MAINSTREAMING ADAPTATION TO CLIMATE CHANGE IN LEAST DEVELOPED COUNTRIES (LDCS)

Working Paper 3: Mali Country Case Study

Mama Konate and Youba Sokona April 2003

The International Institute for Environment and Development **CLIMATE CHANGE PROGRAMME** was established in 2001. The programme's goal is to enhance understanding of the linkages between sustainable development and climate change. Priority themes for the programme include: enhancing adaptation capacity in developing countries; climate change and sustainable livelihoods linkages in developing countries; capacity strengthening in developing countries; information dissemination; equity and; enhancing opportunities for developing countries to take advantage of opportunities offered for carbon trading (including CDM).

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1. Introduction

The least Developed Countries (LDC's), constitute a group which comprises 46 of the poorest Developing Countries. The LDC's are recognised by the United Nations system as a specific group within the larger group of 77 and China. Indeed, they have always spoken as a group during negotiations with the World Trade Organisation (WTO), although negotiating as a group in Climate negotations, dates from June 2000 during the 14th session of subsidiary organs of the UNFCCC in Lyon. The group comprises 29 countries in Africa, 10 in Asia and seven small developing island states. Despite its wide geographical spread, the group is characterised by its vulnerability to climate change, due to its precarious economic situation on the one hand and its exposure to very extreme weather conditions, on the other.

Efforts by this relatively homogenous group to co-ordinate its actions and respond as a group, have encouraged its negotiating partners to provide assistance in fulfilling some of its objectives. Hence at COP 7, important decisions were taken which led to the creation of a fund for the Least Developed Countries, with straight forward and carefully worked out management procedures; in addition to the formation of a group of experts on the LDCs and guidelines for the preparation of National Adaptation Plans of Action (NAPAs). The fund will be used, mainly for financing the preparation of the NAPAs, for capacity building and public sensitisation activities, in order to promote the development and transfer of technological knowhow, particularly adaptation techniques; strengthen the capacity building programmes of the meteorological and hydrological services, involving the collection, analysis, interpretation and dissemination of meteorological, hydrological and climatic information, to ensure the sucessful implementation of the NAPAs.

The International Institute for Enviroment and Development, in collaboration with Bangladesh Center for Advenced Studies in Bangladesh and Environnement et Développement du Tiers Monde in Senegal have initiated a work program to contribute to finding an "alternative climate change adaptation mechanisms and strategies for LDCs". The initial phase of the work program concentrate on country case studies of Bangladesh and Mali. The case studies consiste primarily of reviewing existing information on vulnerability and adaptation to climate change in the participating countries.

The present report on the case of Mali is based on desk study and addresses:

- A preliminary evaluation of Mali's vulnerability to Climate Change and identification of the main adaptation options;
- A review of existing information on Vulnerability and Adaptation to Climate Change (including all existing reports, national communications etc.);
- Identification and recommendation of a list of key parties concerned, selected from the ranks of the government, university, private sector, NGOs, etc, with the aim of conducting an interview sometime in the future, in collaboration with the International Environment and Development Institute (IIED) and ENDA, concening possible adaptation and implementation measures.

2. Country background

Mali is a West African country with a surface area of 1 240 192 km^2 and which lies between the 10th and 25th latitude north, and between the 4^{th} and the 12^{th} longitude east. It is bound to the north by Algeria, to the west by Mauritania and Senegal, to the east by Niger and to the south by Guinea, the Ivory Coast and Burkina Faso.

In terms of vegetation, the country possesses a diverse ecology, contrasting forest formations with the shrub-covered savana in the north (around 10 m3/ha) and the drifts of forest to the west and south (around 100 m3/ha). In terms of climate, the country typically has one rainy season per year with light rain throughout (between 200 mm and 1200 mm). However, two large rivers (the Niger and the Senegal) and their affluents flow through it.

The population rose from 4.2 million in 1960 to 10 million in 2000. The population is on the whole rural despite a continuing rise in urbanisation, which has gone from 5% in 1960 to 25% in 2000. The growth rate is at 3.2% per year. The greatest concentration is in the triangle Bamako-Mopti-Sikasso. The 5 main towns are Bamako (the capital), Ségou, Sikasso, Mopti and Koutiala.

