, RSD
Objective: to consolidate gains made following experiment conducted by PS/PR in the area of health coverage through increased effectiveness of investments in favor of vulnerable groups (women and children).
Contractors: PS/PRSP, Ministry of Public Health
Duration: 2 years
Methodology: Equip small integrated health centers (ICSs) and health posts of major rural centers to promote outreach immunization, prenatal consultation and medical evacuation.
Cost: US$ 350,000
Project No 12
Project title: *Pilot project for the* use of slaughterhouse wastes for power generation in urban areas of Niger *(Niamey, Maradi, Zinder et Tahoua)*
National priorities and macroeconomic guidelines: PRSP, RSD
Objective: To use slaughterhouse wastes for power generation in urban areas of Niger.

Contractors: MoAR, slaughterhouses, individuals
Duration: 2 years
Methodology: Feasibility study and building of a pilot digester for power generation.
Cost: US$ 500,000
Project No 13
Project title: *Project for* assessing energy needs at national level and in the context of West African regional integration, based on uranium sector potential in Niger
National priorities and macroeconomic scenario: PRSP
Objective: To assess energy needs at national level and in the context of West African regional integration, in the light of uranium sector potential in Niger.
Contractors: Prime Minister’s Office, MoME
Duration: 1 year
Methodology: Technical study on human resources and exports potential.
Cost: US$ 400,000
Project No 14
Project title:Setting up of 2 centers to promote the use of UDP technologies
National priorities and macroeconomic scenario: RSD
Objectives: To test UDP technology on a large-scale irrigation scheme and on a millet field
Contractors: PS/RSD, Ministry of Agriculture
Duration: 2 years
Methodology: Utilization of urea compressed briquettes once during the crop season, as this is done in other UDC which have used this technology.
Cost: US$ 100,000
Project No 15
Project title: *Integration of climatic information in the prevention and fight aginst malaria, meningitis and the major climate sensitive diseases in Niger*
National priorities and macroeconomic scenario: PRSP, RSD
Objective: In the midterm, to provide the health sector with relevant information that would be integrated into the various aspects of planning and operation management and, to a larger extent, into the permanent health watch system.
Contractors: PS/PRSP, Ministry of Health, ACMAD Centre
Duration: 2 years

Methodology: Develop, test and evaluate an approach which helps produce on a regular basis, climate and weather forecast data on the likelihood of epidemic occurrence and spreading through regular production of information linking climate and health.	
Cost: US$ 100,000	

Thus, a set of 15 projects was proposed, amounting to a total of US$ 3,200,000, to address the requirements related to both climate change mitigation and adaptation measures in connection with national strategic framework priorities such as: PRSP, NAPA, PDS, SNASEM.

For the purpose of this study, technology transfer is mostly meant as a process for facilitating the application of the provisions of the Convention with a view to reaching the final goal. This study has taken into account, on the one hand, the implementation by Niger of this Convention through the 1st National Communication to the Conference of the Parties and, on the other hand, the priorities defined by the PRSP, RSD, NAPA, PDS, DPE and SNASEM, as well as other strategic papers on sub-regional integration.

Technology transfer is considered both from the climate change mitigation and adaptation to change perspectives. Implementation of such process should also involve capacity building activities.

Since this is a needs assessment exercise – i.e. national priority needs as they relate to those defined in country strategic frameworks – there is need, first and foremost, to come up with projects ideas which would then help identify and develop technology transfer projects which correspond to needs at national level. Fifteen projects ideas were thus proposed in the areas of both climate change mitigation and adaptation. At this junction, these projects anticipate necessary updates of the PRSP and RSD, which would take into account climate change related risks, and policies to address them, as indicated in the 2007/08 UNDP report on human development. The process of technology transfer under the Convention is currently in its operational phase. To achieve sustainable development, there is need to closely link development plans as well as commitments made under the Convention, to a strategy aimed at intensifying technology transfer.

