

CLIMATE CHANGE AND FOOD SECURITY

Course Book

By

Professor Michel BOKO

Table of content

Acronyms

Introduction

CHAPTER I:

OVERVIEW ON CLIMATE CHANGE, AGRICULTURAL POLICIES AND FOOD SECURITY ISSUES IN AFRICA

- 1.1. Summary of the Major Conferences on Climate Change
- 1.2. Overview of the Major Continental, Sub-Regional and National Initiatives Regarding Climate Change
 - 1.2.1. ClimDev-Africa Program
 - 1.2.2. United Nations Program of Reducing Emissions regarding Deforestation and Soil Degradation (REDD)
 - 1.2.3. Sub-Regional Action Program for Reducing West Africa and Chad's Vulnerability Regarding Climate Change
 - 1.2.4. National Initiatives: The National Action Plans for Adaptation (NAPA) to Climate Change
- 1.3. Political, Institutional and Scientific Ruling Regarding Climate Change
- 1.4. Regional Policies and Strategies for Agriculture
 - 1.4.1. Overall Trends and Developments of National Agricultural Policies over the Past Decades
 - 1.4.2. National Investment Programs for Agriculture (NIPA)
- 1.5. Situation of Food Security and Food Independence in Africa
 - 1.5.1. Hunger and Nutrition Situation
 - 1.5.2. Dependence on Food Exportation

CHAPTER II:

MANIFESTATION, CURRENT AND FUTURE CLIMATE CHANGE IMPACTS ON AGRICULTURE AND FOOD SECURITY

- 2.1. Manifestation of Climate Change
 - 2.1.1. Evident Increase in Ambient Temperature
 - 2.1.2. Alarming Sea-Level Elevation
 - 2.1.3. Increased Variability in Rainfall and an Uncertain Future Trend
 - 2.1.4. An Upsurge in Extreme Hydrological and Climate Events
- 2.2. Current and Future Impacts of Climate Change on Agriculture and Food Security
 - 2.2.1. Impacts on Agricultural Production
 - 2.2.2. Overall Cost Estimate of Damage Regarding Floods from 2000 to 2008
 - 2.2.3. Impacts on Breeding and Fishing
 - 2.2.4. Current Impacts on Nutrition/Health
 - 2.2.5. Current Impacts on Existing Transportation Systems
 - 2.2.6. Impacts on Supply and Demand, and Agricultural Product Prices
 - 2.2.7. Future Climate Change Impacts on Agricultural Production and Food Security

**CHAPTER III:
ADAPTATION OF AGRICULTURE TO CLIMATE CHANGE FOR A SUSTAINABLE
FOOD SECURITY IN AFRICA**

- 3.1. Adaptation to Climate Change Associated with Development Policies
 - 3.1.1. Theoretical Framework Regarding Adaptation
 - 3.1.1.1. UNFCCC Theoretical Framework
 - 3.1.1.2. FAO Theoretical Framework Regarding Adaptation
 - 3.1.1.3. Theoretical Framework Regarding Adaptation in West Africa
 - 3.1.2. Adaptation Capacities Regarding Climate Change
 - 3.1.3. Assessment of Adaptation Measures
 - 3.1.3.1. Cost-Benefit-Based Method
 - 3.1.3.2. Cost-Effectiveness-Based Method
- 3.2. Adaptation to Climate Change Integrated to Agricultural Projects Development
- 3.3. Adaptation and/or mitigation measures to agriculture for a sustainable food security in Africa
 - 3.3.1. Forecasting, Prevention, Addressing and Anticipation on Natural Disasters
 - 3.3.2. Improving the Resilience in Agriculture, Forestry, livestock and Fish Breeding Systems
 - 3.3.3. Regional Governance of Sustainable Food Security
 - 3.3.4. Agricultural/Crop Insurance
 - 3.3.5. Sustainable Management of Forests (REDD+): Combining Agriculture and Agro Forestry
 - 3.3.6. Carbon Market under the CDM

Conclusion

Bibliography

Glossary

Acronyms

ADB: African Development Bank

BOAD: West African Bank of Development

UNFCCC: United Nations Framework Convention on Climate Change

ECA: Economic Commission for Africa

ECOWAS: Economic Community of West African States

CILSS: Permanent Inter-State Panel for Drought in the Sahel

SWAC: Club of Sahel and West Africa Countries

FAO: United Nations Food and Agriculture Organization

IFAD: International Fund for Agricultural Development

GHG: Green House Gas

IPCC: Intergovernmental Panel on Climate Change

GOANA: Great Agricultural Offensive for Food and Abundance

IFPRI: International Food Policy Research.

CDM: Clean Development Mechanism

NEPAD: New Partnership for Africa's Development

MDGs: Millennium Development Goals

WMO: World Meteorological Organization

NAPA: National Action Plans for Adaptation

SRAP-RV-WA: Sub-Regional Action Plan for the Reduction of Vulnerability of West Africa and Chad on Climate Change

GDP: Gross Domestic Product

LDC: Least Developed Countries

NIPA: National Agricultural Investment Program

UNDP: United Nations Development Program

PRIA: Regional Program for Agricultural Investment

REDD: Reducing Emissions from Deforestation and Land Degradation

WAEMU: West African Economic and Monetary Union

IUCN: International Union for Conservation of Nature

Introduction

According to scientists, Climate Change is increasingly a harsh reality which humanity must now cope with. The evaluation of main climate parameters shows an overall change in the atmosphere. According to the Intergovernmental Panel on Climate Change (IPCC), various current and future trends are likely to occur worldwide as well as in Africa: rise in temperatures, sea-levels, increased variability of rainfall and the characteristics of the agricultural seasons, increase of extreme events such as droughts and floods, etc... It is therefore a question of major trends for African countries with quite poor economy which are mainly based on local natural resources exploitation characterized as highly sensitive to climate and its variations.

However, by 2015, all African countries have set the ambitious goal of reducing hunger by half. As regards to this new situation, the risk of food insecurity exacerbation remains facing many risks associated with climate change. Despite efforts undertaken by African Governments in aim to revive the agricultural sector, Africa is still considered as one of the most vulnerable regions in the world due to negative effects of variability and climate change despite its low contribution to greenhouse gases emission.

According to the latest IPCC report (2007), global warming will be more important in Africa than elsewhere over the 21st century. Current trends show that large areas of Africa, including the Sahel and parts of southern Africa, will be marked by a warming of about 3 to 6 °C during this century. Rainfall patterns will also be affected by a decrease of over 20% to 30% considering the baseline 1961-1990. More than 95% of African agriculture is rain-fed. Therefore, crop production will be severely compromised with the increased variability of rainfall combined with rise in temperatures and occurrence of devastating extreme events. While in coastal areas, activities will be disabled by flooding, marine erosion and soil salinity. The expected effects are reduction of arable inland and coastal land surfaces, changes in the length of seasons, disruption of crops' biological cycles combined with water and heat stress.

This situation compels the international scientific community to admit that no matter the importance of mitigation efforts to be deployed in the world, especially by the industrialized countries; the adverse effects of climate change will be due to past greenhouse gas emissions. These impacts will concern natural and human systems as well as on the socio-economic systems such as agriculture, forestry, fisheries and water resources essential to the development and populations' well-being.

Such a forecasting is of a great importance to African countries and provides that a planned adaptation in the agricultural sector is of a major priority for these countries.

Facing these challenges, three options for dealing with climate change are advocated by the international scientific community (WMO, UNEP through the IPCC). These are:

- Science: to promote scientific knowledge necessary for decisions making based on mitigation and adaptation;
- Mitigation: to reduce emissions of greenhouse gases causing climate change;
- Adaptation: to adjust practices, procedures or structures to current and future climate change.

To address the negative effects of climate change, people have always put into practice their basic skills, which in some cases may seem to be limited as evidenced in some situations of food crises that occurred during these decades. Facing the exacerbation of climate change, many African countries have made international commitments through the United Nations Framework Convention on Climate Change (UNFCCC). It consists of making not only a comprehensive assessment of risks and vulnerability of key sectors of their economies, but also identifying priority actions and projects on adaptation to climate change through the National Action Plans for Adaptation (NAPA).

This course is made up of three chapters. The first chapter presents overview of climate change, and food security issues in Africa. The second deals with manifestation, current and future climate change impacts on agriculture and food security. The third chapter addresses the issue of adapting agriculture to climate change for a sustainable food security in Africa.

CHAPTER I:

OVERVIEW ON CLIMATE CHANGE, AGRICULTURAL POLICIES AND FOOD SECURITY ISSUES IN AFRICA

This chapter presents a synthesis of climate change, agricultural policies and the situation of food security in Africa through examples from some countries, particularly in the West African sub-region.

1.1. Summary of the Major Conferences on Climate Change

Since the establishment of international legal instruments on climate, various reports show that Africa is the most vulnerable continent regarding climate change. Here are the most significant conferences pertaining to African and the opportunities that they convey:

At International Level:

Many conferences have been made by the international community, including:

- The UN third conference on climate change held in September 2009 in Geneva, Switzerland which has drawn the international community attention on current and future climate risks, especially in the poorest countries in the world. It has urged the international community to find a new framework of climate governance at COP15 in Copenhagen (Denmark);
- The initiative launched by African leaders through a consortium of organizations consisting of Africa Progress Panel, African Development Bank (ADB), Economic Commission of the United Nations of Africa (UNECA) and United Nations Environmental Program (UNEP), in June 2009 as a preparation for the Conference of Parties in December 2009 in Copenhagen, Denmark in aim to address climate change, especially as regard to agricultural productivity and biodiversity conservation, infrastructure and trade facilitation, etc;
- The Rome Declaration on World Food Security during the World Food Summit organized by FAO in November 2009 which has adopted an action plan on food with seven (7) major commitments for hunger eradication worldwide, it includes:
 - pursue participatory method and policies for a sustainable food supply, agriculture, fisheries, forestry in rural areas with high potential as well as in those with low potential. These are essential to ensure adequate and reliable food supplies at households' level as well as national, regional and global area. The said methods and policies

will help fight against pests, drought and desertification, basing on the multifunctional aspect of agriculture;

- make every effort to ensure that the policies concerning foodstuffs and agricultural trade and in general help to better food security for all, through a world trading system which is at the same fair and market oriented;
- make every effort to prevent natural disasters and crises caused by humans, be prepared, and meet transitory and emergency food needs, in ways that encourage recovery, rehabilitation and development and strengthen the capacity to satisfy future needs;
- promote optimal allocation and use of public and private investments to foster a sustainable human resources, food, agriculture, fisheries and forestry systems and development in rural areas with both high and low potential.