The economy is dominated by the agricultural sector, which is based around cotton (the principal export) and livestock, but also gold. Wood production and fishing, which are considered to be the poor relations, exist alongside. The GNP evolved from 1,81 to 2,6 billion dollars from 1994 to 1997. The country is classed as one of the least developed countries but has a healthy economic growth rate; the GDP has gone from 2.3% to 6.7% whilst the inflation rate has dropped from 23,2% to –1,2% for the same period. These trends are continuing favourably. The country uses its hydraulic potential but also, and overall, its ligneous energy for its energy consumption (0,2 billion tep per year). These energy needs are met by the country's on board thermal capacity, an important addition to its hydroulic potential mentionned above.

3. Review of existing information on Mali's vulnerability to climate change

This review covers essentially all publications and reports completed within the framework of the implementation of the three Rio conventions, namely the United Nations Framework Convention on Climate Change, the Convention on Biological Diversity and the United Nations Convention to Combat Desertification.

3.1 Vulnerability

The existing studies on vulnerability in Mali were conducted within the implentation framework og the UNFCCC and particularly the initial national communication. These studies cover the water ressources and agricultural sectors. Such studies are justified, given the fact that the main occupation of the country's inhabitants is agro-sylvo-pastoral in nature. Indeed, 95 percent of the country's population depend on the primary sector, which provides the basic raw materials required by the industrial sector and which thus contributes an important part of the country's gross national product.

The zone of the study is located at the upper valley of the Niger River one of the main agricultural areas of the country. The objectives of the exercise were to (i) evaluate the eventual consequences of climate change on yields od millet and sorghum in the area, (ii) evaluate the socio economic impact of climate change and (iii) propose strategies for adaptating to any climate changes that may ensue.

The area covered by the study straddles two agro-climatic zones: a sahelo-Saharian zone (average rainfall less than 600 mm, a vegatation period ranging from 45 to 90 days, transhumant animal husbandry and dry crops, notably millet and flood recession crops), and a Sudano-Sahelian and Sudano-Guinean zone (average rainfall from 600 mm to 1,200 mm, vegetation period of 130 days, cash crops, dry crops and animal husbandry).

The area's rainfall ranges from 460 mm to 1,130 mm alternating humid periods with dry ones. At the moment, average rainfall is consistently less than it was during the period 1961-1990, this causes fluctuations in the duration of the vegetation season which in turn leads to unsustainable agricultural production and degradation of the soil and vegetation.

The average surface area used each year for growing millet/sorghum was 51,000 ha between 1971-1995. The annual average variation in cultivated land is 30,00 ha and long-term trends indicate an increase in the amount of land worked. If there is no climate change, and provided current trends continue in the long term, there should be no structural shortages of food in the area.

The maximum temperature in the shade is between 34 and 36°C and the minimum is 21 or 22°C. The average rate of monthly sunlight is 232.2 to 266.2 hours. There has been an average rise of 0.4°C in the areas temperature between 1981 and 1995.

3.1.1 Vulnerability of the agricultural sector

This study was carried out using general circulation models or global climatic models (GCM) and simulation models involving crop growth. The study considered:

- 1995: as the reference year for all projections
- 1961-1990: as the normal climatological period
- 2025: as the temporal horizon.

The global climatic models (GCM), were used to establish the possible climate scenarios, which were derived from reaction equilibrium experiments. The models were developed, using data which included the geographical co-ordinates of selected meteorological stations located in the study area, the average daily maximum temperature values for the period: (1961-1990), the minimum insulation temperature and the daily precipitation figures for 1995. These calculations were made by assuming that the background level of carbon dioxide concentration to be equivalent to (2x CO2), until the simulated climate reaches a state of equilibrium. An indication of the climatic response when the carbon dioxide concentration in the atmosphere is doubled could be obtained from the difference between the climatic conditions at (2 x CO2) and those at (1 x CO2). Six global climatic models (GCM) were used:

- Canadian Climate Change Model (CCCM);

- United Kingdom Meteorological Office (UKMO)
- United Kingdom Meteorological Office for 1989 (UK89)
- Geophysical Fluid Dynamics Laboratory Model (GFDL)
- Goddard Institute for Space Studies Model (GISS)
- Geophysical fluid Dynamics (Gfd3)

In order to assess climate change impacts two Crop Growth simulation models were used. The first one is the MAIN model developed in collaboration with the Center for Agro-biological Research in the Netherlands. This model was calibrated, using agro-meteorological data obtained from the upper valley of Niger River, which was chosen as the study zone. Scenarios involving temperature increases of 1, 2, 3 and 4 degrees centigrade, were used to develop the simulation models.