A2. Building capacity on systematic reporting and research systems in the field of climate change

Technical project brief 1

Project for strengthening networks for measuring altitude climate variables

Justification	Strengthen the national component for altitude measurements of RSBR to support GUAN network. To that end, the stations of Bilma and Zinder should be converted into stations for altitude measurements using radiosonde.
Objectives	• To ensure optimal national coverage in connection with temperature, wind, pressure and humidity reports; • To determine current climate characteristics using a release of balloon every day at 00 and 12 UT; • To validate models and make forecast on future climate.
Expected outcomes	Setting up of a wide network of altitude measurement stations providing altitude data, over a very long period to support GUAN, especially to implement the altitude information components of the National Composite network which is a key aspect for the future.
Operations	• Zinder station: 2 additional release of balloon each day at 00 and 12 UT; • Bilma station: 2 additional release of balloon each day at 00 and 12 UT; • Agadez station: programming of a second release of balloon at 00 UT.

Technical project brief 2

Project on implementing GUAN Station

Justification	In Niger, Niamey station has been included in the GUAN network because it meets all selection requirements.
Objective	To make all GUAN stations operational.
Expected outcomes	Development of a base for measuring global climate.
Activities	Niamey will continue to implement its program consisting of 2 releases of balloon/day at 00 and 12 UT; the station has therefore been provided with some equipment: a hydrogen generator, a DIGICORA, a PCD, an annual stock of expendable balloons, a GPS sonde, and a back up energy system.

Technical project brief 3

Project on implementing GUAN Station

Justification	Altitude satellite information provided has global coverage; thus, integration of radiosonde data and AMDAR, especially water vapor measurements into a composite system, will complement satellite information.
Objective	To define characteristics of current climate and submit reports aimed at validating the models and take part in forecasts through the implementation of a composite system.
Expected outcomes	Ensuring that the composite system provides, over a very long period of time and without interruption, consistent and homogeneous data that would serve as a basis for meteorological measurements intended for the global climate system.
Activities	Provide the operational unit for data collection and processing, with efficient tools capable of receiving meteorological data observed by satellites and AMDAR especially water vapor measurements. These data and their derived products covering the West African region will be part of operational activities.

Technical project brief 4

Project on measurements of layer average temperatures

Justification	Significant, consistent and objective measurements of layer average temperatures in the troposphere and stratosphere are variables needed to detect and quantify a “fingerprint” indicating warming due to increase in concentration of greenhouse gases.
Objectives	• To secure information for detecting climate change, determining change rate and identifying the causes of change. • To provide reports for model validation and make climate forecast.
Expected outcomes	Obtain weather forecasting and satellite data sets from these measurements over many years and on a permanent basis
Activities	• Data are produced based on the operation of the radiosonde system, in the four stations selected to be part of RSBR national component.

	• These stations will be used to calibrate similar types of satellite measurements.

Technical project brief 5

Project on strengthening surface climate variable measurement networks

Justification	Surface climate variables contained in CLIMAT messages are essential to the evaluation of the climate system, its variability and forecasts at global, regional and national levels, and the assessments of impacts of climate change on human activities.
Objectives	• To determine present climate characteristics; • To validate models; • To contribute to observations that will help understand and quantify impact of climate change on human activities and natural systems as defined by the GCOS, by strengthening and improving the National Component of Regional Basic Climate Network (*Composante Nationale du Réseau Climatologique de Base Régional*).
Expected mes	• Availability of sets of surface meteorological data from stations of RSBR national component, GSN stations and climate stations; • CLIMAT reporting produced and shared over a long period of time among all previous stations.
Activities	All RSBR and GSN stations as well as some climate stations (a dozen) will be equipped with automatic stations coupled with PCD to enable them to automatically issue a CLIMAT report and send it directly on RPT.