Finally, the 15th Conference of Parties for Climate Convention held in December 2009 in Copenhagen, Denmark with a minima agreement opens up new important perspectives, especially for the reduction of the global temperature average to 2 ° C and increased funds to help vulnerable countries adapt to climate change. Despite this commitment which aligns up with the warming cause, a new binding agreement on the new regime of post-Kyoto climate is to be set up.

At Continental Level:

The African Union (AU) through the African Ministerial Conference on Environment (AMCEN) and the Group of African negotiators on climate change is an avant-garde to the climate change issues with special focus on seeking for a common African position to be defended at the COP. Resolutions and declarations have been made during numerous conferences and summits of African Union State Heads which are held in 2009. It includes:

- Declaration of State and Government Heads during the African Union Summit in Addis Ababa (ETHIOPIA) in January 2007 and out of which formal recommendations have been made. These include:

- fund raising in aim to promote and better scientific and technologic applications as regard to climate data collect, analysis, availability of information on early warning and timely communication;

- help African countries get access to GEF financial resources, and explore other financial resources and mechanisms to back up adaptation programs in Africa;
- build up the capacity of regional and sub regional African first-rate climate centers to enable them to ensure forecasting of climate change and variability and to develop decision making tools for climate applications;
- make possible the transfer of relevant technologies adjustable to the climate between developing countries.

Finally, the Summit openly asked the Commission of the African Union (AU) to initiate consultations with the African Ministerial Conference on Environment to set up necessary mechanisms for monitoring the implementation of the said declaration in collaboration with the United Nations Economic Commission for Africa (UNECA), the African Development Bank (ADB).

- The Declaration of State and Government Heads of the 13th Ordinary Session of the African Union Assembly in Syrth (Libya) in June 2009 has explicitly adopted a common position and focused its appeal on two points which are stated below:

- increasing of fund granted as regard to the mechanism of adaptation and mitigation to climate change;
- compensations for indirect damage to African economies in response to the crisis, a relevant access to financial markets of carbon and access to new technologies as well as to the three core cross-border projects that are: Green Wall Sahara initiative, the Chad and Nile Lakes' basins and the Congo River's Basin Initiative.

- the AU Government and State Heads have renewed the Maputo Declaration which urges them to allocate at least 10% of national budgets to agriculture and rural development. Finally, the African Civil Society has also spoken their mind as regards to climate change at this summit and called for greater investment in agriculture for a better economic growth and food security at both national and regional levels as well as panafrican area.

- The declaration of the 7th Global Forum on Sustainable Development in Ouagadougou (Burkina Faso), in October 2009, where Africans have reached a common position to be supported at Copenhagen conference and agreed to:

- promote adaptation to climate change integration to policies, programs and strategies at local, national and regional levels to provide a comprehensive response to meet climate change challenges and grab the opportunities offered by these in terms of sustainable development;
- support the Bali project which aims to include in the post-2012 Kyoto climate treaties, a mechanism aiming to take into account the Reduction of Emissions from Deforestation and Degradation (REDD) and yet more recently, negotiations including the sustainable management of forests (REDD +) which is a kind of direct funding of national sector-based policies approach with the creation of a special interim funding mainly by contributions from developed countries;
- increase carbon reservoirs through a comprehensive program of reforestation and conservation of forest ecosystems;
- align up with adaptation options and measures aiming at reversing water and soil resources degradation trends as well as the river and lake basins;
- launch a call upon strong support for the fight against erosion;
- support the African position which calls for a substantial replenishment of the Global Environment Facility (GEF) and for maintaining the experiences of the Convention and the Kyoto Protocol, especially on the quantified commitments of greenhouse gas emissions reduction in developed countries, and support to developing countries for adaptation, mitigation, access to clean energy, technology transfer, capacity building and funding, through projects and relevant actions.

At West Africa Sub-Region Level:

Because of its greater vulnerability, numerous consultations, scientific and technical meetings have been held over recent years as a prelude to the COP15 in Copenhagen, Denmark. It includes:

- International Conference on: "Reducing the Vulnerability of Natural, Economic and Social Systems in West Africa as regards to Climate Change" in January 2007 in Ouagadougou. It has been recommended that the CILSS in collaboration with ACMAD, ECOWAS, UEMOA and UNECA should develop "a sub-regional action plan to reduce the vulnerability of natural, economic and social systems as regards to climate change in West Africa and Chad

"(PASR-RV-OA), which has been voted and adopted by the ECOWAS political institutions on March 18th, 2010 in Accra, Ghana;

- the Sub-regional dialogue on climate change of Cotonou in October 2008 organized by the Government of Benin and the Economic Commission of West African States (ECOWAS), has aimed at institutionalizing a Regional dialogue on Climate Change in West Africa. Many recommendations have been made, and which comes in line of strengthening regional solidarity in addressing climate change;
- The Conference of Lome in September 2009 organized by the United Nations with a close collaboration of the Economic Community of West African States (ECOWAS) and the Government of Togo;
- Out of the Regional Conference on Protection challenges regarding climate change in West Africa, many recommendations have also been made. It includes mainly those relating to:
 - The creating of special fund to meet the impact-induced of climate change on populations directly impacted;
 - Capacity building of national and regional stakeholders as regards to their awareness and response to humanitarian emergencies;
 - The development of a new legal instrument to protect displaced people because of climate change impacts and who find themselves outside their original country;
 - The establishment of a regional platform aiming to set up a Database Management System and information exchange for Member-States of ECOWAS and the Mauritania.

In addition, it fits to mention about the declarations of the Fifth Workshop of the African Agricultural Sciences on "Innovations in African Agriculture" held during the General Assembly of the African Forum for Agricultural Research (FARA) from 19 to July 24, 2010 in Ouagadougou, Burkina Faso.

1.2. Overview of the Major Continental, Sub-Regional and National Initiatives Regarding Climate Change

Following the examples of many calls to the benefit of the most vulnerable countries, especially those in Africa, many initiatives on climate change and food security are also developed at national and sub-regional level as well as continental area. At these different scales, and as example, some major initiatives relevant to Africa in general and West Africa in particular are presented below.

1.2.1. ClimDev-Africa Program

Basing on the commitment set by the G8 at Gleneagles (England) in 2005, the GCOS Secretariat (Global Climate Observing System) of the World Meteorological Organization (WMO) has decided to work out a significant program to improve observation systems and climate services in Africa. This program known as ClimDev-Africa is conducted by the African Union (AU), the United Nations Economic Commission for Africa (UNECA) and African Development Bank (ADB). It aims to fully use the potential of science and climate services to help achieve the Millennium Development Goals (MDGs). Phase 1 of the said program is scheduled for 2010-2012, and entitled "Support to African Climate Institutions". It is fully financed by the ADB. AGRHYMET, a specialized institution of CILSS which is a beneficiary of this fund will be in charge of climate concerns pertaining to West Africa.

1.2.2. United Nations Program of Reducing Emissions regarding Deforestation and Soil Degradation (REDD)

According to the IPCC, deforestation contributes to almost 20 % of greenhouse gases global emissions. The United Nations has initiated a major program on reducing emissions from deforestation and soil degradation in developing countries (UN-REDD).

It aims to reduce CO₂ emissions resulting from forests by giving forests a monetary-based value as regards to their capacity to store carbon in order to turn the economic balance in favor of sustainable management of forests so that their economic, environmental and social goods and services benefit to countries, communities and forest beneficiaries. Out of nine experimental countries which are eligible for REDD worldwide, three African countries (Democratic Republic of Congo, Tanzania and Zambia) are part of this program. Reflection for the extension of REDD, known as REDD+ aiming cover the non-equatorial forests (The Amazon and the Congo off-Basin etc) is ongoing and would take into account the West Africa.

1.2.3. Sub-Regional Action Program for Reducing West Africa and Chad's Vulnerability Regarding Climate Change

All countries of West Africa have attended the United Nations Convention Framework on Climate Change and Kyoto Protocol. However, the IPCC recommends, increasingly, taking into account the regional or sub-regional aspect with regard to the transnational character of the expected impacts pertaining to climate change. Therefore, intergovernmental organizations in the sub-region such as ECOWAS, WAEMU, CILSS, etc. are constantly being called upon to take into account this new cross-border environmental concern.

To be aligned up with this, participants in the International Conference on Climate Change in January 2007 in Ouagadougou, Burkina Faso, have made an important recommendation relating to the implementation of a Sub-Regional Action Program for Reducing West Africa and Chad's Vulnerability Regarding Climate Change (SRAP-RV-WA). It aims to taking into account and integrating climate change aspects to programs and policies for sustainable development in West Africa. CILSS, ECOWAS, ACMAD, UEMOA and ECA have been in charge of working out his program.

The program has as vision: "Rooting out the negative impacts of climate change in West African sub-region, by 2025". It has also set an overall goal of developing and strengthening the resilience and adaptation capacities of the sub-region as regards to climate change. The program presents three specific objectives below:

- 1:** capacity building of sub-regional institutions to better support Governments in their efforts to reduce vulnerability regarding climate change;
- 2:** promote the mainstreaming of climate change in developing policies, strategies, programs and projects at both local and national level as well as the sub- regional area;
- 3:** promote a coordinated implementation of both national and sub-regional projects and programs aiming to reduce the vulnerability as regards to climate change.

1.2.4. National Initiatives: The National Action Plans for Adaptation (NAPA) to Climate Change

In addition to national communications considered as one of the obligations imposed over the Parties attending the Climate Convention; funds for adaptation have been granted to the Least Developed Countries (LDCs) for the

preparation of NAPAs. Up to now, all countries of the WAEMU, said to be LDC except Côte d'Ivoire, have started or done with the writing out of their document. By definition and because of the participatory approach that characterizes the writing of the NAPA, these are good materials for local adaptation actions, thus reducing populations' vulnerability. Lack of funding is, however, the main obstacle to the implementation of NAPAs.

1.3. Political, Institutional and Scientific Ruling Regarding Climate Change

Since the Earth Summit in Rio in 1992, initiatives have been taken at different levels concerning the political, institutional and scientific ruling on climate.