The second one is the DSSAT model (Decision Support System for Agrotechnology Transfer), which uses symplified functions to forecast crop growth, under the influence of certain factors which affect their yield, namely: genetic, climatic (sunlight, maximum and minimum temperatures, precipitation), soil properties and agricultural practices. This model is developed from data which include: daily figures for sunlight intensity maximum and minimum temperatures and precipitation, as well as the necessary agronomical data such as: the sowing date, crop density, variety, the quantity of water from irrigation, with dates (where relevant).

The synthesis of the results obtained from the general circulation models show that the best possible correlation is obtained between the Gfd3 model (at temperatures between 0.78 and 0.96 and rainfall between 0.92 and 0.98) and the CCCM model (for insulations of 0.51 and 0.67). By the year 2025, the average temperature rise will vary between 2.71 and 4.51°C; while the decrease in rainfall and insulation will range between 8 and 10% and 1and 10% respectively. The impact that this will have on crops such as sorghum, can be summarised as follows:

- 16% decrease in yield for the Tiémantié variety, (for a temperature rise of 4%); which will be equivalent to food shortage affecting 12% of the region's population;
- 26% decrease in yield for the CSM388 variety, which is equivalent to the food ration of 44% of the region's population.

3.2 Vulnerability of the water ressources sector:

This aspect was studied, using the analog method, in addition to expert judgment and simulation models. It considered:

- 1995 as the reference year
- 1961-1990 as the climatological normal
- 2025 as the temporal horizon
- The Niger basin at Mopti, as the study area

Two possible climate scenarios could be envisaged:

- A continuation of the present trend, which, by the year 2025 will culminate in a temperature rise of 0.4 to 1.1°C and a decrease in rainfall of between 12 and 29%;

- A doubling of the CO2 concentration, resulting in a 15% increase in rainfall in the year 2025.

4. Adaptation Strategies

The adaptation strategies cover the agricultural sector and water resource sector.

4.1 Agricultural sector

Following the droughts experienced in the 70's, the Malian Meteorological Department, with the assistance of the International community, developed a two-pronged approach to tackle the impact of drought on agriculture.

The first approach involves keeping the decision makers and agricultural officials regularlly informed about the state and evolution of agro-pastoral fields by means of a follow-up of relevant indicators (meteorological indicators, rainfall, water reports, hydrological indicators etc.) and their impacts on crops, pastures and well points. The second approach involves providing the rural community with the technical knowledge they need to enable them to plan and manage their agricultural activities more efficiently.

4.1.1 Current adaptation strategies

4.1.1.1 Agro-hydro-meteorological follow-up studies on Cultivation and Pastural Lands

A multi disciplinary working group made-up of representatives from the technical services of the rural sector, as well as from the Hydrology department and the National Radio and Television service, meets every ten days during the wet season. Their work is co-ordinated by the National Meteorological Department. This group analyses data received from meteorological and hydological stations, as well as from satelites (maps indicating vegetation cover) and also data on farming, farming hazards, pastoral lands and well points; sent in by agricultural and lifestock farming agents. At the end of each meeting, an Agro-hydro-meteorological information bulletin is prepared and distributed by mail, or over the national radio and television, to policy makers, agricultural officials and development partners. The bulletin provides up- to-date information on meteorological conditions, rainfall, water table levels and their impact on agriculture; in addition to information on pastural lands, well points and detailed forecasts for the following ten days. These bulletins enable agricultural activities to be closely monitored and to detect areas where conditions are critical. These items of information are used by the Early Warning System (EWS), in addition to other indicators, to evaluate the country's nutritional, health and food situation, thus enabling decision makers to make the right decisions and take appropriate action in time.

4.1.1.2 Agro-hydro-meteorological assistance to rural communities

One of the consequences of the severe drought of the 1970's in Mali was the extinction of certain plant and animal species, as well as the disruption of their normal physiological

behaviour, causing the rural population to lose valuable reference indicators, in their empirical cultural calenders.