Technical project brief 6

Project on strengthening cloud observation and precipitation measurement networks

Justification	Cloud observation variable is a key element of climate system characterization and it plays an important role in assessing atmospheric radiation. As for rainfall, it is one of the most important climate variables. Thus, national data on clouds and rainfall could in the end be used in PMRC projects on cloud satellite climatology and rainfall global climatology.
Objectives	• Define present climate characteristics; • Validate models; • Understand and quantify climate change impacts on human activities and natural systems
Expected	Availability of sets of surface meteorological data from RSBR national component stations, GSN and climate stations, and rainfall stations, for a long period of time.
Activities	All stations of the RSBR and GSN national component as well as some climatology (a dozen) and rainfall stations will be equipped with automatic stations coupled with PCD, that would specifically observe clouds and make adequate measurements of rainfall to automatically produce a message and send it directly on GCOS network. Therefore, satellite data on clouds and rainfall observations could also be sent to the *Centre national du système de climat*.

Technical project brief 7

Extension of satellite observation applications to climate and society

Justification	In the past, technological and scientific progress made in the area of satellite observations, for example for digitalized weather forecasts and monitoring, have not always been shared with other countries in the region, which did not often have access to satellite data and did not have the facilities nor the skills to process them. PUMA project (preparation to using METEOSAT second generation in Africa) has helped make up for these deficiencies some of which have not yet been addressed.
Objectives	• To develop methods to convert remote sensing data into weather and climate variable measurements; • To build regional capacity to efficiently use remote sensing data for weather and climate monitoring; • To raise awareness of decision makers on the use of space technology.
Expected	The new project would build the capacity to interpret and to use satellite data through workshops, public education, and networking among national experts; and it would encourage all users of all fields of application to express their needs.
Activities	Training on remote sensing tools.

Technical project brief 8

Project on ozone observation program

Justification	Following its second assessment, the IPCC acknowledged the important role played by atmospheric ozone in climate regional variations. Niger has to take an active part in implementing an ozone measurement program.
Objective	Support GAW through the creation of an ozone measurement station in the country (Niamey) which, added to satellite measurements, will help provide information on climate change detection and on the type of climate forcing to determinate, which may result from greenhouse gas concentration change and from other causes.
Expected	Availability of sets of ozone observations from Niamey station.
Activities	Regular ozone observations.

Technical project brief 9

Project on GAW network development

Justification	This project aims at improving observation of major atmospheric components, including greenhouse gases and air quality, from stations collaborating with GAW global and regional networks. In Africa, lack of accurate data alters the results of climatic models and projections and, consequently, undermines the credibility of climate change scenarios and their impacts on human activities. Niger should actively take part in generating data on greenhouse gas concentration measurements, on the national territory.
Objectives	• To determiner climate forcing of greenhouse gases; • To collect information for climate change detection; • To define change rate; • To identify causes of change; • To provide reports for model validation.

Expected omes	• Secure sets of data on greenhouse gas concentrations from three new stations of GAW national network to support global network; • Regional carbon sources and sinks are identified based on greenhouse gas evolution and variability measurements; • Station reports are regularly released; data are really accurate.
Activities	• The three stations of the national network can be established in Tillabery, N'Guigmi and EAMAC. N'Guigmi is close to Tanamarasset which is one of the 60 stations of GAW global network; • Measurements will consist in carbon gas concentrations, methane (CH_4 in equivalent CO_2), nitrous oxide (N_2O in equivalent CO_2) and other less important gases such as sulphur dioxide (SO_2), carbon monoxide (CO), non-methane volatile compounds and nitrogen oxides (NO_X).

Technical project brief 10

Project on aerosol observation program

Justification	The IPCC second evaluation has acknowledged the important role played by atmospheric aerosols in climate regional variations. Niger has to take an active part in the implementation of an aerosol measurement program.
Objective	To support GAW in establishing three national stations of aerosol measurements, in addition to satellite measurements, which will help collect information for climate change detection.
Expected	Secure a set of data on aerosol observations from the three new national stations.
Activities	The three stations of the national network could be part of GAW national network to be established in Tillabery, N'Guigmi and EAMAC in Niamey.