Internationally, first of all, there is the submission for signature and ratification of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. The UNFCCC is a non-binding treaty that commits Parties to cooperate in maintaining greenhouse gases emission at a level that does not threaten the global climate. It has later been supplemented by the Kyoto Protocol in 1997, which aims to fix in such an accurate and compelling way the reduction of emission of the six (6) main and most significant greenhouse gases.

Because of lack of scientific evidences pertaining to climate change, the World Meteorological Organization (WMO) and United Nations Environment Program (UNEP) have established in 1988, the Intergovernmental Panel on Climate Change (IPCC) aiming to collect, assess and provide scientific data to the public and policy-makers, accordingly. The IPCC acts as a global supreme scientific institution of climate. In addition to the political, institutional and scientific ruling regarding climate change, the international community has also several funding mechanisms such as the Global Environment Fund, the adaptation fund and carbon.

At national and West Africa sub-region level, we can point out that all countries of the West African sub-region have signed and ratified all these legal instruments of the international institution of the climate. This commitment to the climate cause has been evidenced with the implementation of mainstreamed legal frameworks (national committees on climate change, national councils for sustainable development, etc.) in each country for a better understanding and conduct of activities related to climate change.

Following the example of large aggregations with economic and geostrategic purposes worldwide, the West African sub-region has set up political, economic and monetary mainstreamed organizations such as ECOWAS, WAEMU; river basin organizations such as the Niger Basin Authority (NBA), the Authority of the Volta Valleys (AVV), the Organization for the Development of the Senegal River (ODSR), a specialized technical institutions such as CILSS, etc. The impacts of climate change being transnational, these organizations have started working

collectively over recent years considering both regional and sub-regional aspects of climate change. This has resulted in the creation of the African Negotiators' Group, the meeting of Environment Ministers initiated by the African Union, the organization of consultations at the sub-regional level etc. aiming to define an adequate sub-regional institutional framework.

1.4. Regional Policies and Strategies for Agriculture

1.4.1. Overall Trends and Developments of National Agricultural Policies over the Past Decades

To address issues and challenges relating to agricultural development, State governments have developed policies and agricultural development strategies with several steps of evolution.

In terms of agriculture, policies and strategies have successively been conducted from one country to another. Thus in the early 1990s, there has been the implementation of Structural Adjustment Programs for Agriculture (PASA) after introducing the Letter of Agricultural Development Policy (LPDA) in different countries. These PASA have generally resulted in a set of reforms and measures of State government disengagement from productive activities in the advantage of private businesses. The PASA objectives have mainly aimed at, (i) modernizing and diversification of production, (ii) strengthening food security and (iii) improvement of natural resources management.

After the PASA events, among changes which marked different countries, there is mainly the development of Directive Plans for Agriculture and Rural Development (SDDAR) which deal on the one hand, with policy and the general strategy for agricultural development, and on the other hand the sub-sector-based strategies.

Today, the agricultural policies and strategies in force in the UEMOA countries are:

- i) The Rural Development Strategy (SDR); in Burkina Faso and Niger,
- ii) In Mali, we have the Directive Plan for Rural Area Development (SDDR) in addition to the Letter of Institutional Policy Development (LPDI), and an orientation for Agricultural Bill as well as a special program on intensification of rice paddy which is known as "Rice Initiative";
- iii) In Benin, we have the Strategic Plan for the Revival of Agriculture Sector (PSRSA), which has been a key document for agricultural development since 2006;

iv) In the Ivory Coast, there is the Recovery Strategy and Promotion for Agricultural Sectors in addition to an Agricultural Orientation Law (LOA);

v) The Letter of Agricultural Development Policy in Guinea Bissau (LPDA);

vi) In Senegal, it is the Agricultural and Sylvan Orientation Law (LOASP) backed up with the Strategic Document for Poverty Reduction (D.S.R.P.II or new generation) of the REVA Plan (Back to Agriculture and the GOANA (Great Agricultural Offensive for Food and Abundance) ;

vii) In Togo, it is the Declaration of Agricultural Development Policy (DPDA).

1.4.2. National Investment Programs for Agriculture (NIPA)

In aim to implement ECOWAP and CAADP/NEPAD, several countries have developed and voted under the sponsorship of ECOWAS, a National Investment Program for Agriculture (NIPA) in synergy with the Regional Investment Programs for Agriculture which will be implemented throughout the ECOWAS sub-region. This comes in the line of the CAADP implementation. Round tables have been held in different countries in order to validate the NIPA and sign agreements for their implementation. As regards to the specific area of food security, CILSS has also supported its State-members (Burkina Faso, Guinea Bissau, Mali, Niger, and Senegal) to adopt national strategies operational for food security.

Besides, to greatly integrate climate change concerns in national agricultural development, most countries of the UEMOA have currently adopted A National Action Plans for Adaptation to Climate Change (NAPA).

1.5. Situation of Food Security and Food Independence in Africa

1.5.1. Hunger and Nutrition Situation

In addition to the fact that change in terms of number and proportion of malnourished individuals is mentioned above, it is also interesting to give evidence on the evolution of the malnutrition and hunger situation as it is in countries and within households in Africa, by highlighting the one of the sub-regions, countries and areas most affected and where it is said to be more urging.

The hunger index worldwide, in 2010, (IFPRI et al., 2010) as shown in Table 1 describes the evolution of hunger by taking into account three interrelated indicators of hunger (Wiesman, 2004; Wiesman, 2006) (proportion of population underfed, underweight prevalence of infant and child mortality rates) which available malnutrition indicators do not adequately count for the situation. The

Index shows that sub-Saharan Africa rates in the second position with 21.7 after Asia (22.9) in terms of highest regional scores in 2010.

This score represents a decrease of 14% as regards to the year 1990 Regional Index, compared to South Asia (25%), Middle East and North Africa (33%). The situation varies considerably regarding the sub-regions and African countries. So, Central and East Africa are sub-regions that received the worst scores.

Overall, progress in reducing hunger (calculated from the annual decrease of index scores) has been significantly remarkable in Tunisia (- 58%) and Ghana (- 57%), the single country in sub-Saharan Africa which ranks among the 10 countries with the best results in terms of improving their index score worldwide since 1990.

The nine countries where the Index has increased at the global level over the period of 1990 to 2010 are all African. Considering the scores, the most affected countries are: Burundi (+20%), Comoros (+21%), Gambia (+6%), Guinea-Bissau (+8%), Liberia (+6%), the Democratic Republic of Congo (DRC) (+66%), Swaziland (+14%) and Zimbabwe (+12%).

Table 1: World hunger Index in terms of African sub region, 1990-2008

Tableau 0 : Indice de la faim dans le monde par sous-region africaine, 1990-2008

	Proportion de la population sous-alimentée (en %)		Prevalence de l'insuffisance pondérale chez les enfants de moins de cinq ans (en %)		Taux de mortalité chez les enfants de moins de cinq ans (en %)		Indice de la faim dans le monde					
	1990-1992	2004-2006	1988-1992	2003-2008	1990	2008	1990 Y compris des données de 1988-1992	2010 y compris des données de 2003-2008				
Afrique du Nord	7,8	5,8	25,4	16,7	11,3	32,1	8,3	5,2	37,3	11,2	8,5	24,1
Afrique centrale	35,6	33,5	6,0	21,3	20,4	3,9	15,3	15,2	0,7	24,1	23,0	4,2
Afrique de l'Est	42,8	40,5	5,5	25,4	26,1	-2,6	16,6	12,3	25,7	28,2	25,7	8,7
Afrique australe	31,6	28,3	3,4	18,9	16,0	9,2	12,8	9,4	21,3	21,1	17,8	9,9
Afrique de l'Ouest	26,0	22,7	12,8	25,4	21,9	14,0	20,4	14,4	29,3	23,9	19,6	17,9
Afrique	29	26	11	22	19	11	15	11	23	22	19	13

Source : IFPRI. Voir pour les détails : *Indice de la faim dans le monde, 2010*.

Note: A shows a relative decrease in the proportion of underfed populations against baselines of 1990-1992 and 2004-2006; B indicates a relative decrease in the prevalence of underweight among children under five against baselines 1988-1992 and 2003-2008; C indicates a relative decrease in mortality rate among children under five between 1990 and 2008; D indicates a relative improvement in world hunger Index between 1990 and 2010. A, B, C and D correspond to the author's calculations based on data provided above.

Regarding the components of the Index, the highest proportion of underfed people --more than 50% of the population-- are found in Burundi, Comoros,

Eritrea and the DRC. Angola, Chad and Somalia have the highest mortality rate among children less than five years (20% and more). Making a rapid progress in reducing cases of underweight children, children feeding issue should be resolved very quickly in sub-Saharan Africa so that the expected improvement is met as regard to these scores. As far as the impacted countries are concerned, nearly half the children suffer from stunted growth, according to UNICEF (2009). It includes: Ethiopia and Rwanda (51%), Guinea-Bissau and Niger (47%).

1.5.2. Dependence on Food Exportation

The African market is characterized by high cereal importations from emerging European and Asian markets, due to growing demand. These importations are so important regarding food availability for populations. Statistics show disparities in the past decades: i) the overall cereal production in the Sahelian countries has increased by 19 %, ii) the production per capita has decreased by 6 %, iii) total importations of cereal have increased by 65 % iv) the importation per capita has increased by 32 %. These evolutionary trends reflect the difficulties facing African countries in meeting growing demand for rice (50 % of cereal importations) and wheat. This growth in demand is particularly high regarding urban consumers, but also (and increasingly) rural due to the change in diet habits.

Since the early 1990s, African countries and particularly LDCs have been exposed to the increasing importation surges (in terms of numbers and frequency). This trend has accelerated from 2000 to 2003, a period during which African countries have quite turned into foodstuffs importers after receiving high surpluses in the 1980s (UNCTAD, 2006). This period of expansion of world trade has been that of a more opening for food market on the continent. The continent's world export has remained relatively stable at about 3 percent while the on the import side, it has increased by 4 to 5 percent.

Food supply situation as shown on Diagram 1, masks contrasting situations at countries' level, where part of food aids in total food availability can vary considerably.