Moreover, farming calenders, symplified for local farmers by agicultural training Institutions, have undergone various modifications due to fluctuations in rainfall. It was in this particular context that an agro-meteorological assistance scheme was set up in 1982, through a participative, demonstrative, and multi disciplinary approach, with Suisse financial assistance and the technical support of the World Meteorological Organisation (WMO). The objectives of this assistance scheme were:

- The sensitisation of rural communities, by getting them to be directly involved in the various activities, through teamwork and a chain reaction network, involving extension workers, agricultural officials and policy makers. The sensitisation exercise will emphasize the importance of considering meteoroogical information in all agricultural decision making processes, so as to minimise climatic risks and safeguard or even increase agricultural production.
- The provision of professional training for local farmers and their introduction to data collection and the practical use of meteorological and agro-meteorological information, in all agricultural decision making processes.
- The establishment of a functioning system of compilation and dissemination of agro-meteorological information and advice to rural communities.
- The preperation of forecasting tables to determine when to begin the main planting seasons.
- The establishment of a rural database to help with agro-meteorological work and operations.

a) Technical Assistance Methodology

The implementation of the rural community assistance scheme is underaken by the multi-disciplinary working group (GTP), which meets every ten days, to analyse data and information received from their zones of operation, in order to prepare agro-meteorological advice. Advice given to rural communities generally deal with the following:

- Agro-climatic reference tables, for planning agricultural activities (the appropriate time for preparing the field and the agricultural seeds);
- The right time to begin the planting season, with the help of planting forecast tables, daily rainfall figures, hydrological reports and daily weather forecasts;
- The appropriate time to undertake the various agricultural activities, such as: mobilisation, field clearing, the use of different varieties of seeds and pesticides, etc., based on the hydrological report and daily weather forecasts;
- The outbreak of certain crop diseases, especially mildew (Warning based on rainfall, temperature and humidity).

Data collection is carried out by the farmers and instructors. The data reaches the multi disciplinary working group, (« GTP »), through the sensitisation institutions. The information is then treated and analysed by the « GTP », during its fortnightly meetings. It is also during these meetings that agro-meteorological opinions, warnings and advice are formulated and circulated by means of the national radio and television, to the local community (In french and in the local languages).

b) Socio-economic and Environmental Impacts

In general, as an outcome of those strategies, production has increased by an average of 42% for millet, 35% for sorghum and 68% for maise, within the entire area covered by these activities. In addition due to the use of calenders showing seed planting times, there has been a significant reduction in seed planting failure, which dereased from 40% (to 5%, representing a significant decrease in seed loss.

On the basis of production figures obtained between 1990 and 1996, the cost/benefice ratio of the agro-meteorological assistance operations in rural areas was found to be 1/21. Which means that for every franc invested, a profit of 21 francs was realised.

Besides the economic impact, agro-meterological assistance has a positive influence, on both the society and the environment, through:

- The consolidation of social cohesion, (since the regular sharing of the same information helps to bring communities closer together);
- The transfer of technical competence and knowhow to freshly trained members of the community (rainfall measurements, interpretation of meteorological information and a better mastery of agricultural activities, such as the judicious use of the seed planting calenders);
- The alleviation of women's domestic workload (resulting in better house keeping);
- The limitation of rural exodus;
- Better conservation of the environment due to:
    - A better mastery of landuse and the fallow system; and better crop management;
    - A rational use of pesticides and chemical fertilizers (avoiding additional treatment against agricultural hazards and applying fertilizers under favourable conditions of humidity).

4.1.2 Adaptation Strategies envisaged

On the basis of results obtained from agro-meteorological assistance efforts and impact studies of climate change on agriculture, the following strategies designed to minimise the effect of climate change on agriculture, are recommended:

- Genetic modification of certain species in order to produce varieties that are more tolerant to water shortage and elevated temperatures;
- Improvement of agricultural techniques and practices to permit a better use of the water ressources available;
- Reinforcement of agro-meteorological assistance to rural communities, through the improvement of the information system, by taking account of seasonal weather forecasts; rainfall estimation by satelite technology, vegetation cover indicators and the identification of agro-climatological risk zones.