Technical project brief 11

Establishment of a National Centre of Applied Meteorology and Climate Studies

Justification	Systematic observation programs developed by GCOS are aimed at providing, at global, regional and national levels, meteorological, climate, satellite and atmospheric data and products derived from these climate system data. These data must be collected, shared and processed in centers specialized in climate system, climate variability and change and their various impacts on human activities, on the natural system and inter-annual seasonal forecasts.
Objectives	The objectives of the Center will be the following: • To implement all the programs under national plan with a view to providing, at national level, systematic weather and climate data, and to collect and share them with other countries and international climate programs, and finally to obtain other information from composite systems of atmospheric and climatic systematic observations; • To design meteorology applications to development, especially for water resource, agriculture and health sectors; • To contribute to weather forecasts and their application to different socio-economic sectors. • To contribute to climate projections at national level in the context of global climatic change process.
Expected comes	• Data collection, analysis and processing for systematic observation activities and

	operational research activities; • Sharing of data; • National, sub-regional, regional and international decision makers and other partners are sensitized to the design of application products.
Activities	The Center will carry out three key activities: • Systematic weather and climate observation: collection and sharing; • Research on atmospheric environment (variability and likelihood of change) and weather; • Research on climate: seasonal, intra and inter-annual forecasts.

Technical project brief 12

Rehabilitation and strengthening of national hydrometric network in view of assessing the impact of dams built under the Special Program of the President of the Republic to collect surface water resources.

Justification	There is no doubt that a good knowledge of water resources is crucial when one wants to mobilize such resources. In a Sahelian country like Niger, the control of available water resources is paramount and a major concern. In Niger, surface water monitoring network includes a hundred of hydrometric stations made up of seven (07) hydrological units. Currently, the Directorate of Water Resources has an important database on surface water. Thus, this department has a good knowledge of the main watercourses and numerous ponds in Niger. During year 2001, a large-scale development program entitled “Special Program of the President of the Republic” was launched. It includes, among others, a component involving the construction of one hundred (100) water surface collection works, each year, allover the country. The construction of these works (water collection, spillway, infiltration sill, etc.), ninety-four (94) of which were already built in 2001, has some impact on the behavior of watercourses and ponds. Nowadays, there is need to closely monitor all Niger hydrologic units so as to measure the real impact of the construction of various dams on the regime of major streams and ponds of the country. At the same time, it is necessary to monitor the evolution of water bodies thus created to ensure their rational use.
Objective	To assess the impact of dams built within the framework of the Special Program of the President of the Republic on the main watercourses regime, in order to update hydrologic databank; this tool is critical to the implementation of many development actions, especially those involving water resource collection (agriculture, fishing, cattle breeding, hydroelectricity, etc.).
Expected outcomes	In the light of the objectives defined, the outcomes expected from the project are the following: • The major stations of basic hydrometric network are rehabilitated and renovated; • Twelve (12) hydrometric stations are equipped with float gages; • Thirty-five (35) dams are equipped with gages and regularly monitored; • Capacity of regional services is strengthened; • Hydrologic databank is updated; • Seven (7) reports on hydrologic cycle are produced every year (regional departments); • One (1) national activity report is produced each year; • Many mission reports (monitoring, supervision) and an overview report are drafted.
Activities	Based on the expected outcomes, the following activities are planned: • Acquisition of equipment (scales, gages, gauging equipments, computer

	equipments, etc.); • Repairing of stations that monitor the main basins; • Installation of twelve (12) float gages; • Equipping thirty-five (35) dams with graduated gages; • Recruiting and training of observers for the new stations; • Organization of missions to monitor and collect data; • Coordination and supervision missions.