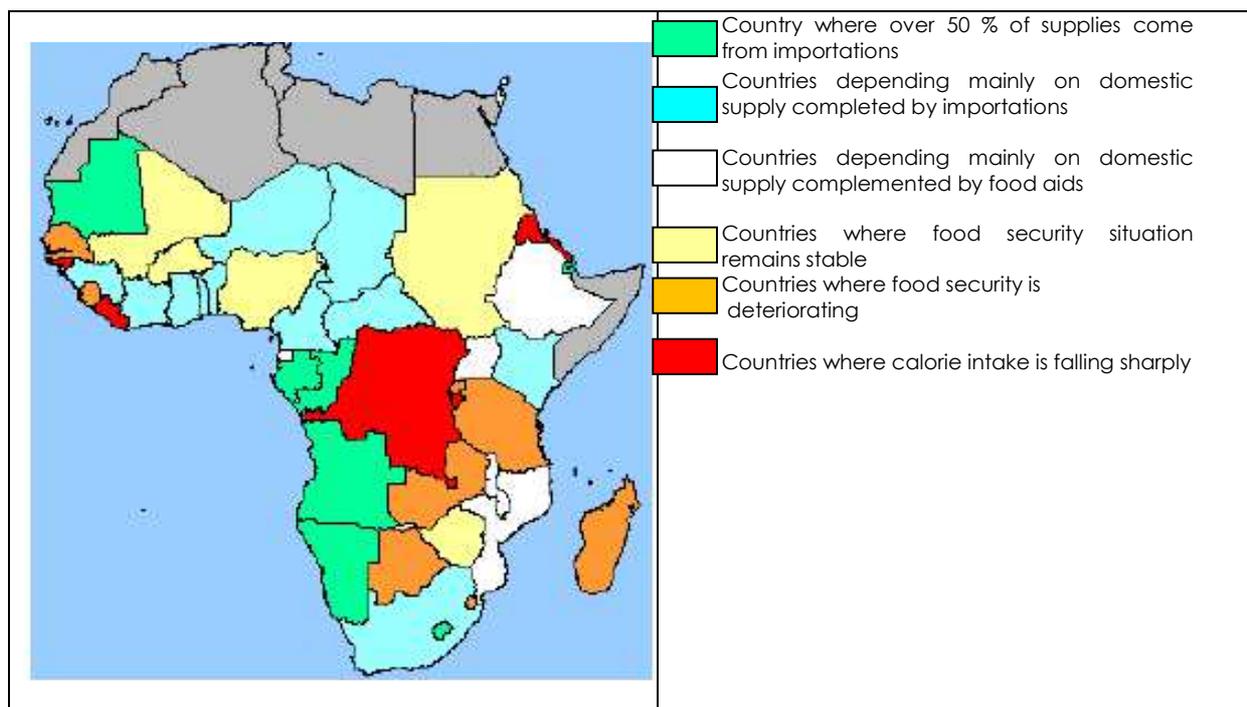


Diagram 1: Foodstuffs supply situation in Africa

Countries with more than half of their foods supply coming from outside (Djibouti, Angola, Cape Verde, Congo, Gabon, Lesotho, Mauritania, Namibia and Seychelles) have their production level unchanged. In the period of 2000 - 2002, the total number of underfed people in this group (8.2 million in 1990-1992) has fallen by 0.8 million. Agriculture has generally smaller share in the GDP of these countries. Their GDP is often based on others sectors such as mining and services. For some, money transfers by migrant workers are an important source of income.

Countries that depend mainly on domestic supply have their cereal production grown:

- Among these, a first group of countries (Ghana, Niger, Kenya, Togo, Guinea, Cameroon, Ivory Coast, Benin, Chad and Central African Republic) has succeeded in reducing the number of underfed people by 4.6 million from 1990 to 1992. The initial total being 31.2 million (Ghana by itself, has 3.3 million in terms of reduction). This group has complemented much of its domestic supplies with commercial importations. It has its cereal production increased on average of 2.1 percent since 1961 and 3.1 percent since 1990.

- A second group (Ethiopia, Malawi, Mozambique, Sao Tome and Principe and Uganda) where the underfed population has decreased by 5.8 million from 1990 to 1992. It has complemented its primarily domestic supplies with food aids. The average growth of cereal production has been 1.7 percent from 1961 and 5.3 percent from 1990.

In the group of countries where there has been some increase in caloric intake per capita (Burkina Faso, Mali, Mauritius, Nigeria, Sudan and Zimbabwe), the number of underfed people has slightly increased (by 1.7 million) from 1990 to 1992 and has been estimated at 31.1 million people in 2002. The average consumption of cereals per capita has been stable or slightly increased.

The food situation of group of countries which are characterized with a relative decrease in caloric intake per capita has got worse. These are Botswana, Gambia, Madagascar, Rwanda, Senegal, Sierra Leone, Swaziland, Tanzania and Zambia. The number of underfed people has increased by 10.3 million between 1990 and 1992. In this group, cereal production has greatly varied in a sense of an overall decrease since 1990 (especially in Zambia), while importations have significantly increased, especially since 2000.

In the last category of groups, there is a sharp drop in caloric supply per capita. These are: Burundi, Comoros, Democratic Republic of Congo, Eritrea, Guinea Bissau and Liberia. These countries have all been affected by conflict. The number of underfed people in this group has far more doubled since 1990-1992, reaching a total of 44.1 million (an increase of 26.3 million), including 23.3 million in the Democratic Republic of Congo. Cereal production in this group has much better got stable with an annual production increase of 0.5 percent during the period 1990 to 2002. These countries are strongly dependent on importation (including food aids), which represents more than 30 percent of cereal total consumption since the 1960s. Since 1990, food aid represents for nearly 18 percent of cereal total consumption.

CHAPTER II:

MANIFESTATION, CURRENT AND FUTURE CLIMATE CHANGE IMPACTS ON AGRICULTURE AND FOOD SECURITY

Climate change is a major threat to the agricultural growth and achievement of food security in Africa. This chapter focuses on evidences of climate change and its impacts on food security.

2.1. Manifestation of Climate Change

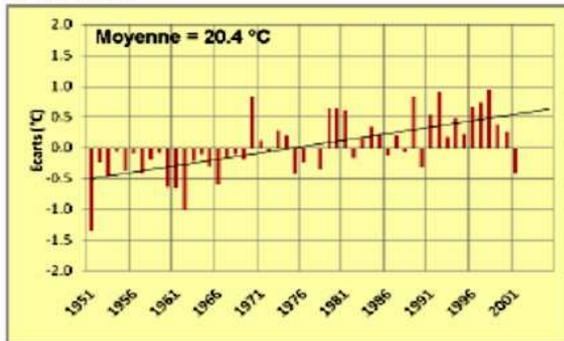
2.1.1. Evident Increase in Ambient Temperature

Global warming is a harsh reality considering current temperatures' trend known since the 19th century. Observations show an overall upward trend across the globe. Thus, the average surface temperature has risen by 0.6 °C since 1861. The observations indicate that the 20th century probably will be marked by the most significant warming during the past 1000 years. The 1900 and 2000 decades have been the warmest of the 20th century. Since 1976, it has sharply risen, reaching 0.18 ° C per decade. The years 1998, 2005, 2003 and 2002 have been the warmest ever.

The linear trend of warming over the last 50 years from 1956 to 2005 which is rates by 0.13 ° C per decade is nearly tow times the one of 100 years period from 1906 to 2005. Temperatures around the world (Diagram 2) have changed somehow faster in the Sahel-Saharan areas, Sahel and the Sudan region (PASR-RV-AO CILSS, 2008) than the global trend since the late 70s. They have increased from 0.2 ° to 0.8 ° C. The increase is however more important on the minimal temperatures (up to 1 ° C and more) than on the maximum (up to + 0.5 ° C). Regarding the coastal countries, such as Togo, it has been known over the past 20 years (1986-2006) increases in temperatures average between 0.5°C and 1.1°C compared to the baseline of 1961-1985.

Zone sahélo-saharienne

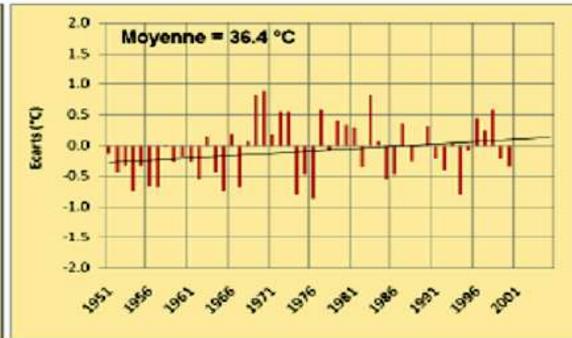
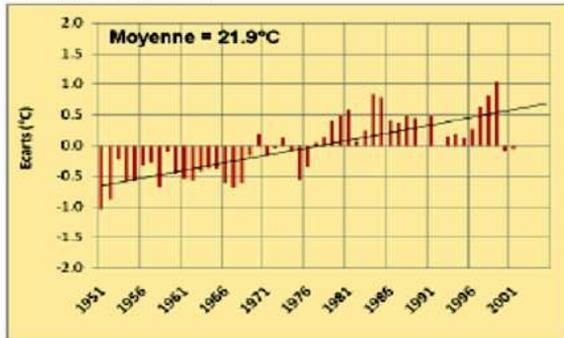
Minimales



Maximales



Zone sahélienne



Zone soudanienne

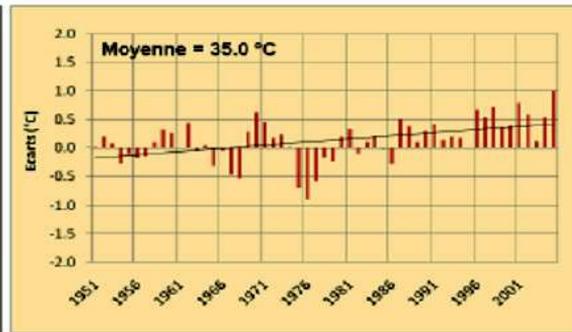
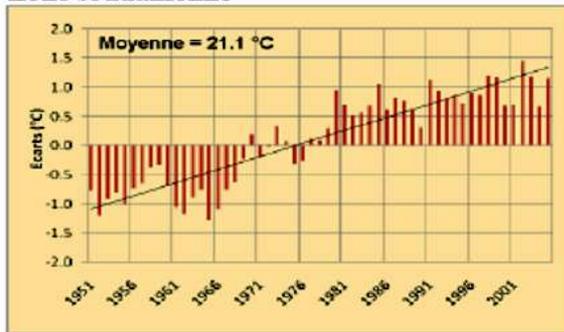


Diagram 2: Evolution of anomalies in minimal and maximal temperatures in three agro-ecological zones in the northern countries of the Union

(Source, ECOWAS-SWAC/OECD - CILSS, 2008)

According to forecasts, global warming will be more important in Africa than at the global level in the twentieth century.