In order to to implement the above recommendations and to make a meaningful contribution towards food security, the reduction of poverty and environmental protection, through the use

of agro -climatic information an adaptation strategy project were developed. The objectives of the project were to:

- Develop viable climatic forecasts, for productive application, adapted to the needs of potential users
- Develop crop varieties that are more adapted to climate change**;**
- Provide farmers with the best varieties;
- Promote the eficient use of rain water through the adoption of the relevant agro-climatic recommendations and through the use of appropriately adapted varieties;
- Provide farmers with a technological package, consisting of adapted varieties and agro-meteorological information;
- Convince farmers to use the technological packages, through a functional information system.

For the implementation, various activities has been identified and they include:

- Regular maintenance of meteorological and hydrological stations
- Collection and processing of rainfall, agro-climatic, hydrological and socio-economic data;
- Determination of meteorological and hydrological parameters;
- Phenological monitoring of crop cultivation;
- Continuation of studies on climate change and variability and their impact on socio-economic activity;
- Development of agro-climatic forecasting methods for crop yield in different agro-ecological zones, in relation to the effect of climate change on crop production;
- Research and selection of varieties resistant to climate change, for different agro-ecological zones;
- Preparation of a technological advice package on adaptation practices for farmers and rural agricultural instructors;
- Training and Sensitisation of rural agricultural instructors and farmers;
- Sensitisation of decision makers and potential users on the environmental and socio-economic implications of climate change;
- Specialisation of the entire personnel in fields related to climate change.

The methodology consist in the:

- Collection and Processing of meteorological, hydrological, pedological and rainfall data;
- Enlargement of the genetic species base: collection of data on: genetic variety, genetic crossing, genetic mutation and genetic transformation;
- Physio-morphological and enzymatic characterisation;
- Analysis and compilation of technical advice by a multi-disciplinary group;
- Dissemination of advice through the national or local radio stations;
- Application of agro-meteorological advice by farmers and local communities.

It is expected at the end of the exercise to have following results:

- Farmers are provided with crop varieties adapted to climate change;
- Such varieties are effectively used by farmers;
- Forecast tables, indicating the begining and end of the wet season are made available;
- Calenders indicating the start of crop planting are made available to producers;

- A functioning agricultural and pastoral lands monitoring system is established over the entire country, based on data from meteorological and hydrological observation netwoks, agricultural and pastoral land observatories and satelite reports.
- A well structured system of dissemination of information on climate and climate forecasting;
- Weather forecasts and agro-climatic information, are made available for decision making, related to agricultural activities (with or wihout irrigation);
- Evaluation of the potential for fodder crops, to enable a more rational management of pastoral lands;
- A modern management system of available environmental data, designed to help carry out the studies necessary for effective management and protection of the environment;
- A department well equiped, with the necessary telecommunication and data processing facilities;
- Decision makers, key actors and users, who are well informed about the environmental and socio-economic implications of climate change.

4.2 Water Resources Sector

A study conducted in the river Niger basin, on the evolution of climatic parameters (temperature and rainfall), revealed the necessity for a more effective management of water resources. The strategies to be adopted will have to take account of the physical conditions of the terrain and the economic potential.

Confronted with the acute water shortage, which followed the drought years of very low rainfall, the Malian authorities adopted a number of srategies at the begining of the 1980's, in order to meet the water demand:

- Development of the village and pastoral water supply system, through the construction of a number of wells, equiped with manual pumps;
- Development of urban water supply, through the construction of a supply system, fed either from surface waters or from high capacity borehole wells.;
- Development of the agricultural water supply system, fed from surface water obtained from rivers in the region;
- This policy has proved its worth, despite certain shortcomings observed in the "1991 Malian Water Resources Development Plan".

Within the context of climate change, the above options could be implemented, while correcting the shortcomings. The following options could also be considered:

4.2.1 Construction of water supply systems

- Construction of well points covering the entire needs of rural communities;
- Construction of a water supply system, covering the entire needs of urban communities;
- Deepening of 200 ponds and shallow wells for livestock raising;
- Construction of a number of small dams for agriculture and for recharging underground acquifers;
- Constuction of discharge control dams on permanently flowing watercourses.

4.2.2 Combined exploitation of surface and underground water, for meeting water demands

In urban areas located along permanent watercourses, water supply is obtained, uniquely from the nearby surface water. However, the exploitation of underground water resources could provide water at low cost, to surrounding suburban areas. This is also a serious alternative to easily polluted surface waters.