Technical project brief 13

Development and implementation of minimal monitoring and assessment activities on underground water resources

Justification	In Niger, the uneven distribution of rainfall in time and space very often results in water deficit and in a somewhat chronic food unbalance. However, the country has great underground and surface water potential whose control, collection and rational management are a key factor of socio-economic development, especially in the quest of sustainable solutions to ensure food security. Degradation of underground water could therefore be a serious problem in managing natural resource. This resource is vulnerable because it may deplete because of overexploitation or reduction of recharge or simply pollution due to human activities. Since January 2001, monitoring of most local network has been suspended due to a shift in the orientation of projects which funded this activity. Despite irregular monitoring, the results of the various exercises indicate the need for a rational management of available resources. A case in point is the alluvial sheet of the Goulbi Valley in Maradi, which decreased by more than 3 m between November 1977 and November 1997. This depletion may lead to an ecologic and economic problem. It the same for Gogo and Machaya sheets (Zinder) which are decreasing.
Objectives	• To characterize the initial status of the hydrogeologic system in order to assess subsequent reserves with analytical tools such as modeling; • To provide information that would promote prospective discussions on excessive abstractions at the time of the exploitation of the aquifer.
Expected outcomes	• All piezometry and hydrochemical data from 1990 to 2000 are collected all over the country and analyzed; • Current piezometry monitoring network is entirely revised so as to adapt it. This will contribute to a better representation of the characteristics of various hydrogeologic systems; • Specific quantitative and qualitative monitoring networks for sensitive aquifers are established; • Piezometric data are regularly collected; • Non operational piezometers are rehabilitated and their density is increased in order to provide adequate coverage of the country; • Decentralized structures are provided with scientific measurement equipment; • Twenty national officials are trained.
Activities	• Interpretation of available piezometric and hydrochemical data; • Identification of piezometers and update of a national network; • Construction works and leveling piezometers; • Piezometric data collection, storage and processing; • Capacity building.

Technical project brief 14

Water resources monitoring and assessment in real time

Justification	Sustainable development, fight against poverty, food self-sufficiency and environment protection are not possible without integrated water resources management. Integrated water management implies to know much about such resources and it requires that their quantitative and qualitative parameters be measured. Measurements must thus be done in the field with adequate equipment. Currently, some equipment which is monitored daily by observers and others, do not require the presence of observers. The latter type called telemetry stations or data collection platforms has the advantage of transmitting captured data in real time. Nine stations established on the Niger River have been equipped, since 1985, with Argos type platforms for data collection in real time. Nowadays, Argos system has been replaced by Meteosat system which has the double advantage of providing water levels in addition to physicochemical characteristics (conductivity, pH, temperature, turbidity). This system is used not only for forecasting floods and minimum flow but also for assessing downstream water quality. Moreover, it is used to quantify the sedimentation rate of a work or a watercourse. To this end, the replacement of data collection platforms on sites, identified for dam construction in Niger, is a priority. For this reason, the four (4) following stations were selected: (i) Kandadji; (ii) W on another site identified for dam construction on the Niger River; (iii) Kakassi on the Dargol and (iv) Garbé-Kourou on the Sirba. In addition to data needed for the design of water works, and to equip and monitor these stations will make it possible to forecast exceptional hydrological events (significant floods and low water flow) with a view to informing the populations concerned so that they can be prepared.
Objective	To contribute to the improvement of people living conditions through provision of hydrologic information in real time to protect them as well as their development activities.
Expected outcomes	• Two (2) senior officials are trained: installation and maintenance of data collection platforms; • Four (4) stations are equipped with Meteosat data collection platforms; • Four (4) data collection platforms are operational; • Six (6) maintenance missions are organized every year; • Hydro-climatic parameters (flows, rainfall, water level…) are collected, processed and distributed; • Two (2) technical notes on flooding and minimal flow are written each year; • Six (6) mission reports are produced each year; • Four (4) quarterly reports are produced each year; • One (1) annual review report is produced; • Calibration of stations equipped with data collection platforms are regularly verified; • Communities are regularly informed on the level of the river; • One (1) microcomputer is purchased.
Activities	• Acquisition and installation of 4 Meteosat data collection platforms ; • Control of installation and maintenance operations of data collection platforms; • Training of two senior officials; • Maintenance missions; • Data collection and processing; • Drafting and distribution of reports and technical information notes.

Bibliography

1. *République du Niger Cabinet du Premier Ministre CNEDD : Première Communication Nationale du Niger*, November 2000.