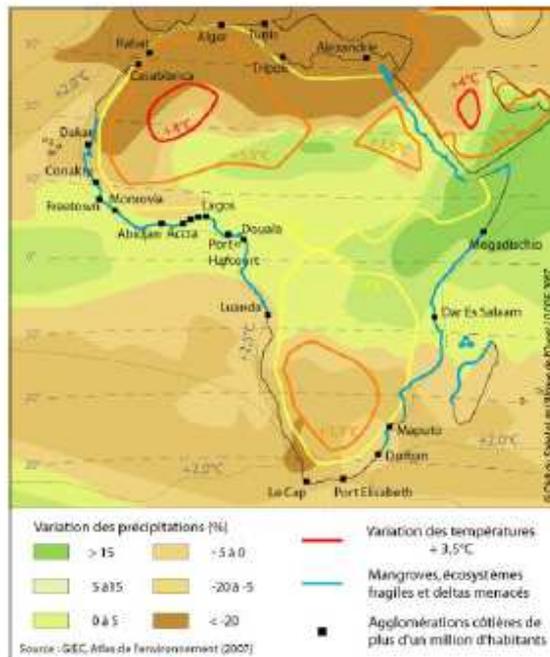


Diagram 3: Trends in temperature and rainfall in Africa between 1980/1999 and 2080/2099

The increase in temperature average between 1980/99 and 2080/99 will range between 3 °C and 4 °C throughout the continent, saying 1.5 times more than at the global level (Diagram 3). This increase is of about +3 °C within coastal areas (Senegal, Guinea Bissau) and Equatorial and Coastal ones (Cote d'Ivoire, Benin, and Togo). It will be higher (+4 °C) in the Continental Sahel (Mali, Burkina Faso, and Niger).

2.1.2. Alarming Sea-Level Elevation

On the basis of data pertaining to tides, an average rise of 10 cm to 20 cm in sea-level has been noticed over the 20th century. At the global level, the total rise in the 20th century is estimated to 0.17 m. This rise is due to thermal expansion of seawater and ice melting in correlation with the increase in temperatures at global level. According to the IPCC (2007), there is great confidence in the fact that the rate of rise in sea-level has increased from 19th to 20th century. The average sea-level has risen at an average rate of 1.8 mm per year from 1961 to 2003. This speed has been faster from 1993 to 2003, saying about 3.1 mm per year.

As for coastal areas of SSA, it has been noticed on the Senegal shores an average rise of 2 mm/yr in sea-level during the 20th century. This rate of increase is accelerating over the past decade. This can be regarded as a progress of seawater by several meters. It leads to strong coastal erosion (Niang, 2007). The seawater is also moving back with 1 to 2 meters per year in some parts of Ivory Coast's shores. In Benin, a progress of 10 to 15 m per year in seawater has been noticed. The average difference between the coastlines of 1954 and 1995 is about 50 meters along the entire coast of Benin (CN 2001). The maximum decrease observed between the coastlines of 1981 and 1996 is about 150 meters.

In Senegal, future forecasts say, by the year 2100, an average rise between 20 and 86 cm, which equals to an annual rate of 2 to 8.6 mm/year (CN, Senegal, 1997). In Benin, data from different surveys predict a decrease of the coast line of 50 m for the year 2025 and 100 m by 2050 if no measure of coastal protection is undertaken.

2.1.3. Increased Variability in Rainfall and an Uncertain Future Trend

During recent years, SSA has marked by a substantial reduction in rainfall. A noticeable decrease in rainfall pattern has been observed over 1968-1972, with 1970 as a pivotal year (Le barbé et al., 1997; Nicholson, 2001; Abdou et al. 2008). The significant reduction in rainfall is clearly evident considering the evolution of rainfall index in the Sahel and the Sudan zones of the Union with events of heavy deficits in 1972-73, 1982-84. These deficits have not spared the wetter areas of Guinea in the southern part of the Union (Diagram 4).

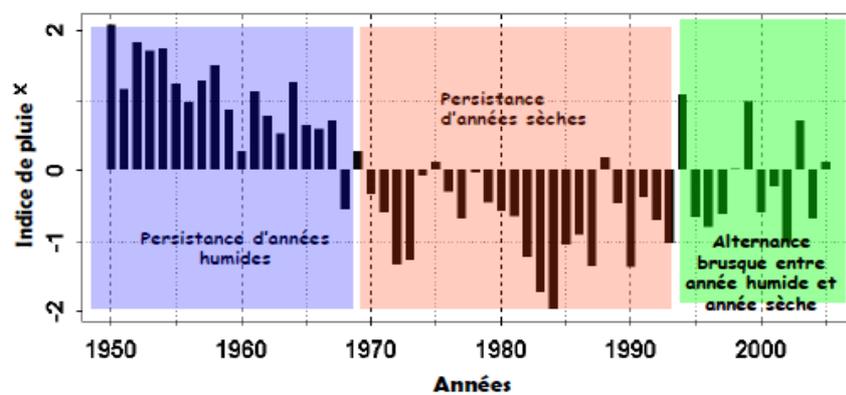


Diagram 4: Evolution of the rainfall index in the Sahel countries of the Sahel Union from 1950 to 2005
Source: Agrhymet Regional Centre

Annual rainfalls decrease of 20 to 40% from 1931-1960 and 1968-1990 compared to 15% in areas of tropical rainforests. As for the Sudan-Sahel Area, this trend has resulted in a shift of 150 to 200 km in isohyets toward the south (Diouf et al. 2000). From the years 90 and 2000, much better rainfall conditions have been observed. These conditions are most often associated with stormy rains which are becoming more and more frequent causing flooding and extensive damage in several regions of Africa, especially in the UEMOA and the Sahel regions (Sarr et al. 2009). The droughts of the 70's and 80's, and heavy rains of the past 2000 that have poured down on inhabitants of the area in recent decades are one of extreme events which would most likely be amplified by climate change.

However, there remains considerable uncertainty about future rainfall trends. Significant differences have been recorded between climate models. Furthermore, these global climate models seem to be less reliable regarding West Africa rainfall representation (ECOWAS-SWAC/OECD and CILSS, 2008). Despite these differences over future rainfall projections, we can still assess the UEMOA general trends.

The western part of sub-Saharan Africa (Senegal, Guinea Bissau, Mali) will be marked by a decrease in precipitation (5 to 20%) during this century. Conversely, estimations show an increase by the range of 5 to 15% in the Continental Sahel rainfall (Burkina Faso, Niger), and less significant variations in rainfall in the Gulf of Guinea. The evolution of the Palmer Drought Index from 2000 to 2090 (UNDP, 2008) confirms that there are large gaps between countries in the sub-region. The countries on the west coast of Senegal and Guinea Bissau and the South West of Mali will be marked by drier conditions. However, little dry conditions are expected in the continental Sahel and coastal countries of the Gulf (Diagram 5).

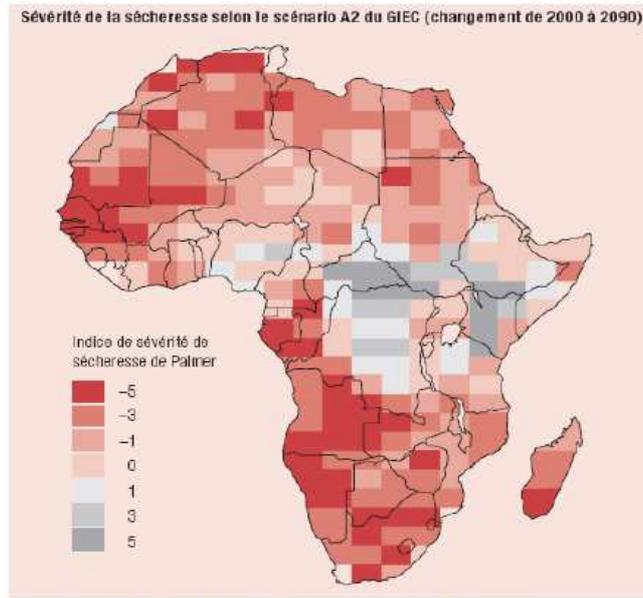


Diagram 5: Evolution of the severity index of the Palmer Drought in East Africa from 2000 to 2090

Source: UKMET Office, 2006, UNDP in 2007/2008

2.1.4. An Upsurge in Extreme Hydrological and Climate Events

Over 80 to 90% of natural disasters are related to hydro-climatic events such as droughts, heavy rains, and floods (WMO 2006). According to the IPCC (2007), in all likelihood (90 to 95%), heavy precipitation events, devastating floods and streams of heat will be more frequent. Surveys conducted by the CRED/UNISDR in 2006 have shown a sharp rapid growing in the number of natural disasters worldwide. This number has increased from 50 in 1975 to 200 in 2000, and has gone over 350, in 2005.

According to WFP (2007) these floods have been considered as the worst in recent decades. More than 1.2 million people have been impacted in the UEMOA (Table2).

Table 2: Number of floods recorded by countries in the UEMOA from 2000 to 2008

Countries	Number of flood events	Number of people affected
Benin	3	325 236
Burkina Faso	6	163 643
Cote d'Ivoire	2	2 450
Guinea Bissau	3	1 750
Mali	10	130 237
Niger	6	189 905
Senegal	6	265 669
Togo	3	188 145
WAEMU	39	1 267 035

Source: Civil Protection Department, Senegal and OCHA, 2009

In countries of sub-Saharan region, an exponential increase in the number of floods caused by heavy rainfall has been recorded. The number of events has increased on average of less than 2/year before 1990 to more than 8 or even 12/year during the 2000's.

2.2. Current and Future Impacts of Climate Change on Agriculture and Food Security

2.2.1. Impacts on Agricultural Production

The rise in temperatures and evaporation added to a decrease in water resources will result into a decrease in agricultural production (Afouda, 1990; Houndénou, 1999; Ogouwalé, 2006; IMPETUS, 2007).