On the agricultural front, the combined use of non-perennial surface waters and underground water resources is considered a very harmonious arrangement.

4.2.3 Protection against flooding

- Construction of embankments,
- Construction of drains to evacuate surface water flows from sensitive areas,
- Preparation of an evacuation plan for the entire area at risk.

4.2.4 Protection against pollution

- Constant monitoring of water quality,
- Implementation of programmes to combat 'silting' of river beds, especially the river Niger,

4.2.5 Educational Research

Quantitative and qualitative evaluation of renewable ressources, with the aim of upgrading information and knowledge on both surface and underground water resources.

4.3 The Energy Sector

Concerning this particular sector, it is necessary to assess all the potential for energy saving and energy efficiency with the aim of enhancing the development of locally produced energy saving technologies as well as the promotion of solar energy. Those actions will contribute to reducing the pressure on forest resources (by reducing the domestic consumption of wood). In order to engage those actions a wide range of activities will be necessary. Those activities include:

- Determination of the efficiency of locally manufactured energy saving technologies (ovens, charcoal cookers and stoves, kerosene stoves);
- Determination of the efficiency of some locally manufactured appliances, which use alternative forms of energy to wood, such as: (briquettes, charcoal formed from agricultural wastes, coal dust concentrates, etc);
- Selection of the most efficient energy sources;
- Increased production of energy saving technologies (ovens, cookers and stoves using charcoal from agricultural wastes, kerosene stoves);
- Promotion and distribution of alternative technologies and combustion fuels;

- Promotion of photovoltaic solar equipments for household lighting.

The study will also enable the calorific values of forestry species used as wood fuel to be determined. These data constitute a precious source of information used in the formulation of CO2 emission limits and adaptation strategies, in the energy sector.

The study area is located to the south and in the central part of the country; more precisely, just south of the 13th parallel, since this is the area where the use of wood as energy, is very significant. Furthermore, the area falls within the limits of the green wall envisaged to check desert encroachment.

The following are the anticipated results:

- Energy saving equipments are manufactured locally,
- Combustion energy alternatives to wood are manufactured locally;
- Industrial units and small local enterprises, manufacture energy saving technological equipments and energy alternatives to wood;
- The use of energy saving technologies and combustion energy alternatives to wood increase;
- Pressure on forestry ressources decrease;
- Technicians and craftsmen are competent and could manufacture various equipments and energy alternatives;
- There is a well defined policy for selecting forest species to be used as fuel;
- Local ghg emission factors are available for forest species selected for energy use.

4.4 Biodiversity

Initiated by the Ministry of the Environment, this study is about to take -off. It will be necessary to intensify it later on, by extending it to other parts of the country. Vast expanses of the arid region of Mali are undergoing serious degradation, due to the combined effects of:

- Unfavourable climatic conditions, which reduced productivity over the entire country;
- Local exploitation of pastoral lands, which has become uncontrollable and destructive;
- Extension of farming into more humid areas, thus reducing the reserve of fodder crops and the extent of pastoral lands.

As rainfall decreases, the pastoral lands become increasingly degraded and this situation is further aggravated by lifestock farmers, whose flock continue to graze on the pastoral lands, despite their low productivity.

This project sets out to help rural communities adopt more efficient alternative solutions, without leaving their local environment, based on their own life experiences and on ancient traditions and practices which are rapidly dying out.

The project's main objective is to preserve the country's biodiversity, while increasing its carbondioxide absorbing capacity, through the development of an efficient arid land and natural resources management system. This should reverse the current degradational tend and establish sustainable livestock production, on a scale that is sufficient to meet the needs of a

constantly growing population, which is becoming increasingly sedentary. More specifically the project will:

- Set up an integrated development demonstration programme, explaining the sustainable use of local ressources (land, plants, water, energy, livestock resources, etc),
- Ensure the stability of the natural resources management system,
- Render traditional management systems more resistant to unfavourable climatic conditions,
- Select options, which could be extended to similar arid zones.