2. *République du Niger Cabinet du Premier Ministre CNEDD : Programme d'Action National pour l'Adaptation aux Changements Climatiques (PANA)*, February 2006.

3. *République du Niger : Stratégie de Développement Accéléré et de Réduction de la Pauvreté 2008-2012*, November 2007. Secrétariat Permanent de la SRP ed., 159 pp.

4. *République du Niger : Stratégie de Développement Rural- Le Secteur Rural, Principal Moteur de la Croissance Economique, 2007*. Secrétariat Permanent de la SDR ed., 159 pp.

5. Isabelle Zotow, 1995 : *Projet Energie II- République du Niger, Energie Domestique, Enquête consommation énergie domestique*.

6. Bontianti Abdou, 1993. Master Thesis (option: Geography), Faculté des Lettres et Sciences Humaines, Université Abdou Moumouni, Niamey, Niger.

7. Direction de la Statistique et des Comptes Nationaux : Recensement Général de l'Agriculture et du Cheptel (RGAC) pour les effectifs de 2005 ; Institut National de la Statistique ed.

8. ONAHA/MDA, 2005 : Rapport annuel de l'Office des Aménagements Hydro-agricoles du Niger.

9. Food and Agricultural Organisation - FAO, 1999 : Aperçus nutritionnels par pays de la FAO : le Niger.

10. Food and Agricultural Organisation - FAO, 2000 : Evaluation des Ressources Forestières Mondiales.

11. Food and Agricultural Organisation - FAO, 2005 : Evaluation des Ressources Forestières Mondiales.

12. Food and Agricultural Organisation - FAO : 2000 Etude Prospective du Secteur Forestier pour le Niger Horizon 2020.

13. Food and Agricultural Organisation - FAO/CIRAF, 2000 : Les parcs agro-forestiers en Afrique Sub-saharienne.

14. Armond, C. and Diagana, B., 1986 : *Création d'un réseau piézométrique national au Niger*. CIEH/BRGM, June 1986.

15. Diallo A.A.S., 2005 : *Caractérisation des rejets des eaux usées dans la CUN : impacts environnementaux sur le fleuve Niger*, CRESA, Université Abdou Moumouni.

16. IPCC, 2007: Intergovernmental Panel on Climate Change Fourth Assessment Report Climate Change 2007, Synthesis Report, 18 pp.

17. Ben Mohamed, A., 2003: Atmospheric dust production on seasonal time scales in the Sahel region of West Africa. Final Report, Exchange Visitor Program No P-1-0381, Columbia University in the City of New York. 30 pp.

18. Ben Mohamed, A., 2007: Risks to Climate change in Sahelian Africa. Accepted for publication by European Climate forum.

19. Ben Mohamed, A., Van Duivenbooden, N., and Abdoussallam, S.: 2000, 'Impact of climate change on agricultural production in the Sahel - Part 1. Methodological approach and case study for millet in Niger'. Climatic Change 54, 327-348.

20. M. ISSA LELE, 2001: Climate Indices for Niger, in" Regional Workshop on Climate Indices for Africa", WMO Report.

21. S. SALACK, B. SARR, S. B. TRAORE, C. BARON, M. DINGHUN, 2008: Evaluation of Climate Change Impacts on Pearl Millet (*Pennisetum Glaucum (L.) R. Br.*) Development and Production in Niger Using a Crop Model. Centre Régional Agrhymet, Niamey-Niger.

22. Armond, C. and Diagana, B., 1986 : *Création d'un réseau piézométrique national au Niger*. CIEH/BRGM, June 1986.

23. O. Seidou, P. Gachon, T. Ouarda, A. Cotnoir, M. Badolo, A. Bokoye, H. Ouaga, A. Amani, I. Seidou Sanda, (2006) : *Variabilité des Rendements du Mil au Niger - Impact du Climat et des Facteurs de Gestion. Rapport du Centre Régional AGRHYMET*, Niamey, Niger.