About 70 % of Africa's population depends on agriculture and 40 % of exportations are agricultural products (WRI 1996). In addition, 1/3 of African income is generated by agriculture, crops and livestock, which represents at least half of households' income. Since the agricultural production is almost rain-based, it is obvious that African agriculture is highly vulnerable because of changes in climate, seasons and precipitations variability. Thus, there are great changes in harvests and crop-productions in most African countries as to regards climate change (Diagram 6).

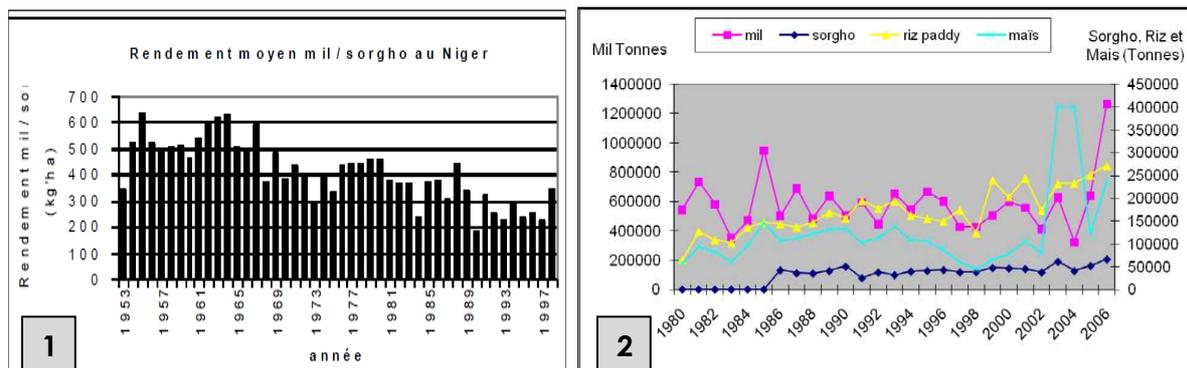


Diagram 6: Changes in inter-annual millet production/sorghum in Niger (1), and production of major food crops in Senegal (2)

Total cereal production in the region has increased by 4.4 million tons during the period of 1961 to 1965, and 11 million tons over the period of 1999 to 2000. In addition to this overall significant increase over the past decades, there is still a strong annual variation, ranging from single to double between the best and the worst harvest campaign during this period.

Moreover, the occurrence of extreme climate events has significantly impacted on population livelihoods, making them vulnerable. In Senegal, for example, the year 2009 has been marked with heavy floods that have caused damage and losses as far as agriculture is concerned in different parts of the country. The upwelling in the various rivers (Senegal, Gambia, etc) has caused losses and damage regarding crops (maize, rice, banana, etc.). The estimation of these damages shows that the region of St. Louis added to the area of Tambacounda and Kedougou are regions where damages are more significant due to extreme weather events. Rice paddy, as well as maize and banana plantations have mostly been impacted (Diagram 7).

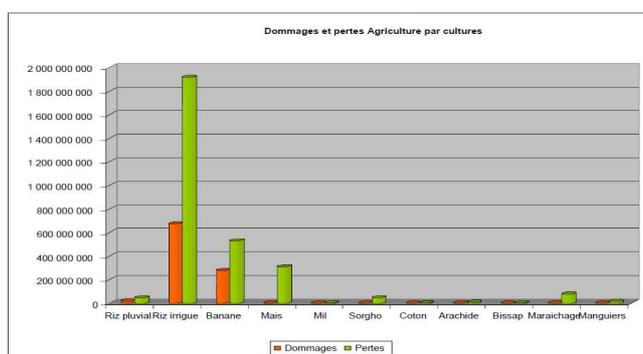


Diagram 7: Cost estimation (F CFA) of damage and losses basing on the crop types in 2009 in Senegal

(Source: Diop and al., 2009, DPC, Senegal)

In Benin, farmers have lost on average over 25 % of production during years marked with floods (Social Watch, 2010). In fact, the regions within river banks, especially, the valleys of Ouémé, Zou, Mono and the Niger Basin are mainly vulnerable. In 2010, the estimated financial cost of damage resulting from flooding in the town of Dangbo is estimated at F CFA 972.009.920 for crop production and F CFA 49.749.000 as for animal breeding. In the commune of Adjohoun, more than 6.257 tons of food supplies have been swept away by waters, and major proportion of crops destroyed (Official parish office of Adjohoun, 2010).



Photo 1: Crops flooded at Athiémé (1), at Adjohoun (2) and Ségbana (3) in BeninSource:

Social Watch, 2010; Plan Benin, 2011

In the northern Benin, specifically at Karimama and Malanville, during the year 2010, 6.000 hectares of rice paddy have been destroyed by floods including 6.000 hectares of sorghum, 2.000 hectares of maize and 70 hectares of cotton. Farmers lost have been estimated to about 60 cattle, 200 sheep, 100 goats, 600 poultry. As for the estimation concerning fishermen, 2500 fish traps are overflowed, and 1000 nets lost (Social Watch, 2010).

2.2.2. Overall Cost Estimate of Damage Regarding Floods from 2000 to 2008

The total cost of damage as regards to floods from 2000 to 2008 on key sectors of the economy (production, transport, infrastructures) affecting food security, has been evaluated on country-based and for the entire UEMOA to several hundred million USD (table 3).

Table 3: Total cost (USD) of damage caused by floods from 2000 to 2008 in UEMOA countries

	Minimal-based impact estimation	Maximal-based impact estimation
Benin	14 635 620	30 040 455
Burkina Faso	7 363 935	15 114 902
Côte d'Ivoire	110 250	226 294
Guinea Bissau	78 750	161 639
Mali	5 860 665	12 029 353
Niger	8 545 725	17 540 594
Senegal	11 955 105	24 538 543
Togo	8 466 525	17 378 031
WAEMU	189 000 000	388 000 000

Source : BOAD, 2010

2.2.3. Impacts on Breeding and Fishing

As far as breeding is concerned, climate change impacts on livestock include:

i) During a year of drought:

- Sharp decrease in milk and meat production due to the scarcity of good pasture and lack of watering facilities. Most breeders take measures by making storage of cattle-feed fodder plant (cowpea-tops and groundnut-tops, residues of millet/sorghum, straw, etc.) or industrial extracts (rice flour, cottonseed crab, etc.).
- Drastic decline in fodder production (aerial and herbaceous),
- Significant mortality of livestock due to watering difficulties and non availability of good pasture, (because of the drought and the distance, breeders walk further and further in vain).

ii) During years of heavy rainfall/flooding:

- The high sensitivity of animals to certain diseases (infectious and parasitic),
- Important losses of animals due to floods: for example, in Senegal, heavy outstanding rains recorded in January 2002 have been followed with sudden and severe drop in temperature with minimal of 14 °C on average over the affected areas causing death within livestock with more than 100,000 cattle and sheep decimated (DNM, 2009).

Regarding fisheries, droughts have significantly impacted on the breeding potentiality leading to a decrease in stocks, thus decrease in fishery products. As consequence, it has affected the availability and populations access to fishery products.

2.2.4. Current Impacts on Nutrition/Health

In many African countries, malnutrition issue has already reached an alarming stage and is getting worst year after year with extreme weather events (droughts, floods). Thus in 2008 for example, in **Niger, Mali, and Burkina Faso**: emergency line of malnutrition has been exceeded, with over 10 % of children under five suffering from acute malnutrition.

In Benin, with nearly 150 000 people displaced and an upsurge spread of malaria with children, and respiratory infections. There is also poor access to nutrition/health care services due to the destruction of communication and transport infrastructure (bridges, roads, railways, etc.).

2.2.5. Current Impacts on Existing Transportation Systems

Because of the resurgence of heavy rains and floods during the past decades, and rising in sea-level, the transport infrastructures has been badly affected. Many cases of destruction of roads, bridges, railway lines, pathways, etc. have been reported (Photo 2).



Photo 2: Destruction of transport infrastructures by floods

Source: Social Watch, Ogouwalé, 2010

According to the IPCC (2007), these phenomena will intensify and become increasingly frequent. Therefore, infrastructures are likely to undergo significant damage during the coming decades.

2.2.6. Impacts on Supply and Demand, and Agricultural Product Prices

Production levels and food availability vary depending on the pattern of rainy years. Thus, in years of low production: the supply decreases whereas the demand and prices increase. For, in addition to traditional consumers, a large majority of producers are used to promptly supplying themselves from markets to bridge the deficit gap. The lean season is also longer than in normal season

because of this production shortfall. **In years of abundant production**, there is an increase in supply compared to the demand and a decrease in prices. The lean period is shorter or non-existent because of the large availability of stocks in households and in markets.

It should emphasize on the fact that there are other factors such as the global economic conditions, previous stocks level (local and international) which influence prices. This is the case in 2007/2008 when a multitude of factors (Diagram 8) have been the origin of the situation of generalized price rise in essential commodities.

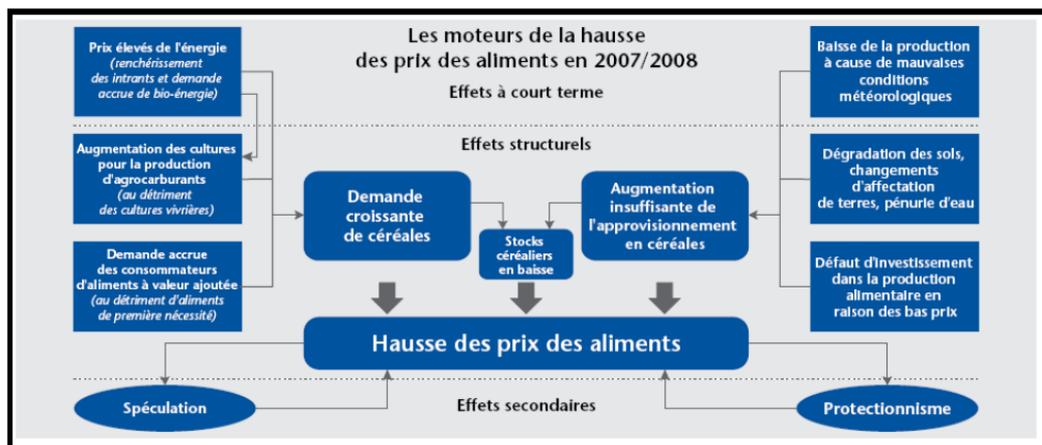


Diagram 8: factors driving rise in food prices worldwide

Source; FAO, 2007

2.2.7. Future Climate Change Impacts on Agricultural Production and Food Security

Long-term prospective analyses show that without appropriate adaptation measures, there will be a fall in cereal production worldwide because of climate change, particularly in sub-Saharan Africa, by 2050 (Diagram 9).