Furthermore, the project will contribute to the preservation / rehabilitation of biodiversity objectives, in two ecosystems and will also include an evaluation of over charges on additional carbon fixation. It is a question of quantifying the costs and benefits of increasing the productivity of sahelian pastoral lands, within the context of an integrated managemet of local natural resources.

4.5 Preparation of climate change scenarios for Mali.

In preceding studies, general circulation models obtained from data from literature for Africa and fror the Sahel, were used. These models make use of experiments on Equilibrium Reaction, which evaluate the equilibrium reaction of global climate, following a doubling of the carbondioxide concentration in the atmosphere. However, these methods contain certain imperfections, which seriously tarnish the viability of the estimates. On the other hand, expriments based on Transitional Reaction, which we want to use in this study, simulate the characteristics of atmospheric perturbation, due to a progressive and continuous increase in ghg concentrations. These models have the following advantages:

- Their easy application,
- The incorporation of a time factor,
- The possibility of studying the various uncertainties.

In order to implement such approach in Mali, a project has been initiated with the support of the Netherlands. The primary objective of the exercise was to prepare climate scenarios, decribing in a coherent way, the possible future climatic situation in Mali. These scenarios are necessary, in order to undertake Vulnerability and Adaptation studies in the agricultural and water resources sectors.

Key Stakeholders to be interviewed

The following key stakeholders from government sector, academia, private sector and NGOs are among the most aware climate change issues. They have been identified for the interview to be conducted later.

1 Government

- Direction Nationale de l'Appui au Monde Rural: (DNAMR: Mr Bandiougou CAMARA)
- Institut d'Economie Rurale: (IER: Siaka DEMBELE)
- Direction Nationale de l'Aménagement et de l'Equipement Rural: (DNAER: Lassina COULIBALY)
- Centre National de Recherche Scientifique et Technologique (CNRST: Mr Abdoulaye BAYOKO)
- Direction Nationale de l'Energie: (DNE, MM Ibrahima Kassambra et Lassiné Sylla)
- Direction Nationale de la Météorologie: (DNM, MM Mama Konaté et Birama Diarra)
- Direction Nationale de la Conservation de la Nature: (DNCN, Mr Alpha Maiga)
- Direction Nationale de l'Hydraulique: (DNH, Mr Navon Cissé)
- Direction Nationale des Transports: (DNT, MM Bréhima FOMBA)
- Direction Nationale de l'Industrie: (DNI, Mr Adama Konaté)
- Centre National d'Energie Solaire et d'Energies Renouvelables: (CNESOLER, Mr Alhousseini MAIGA)
- Secrétariat technique Permanent du Cadre Institutionnel de Gestion des Questions Environnementales: (STP)/CIGQE, MM Salif Kanouté, Bakary Touré et Boubacar S. Dembélé)
- Direction Nationale de la Statistique et de l'Informatique: (DNSI, Mr Brahima Sanogo)

2 Academia/Unversity

- Institut Polytechnique Rural/Institut de Formation et de Recherche Appliquée (IPR/IFRA, Mr Alhousseini Bretaudeau)

- Ecole Nationale d'Ingénieurs (ENI, Mr Famouké Traoré/Sidi Konaté, Arona Coulibaly et Amadou Z. Traoré)

Ecole Normale Supérieure (ENSUP, Amadou Ballo)

3 Non Governmental Organisations

CCA/ONG: Comité de Coordination des Actions des ONG(Mr Moctar Touré Tel:223 23 69)

SECO/ONG: Secrétariat de Concertation des ONG (Mr Mory Moussa Konaté Tel: 229 30 41/229 94 40)

CAFO: Coordination des Associations et ONG Féminines (Mme TRAORE Néné TOURE)

4 Private Sector

APES: Association des Professionnels de l'Energie Solaire (Mr Salifou BENGALY)

Chambre de Commerce et d'Industrie du Mali (CCIM) (Mr Daba TRAORE)
APCAM: Assemblée Permanente des chambres d'Agriculture du Mali (Mr Abderhamane BOUARE)
Fédération Nationale des Transporteurs Routiers du Mali(Mr Moctar THERA)

Fédération Nationale des Employeurs du Mali (Mr Lassina TRAORE)
Fédération des Groupements de Transporteurs Routiers (Mr Lat GUEYE).

Selected Bibliography for a Contribution to Alternative Mechanism and Strategies for Adaptation to Climate Change for Mali

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