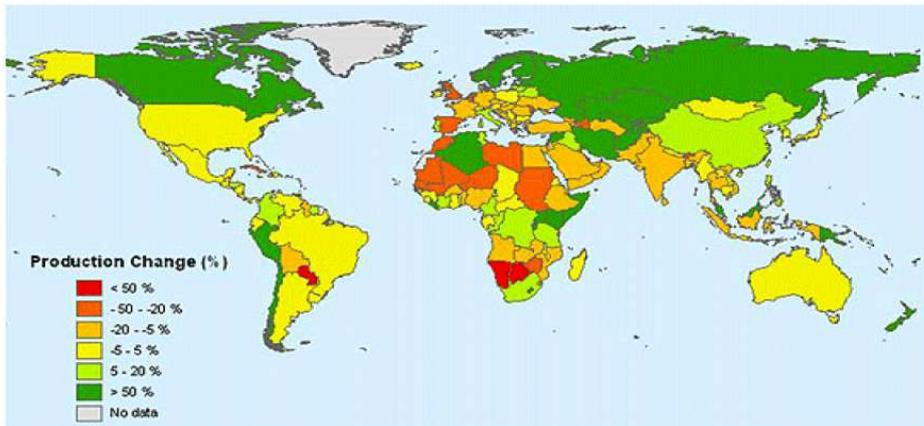


Figure 9: Expected climate change impacts on the potential of rain-fed production of cereal by 2050 (source: FAO, 2008)

Diagram 9 analysis shows that production in the coastal countries could fall by 5 to 20 % and 20 to 50 % in the Sahelian countries. These effects are likely to grow worse due to soil quality degradation resulting from deforestation, and erosion. In addition, salinity of coastal agricultural land, groundwater and surface water due to sea level rise and water pollution is noticeable. Productivity losses resulting from climate change could ultimately affect all aspects of food security (accessibility, availability, supply, prices/markets, health and human nutrition).

According to the IPCC report (2007), projections show that 75 to 250 million of people in Africa will be exposed to severe flood hazards due to climate change by the end of 2020. If this change is followed with a high demand of water, livelihoods will be badly affected and water-related problems worsen. According to projections, agricultural production, including access to food in many African countries and regions are severely jeopardized by climate change and variability.

Reductions in agricultural areas, length of growing seasons and production potential, are expected, especially on the margins of semi-arid and arid lands. This would have an additional negative effect on food security and worsen malnutrition issues in the continent. In some countries, yields from rain-fed production could be reduced by more than 50 % by 2020. The local food production will be adversely affected with the decline of fishery resources in large lakes due to the rise in water temperatures, which can be worsen with overfishing.

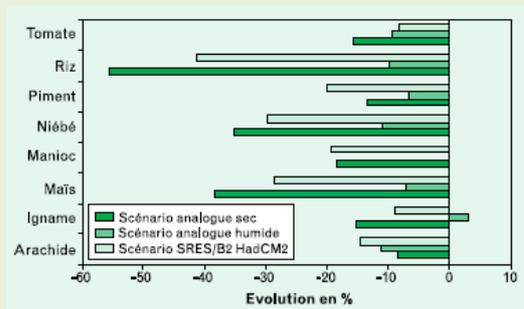
In Benin, for example, a survey conducted by the Laboratoire Pierre Pagney "Climat, Eau, Écosystèmes et Développement" ("Climate, Water, Ecosystems and Development"), provides that in the coming decades, main food crops such as cassava, maize, peanut, and rice will marked by overall decreases

between 12 and 20 % with the scenario SRESB2/HadCM2, between 10 and 30 % with the similar dry climate scenario and between 5 and 10 % for the similar wet climate scenario in the southern Benin (Box 1).

Box 1: Vulnerability of Agriculture Regarding Climate Change in Southern Benin

On the basis of climate conditions of 2050, the modeling results reveal the agricultural vulnerability in southern Benin. The analysis of experimental yields compared to those in southern Benin over the period of 1983 to 2002 indicates a reduction in yields in the context of climate change for all scenarios.

The survey provides that if the current trend of land development is maintained, crop yields will decrease by 2050 in the southern Benin. In the similar wet climate scenario, yields decrease for peanuts, maize, and cassava would be respectively - 8.4, - 7.1 and - 0.1%. As for the experimental scenario, yields for the same crops would fall by - 14.6; -38.2 and -19.2 %. The context of the similar climate dry scenario will result in a greater fall in crop yields, especially the maize, cowpea and rice.



yields evolution in southern Benin

Whatever the scenario, future crop yields except the yam, in the similar wet scenario, would experience relatively large decrease. Considering the consumption per capita per year per commodity necessary to maintain physiological and biological integrity of people, the rates of people who do not have enough to meet their needs for maize in similar dry climate scenario and experimental scenario, would be respectively 63.4 and 73.0 %.

Source: Euloge Ogouwalé, Michel Boko and Djimingue Nanasta, Tempo Africa, N° 2.2009

The falls would be rated from 8 to 18 %; from 5 to 22 % and 10 % for major crops (yam, maize, cassava, peanut, rice) which can be regarded as main foodstuffs for most people in the other parts of Benin. Amplification of droughts and floods could lead to huge agricultural losses.

CHAPTER III:

ADAPTATION OF AGRICULTURE TO CLIMATE CHANGE FOR A SUSTAINABLE FOOD SECURITY IN AFRICA

In the whole world, people have constantly sought to adapt and reduce their vulnerability as regards to negative impacts associated with extreme weather and climate events such as floods, droughts, etc. These different adaptations to climate change which are adopted and planned seem most of the time to have limitations.

However, additional adaptation measures will be necessary at regional and local levels to reduce the adverse effects of climate change on mainly the agriculture sector and on food security.

3.1. Adaptation to Climate Change Associated with Development Policies

The United Nations Framework Convention on Climate Change recommends the elaboration and implementation of adaptation measures in order to mitigate bad effects regarding unpredictable changes of the climate on natural and human systems. We refer to adaptation as all responses to climate changes that can be used to reduce vulnerability relating to climate change. It may also involve measures as such as to take advantage of new opportunities likely to arise as results of climate change. Table 4 for instance, shows the possible adaptation measures in agriculture and breeding sectors (IPCC, 2001).

Table 4: Examples of adaptation measures to climate change pertaining to agriculture and breeding sectors

Socio-economic sectors	Adaptation measures
Agriculture	<ul style="list-style-type: none">- Plant species with more rapid growth;- Plant drought-resistant species;- Plant pest-resistant species;- Adopt new ways of tilling land;- Resort to irrigation system;- Initiate scientific research to find out new variety of species;- Inform, sensitize and train farmers;
Breeding	<ul style="list-style-type: none">- Establish food conservation techniques for the livestock;- Set up fodder stocks;- Resort to industry-made food;- Strengthen natural pasture vegetations or plant adapted species;- Establish veterinary services;- Better address transhumance issues

Source: IPCC, 2001

3.1.1. Theoretical Framework Regarding Adaptation

In theory, the adaptation measures that can be implemented to address the adverse effects of climate change can be grouped into eight categories:

- Bear losses : no response capacity or adaptation measures costs are considered higher compared with the risk or undergone damage;
- Share losses : loss-sharing among members of the community (social mechanisms in traditional societies, public assistances, private insurances);
- Modify the threat : slow down climate change space by reducing greenhouse gases emission;
- Prevent impacts : integrate climate change to development activities by changing agricultural practices and land improvement methods;
- Change customs : for example, change land uses regarding climate hazards;
- change location : move from hazardous places where economic activities are carried out to areas where climate risk is considered low;
- Conduct research : create knowledge or innovate with technologies that contribute to adaptation to climate risks;
- Educate, inform and advocate change in behavior: provide knowledge through education and information campaigns that lead to changes in behavior, is another type of adaptation.

In practice, adaptation to climate change options which are recommended for a community should:

- Have a particular focus on recent climate experiences in the community;
- Take into account adaptation to climate variability and extreme events as a starting point in the process of reducing vulnerability to climate change in the long term;
- Focus on the current and future vulnerability in order to integrate current experiences in future policy;
- Take into account current development policies and activities and future investments;
- Have particular focus on activities which are likely to increase vulnerability to climate change or which do not contribute to adaptation.

For a successful adaptation, its implementation should be based on the knowledge of:

- The most serious vulnerabilities and significant emergencies;
- Context where adaptation is possible and can be the most effective;
- Priorities regarding adaptation.

3.1.1.1. UNFCCC Theoretical Framework

According to the UNFCCC, adaptation to climate change is an adjustment of practices, procedures or structures to future and current climate change. It can be done in response or by anticipation of change. Adaptation is necessary at all levels to complement mitigation of climate change measures. This is a socialization, social learning and political process, and is carried out through local mechanisms of decision making. Also, any political adaptation program that does not take into account the social context is doomed to failure. We must therefore consider what jeopardize adaptation capacities or what makes people vulnerable, in order to build sound cultural and economical adaptation strategies.

3.1.1.2. FAO Theoretical Framework Regarding Adaptation

FAO has reported some key areas relevant to adaptation in line with dynamics and key guidelines set by major international Ruling institutions of food security in its framework paper entitled "Climate Change and Food Security". It has identified six (6) major intervention guidelines in terms of adaptation to deal with food security issue within a climate change context:

- Adaptation while addressing risks;
- Adaptation by responding to the needs of local populations;
- Adaptation by ensuring food availability;
- Adaptation by adjusting consumption and protecting health;
- Adaptation by creating an energy-saving environment;
- Adaptation and mitigation (complementarity and harmony).

3.1.1.3. Theoretical Framework Regarding Adaptation in West Africa

Among the adaptation theoretical frameworks proposed to address the adverse impacts of climate change in the sub-region, we will emphasize on Niasse survey (2007, 2008) which focuses on sharing actions of possible adaptation costs in West Africa. It focuses on four priority areas of actions presented as follows:

1. Promote sub-regional and regional collaboration in creating and using knowledge-based supports as for decision making regarding climate change and its impacts;
2. Promote sub-regional and regional collaboration in creating sustainable use of natural resources and cross-boundary ecosystems;
3. Identify, promote and disseminate appropriate adaptation technologies, techniques and practices to climate change;
4. Establish a regional cooperation framework on climate change and its impacts.

3.1.2. Adaptation Capacities Regarding Climate Change

Several factors determine the adaptation capacity of a given region, country or community to climate change. The most important of these factors are:

- Wealth: it is the factor which determines more the adaptation capacity to climate change. Wealthy nations or communities have resources to develop and implement adaptation options to climate change;
- Scientific background: the scientific aspect of potential climate change impacts is necessary to develop relevant adaptation options to climate change;
- Access to information, technical and technological skills: having access to the information, the technical and technological skills enhance adaptation capacity of communities;
- Equity: a community, with a large number of poor, sick and undereducated people, is generally more vulnerable to climate change.

3.1.3. Assessment of Adaptation Measures

The assessment of adaptation measures in connection with climate change aims at determining in terms of quantity and quality both total costs needed for the implementation of an adaptation measure and the potential benefits that can be drawn (for example, by avoiding impacts).

This requires several methods. To choose a method, we refer to the following criteria:

- The level of accuracy that the method provides for decision-making;
- The ability of the method to deal with the uncertainties related to the magnitude of the impacts of climate change, their expansion in time and space;
- Data availability;
- Resources availability;

As information, we give here the description of two of the methods. It is understood that in practice it is an exercise that requires setting up an appointed team.

3.1.3.1. Cost-Benefit-Based Method

This method is used to determine if an adaptation process is economically relevant: are the benefits higher than the costs?

It involves two steps: identifying and selecting the costs and benefits to be included in the assessment and convert them into monetary units.

3.1.3.2. Cost-Effectiveness-Based Method

This method is used when it is hard to quantify and monetize the benefits.

In such a case, it may be possible to compare the adaptation measures by determining the differences in cost to achieve a given level of efficiency.

3.2. Adaptation to Climate Change Integrated to Agricultural Projects Development

Climate change is a major threat to social and economic development, particularly for developing countries. At regional, national or local levels, they are likely to:

- Jeopardize the current progress in agricultural development, food security, access to drinking water, for example;
- Undermine economic and social development ways forward.

There is now a consensus that the approach indicated to mitigate the impacts of climate change on agriculture is to integrate adaptation into development policies and poverty reduction strategies.

From the methodological point of view, integration of climate change in development projects could be done as follows:

Step 1: Setting up a multidisciplinary team

Considering adaptation to climate change in development projects is a complex process that involves various skills.

To be successful, a multidisciplinary team should be established depending on the nature and complexity of the project.

Step 2: Identification and assessment of climate risks that could jeopardize the project

Depending on the nature and the site where the project is to be implemented, climate risks that could be included in the project should be identified and assessed. Current climate risks and those related to climate change will be considered.

Step 3: Identification of adaptation options

Based on the impacts of the identified climate risks, adaptation options to deal with these risks shall be identified and assessed, especially regarding the economic aspect.

Step 4: Identification of options for adaptation implementation

Depending on the nature and context of the project, guidelines for implementing the selected adaptation options must be identified.

Step 5: Implementation of adaptation

Adaptation options implementation is undertaken based on the outcomes of step 4.

Step 6: Assessing the adaptation

Depending on the nature and context of the project, an assessment procedure of the adaptation process adopted must be developed and implemented.

Considering adaptation in development policies is a complex exercise. To be successful, a cooperation framework including policy-makers, development experts, climate experts and the community (particularly vulnerable groups) shall be set up.

3.3. Adaptation and/or mitigation measures to agriculture for a sustainable food security in Africa

Meeting climate change involves an iterative process of risk management that includes both adaptation and mitigation, and which takes into account damage caused by climate change, shared benefits, sustainability, equity and attitudes towards risks. Adaptation to climate change in agriculture should

enable regional, national and local good governance of food security that addresses the degree of vulnerability of the environment and community. The adaptation measures recommended for the agricultural sector consist of a set of possible solutions to enable decision makers at various levels to deal with extreme climate events.

3.3.1. Forecasting, Prevention, Addressing and Anticipation on Natural Disasters

The increase in natural disasters, with more frequent and more violent phenomena has become a reality with global warming. In the 70s, drought has increased in the Union and has seriously damaged the farming systems and the economies. While the 90s and the year 2000 are marked by frequent and devastating floods

Addressing disaster related risk will play more and more central role to deal with the effects of climate change on food security.

Therefore, experiences based on episodes of natural disasters should be identified, measured and systematically used to improve disaster response planning. We must find new solutions and evaluate how lessons learned can be useful, given the magnitude and speed of these events. Closer cooperation between, climate change experts specialized in forecasting, natural disasters surveillance, national and international units working in the field of disaster related risk management and food security, on the one hand, and populations, on the other hand, should be established. Then, initiatives in reducing disaster related risk and strengthening prior operational planning should be fostered. Emergency and/or contingency plans based on new risk scenarios should be established accordingly.

3.3.2. Improving the Resilience in Agriculture, Forestry, livestock and Fish Breeding Systems

The agro-forestry-pastoral and fish breeding systems in the region undergo multiple stresses associated with variable rainfalls, increase in temperatures, which contributes to the changes in agricultural seasons.

Thus, improving the resilience in agro-forestry-pastoral to address this new climate environment includes:

- The development of adaptable varieties (plant, animal) to water stress and/or heat, redefining adapted crop calendars and the production of quality-based seeds as well,

- The development water management methods in agriculture: water and soil conservation and crop protection against climatic extremes, supplemental irrigation,
- The development of irrigated agriculture and the diversification and intensification of crops,
- The adoption of rational management methods of soil fertility etc.

All appropriate measures identified by countries in their NAPA shall be implemented.

3.3.3. Regional Governance of Sustainable Food Security

In each country, the primary concern of stakeholders has been the establishment of reserves called food security stock in order to supply local markets with crop products. This approach results in the creation of national structures in all countries, such as the National Food Security (ONASA) in Benin, the National Agency for Food Security Togo (ANSAT), Office of Food Products Niger (OPVN), etc. with the mission of storing and supplying markets in the event of food crises. These physical inventories play a key role in the regulation of cereal markets and depreciation of food crises. These structures have reliable storage capacity and generally have low operational capacity to cope with food crises on national and regional levels. In addition, changes in diet habits are not likely to facilitate the task of these structures. Few concepts on food items security at the regional level are undertaken. This transnational dimension of governance on food security is worth exploring.

Regional stocks of agricultural products could be considered to give a more effective support to national structures for procurement. In addition, the establishment of a regional exchange of agricultural products would be a much more reliable alternative for supply and food markets. This exchange may be based on national and regional (CILSS, FAO, Few-Net, country) existing in the monitoring of food security (prices monitoring, markets, availability, cereal availability assessment).

3.3.4. Agricultural/Crop Insurance

Out of all human activities, agriculture remains the most highly influenced sector by climate and its variations. In this context, agricultural insurance as a means of reducing the vulnerability of agricultural systems becomes as much increasingly as a vital tool to develop alongside credit systems and technical advice to promote agricultural intensification and offset losses undergone by producers.

The basic principle is to compensate farmers if an index defined on the basis of rainfall data reaches a certain value (Berg et al., 2008): surveys have clearly shown their potential interest in the Sahelian countries (Berg et al., 2008; Sakurai and Reardon, 1997) and more generally in developing countries to promote agricultural intensification (Skees and Collier, 2008).

In most cases, it is insurance "against drought," but it can also imagine other settings insurance against the risk of flooding and/or excess water, pests, etc.

This kind of insurance system was established in India in 2003 and Malawi in 2005. They have obtained a growing success, with 250,000 policies sold in India in 2005-2006 (Barnett and Mahul, 2007; Giné et al., 2007). In Ethiopia, there are currently two parallel initiatives in the field of index-based climate insurance, led by Oxfam America in collaboration with IRI (IRI, 2008).

In 2007, the Senegalese government has launched an initiative in this area, creating an insurance company specializing in the field of agriculture, CNAAS (National Agricultural Insurance Company of Senegal), which receives funds from the State, private insurance companies and associations of producers (Word Bank, 2009).

3.3.5. Sustainable Management of Forests (REDD+): Combining Agriculture and Agro Forestry

In its limited form, REDD mainly concerns the countries of the Congo Basin which is the largest carbon reserve after the Amazon. But scientists and negotiators are pushing for a comprehensive agreement, called REDD +, which ideally would include forest management, reforestation and carbon sequestration in other regions such as West Africa. The main challenge is how to design agricultural environments that would address the conflict between preserving the environment and livelihoods. These will preserve profits from forest ecosystems such as water storage, the fight against erosion, biodiversity conservation and land rehabilitation, health and food products while ensuring their sustainability. To meet these goals, it would require to associate climate and livelihood, adaptation and mitigation, REDD/REDD + and agriculture. Agro forestry should be an essential component of this approach. The integration of agro forestry on a large scale in agricultural domain results in an effective carbon reservoir while ensuring sustainable food production, and would also, in other ways, adaptation to climate change. It is recognized that systems that rely on agro forestry are more effective in accumulating terrestrial and underground carbon than conventional agriculture. Fertilizer trees can significantly boost soil fertility and increase food security. In addition, varied vegetation can also increase the resilience of agro-ecosystems to drought, pests and diseases and other threats to agricultural production caused by climate change.

The sustainable management of forest is therefore a means of increasing carbon reservoir through extensive programs of reforestation and conservation of forest ecosystems. It is a main issue of appropriation and carbon market.

3.3.6. Carbon Market under the CDM

Established in 2004 under the Kyoto Protocol, that market opens opportunities for poor countries to benefit from credits generated by the reduction of greenhouse gas emissions. However, since its establishment, out of 5.500 CDM projects under validation in the world, only 112 are targeted on the African continent with 36 eligible for carbon credits. Despite the increasing number of projects domiciled in Africa, saying 78 in 2008 against only 2 in 2004 (OSS 2009), the share of CDM projects on the continent remains negligible.

For example, the UEMOA zone does not host eligible CDM project, except Ivory Coast which has just received a CDM project. Yet the CDM, generally dealing with biogas, solar, wind, agro-fuel, represent opportunities for the development of clean energy in Africa.

One major constraint to the eligibility of CDM projects in African countries, particularly those of the UEMOA is ignorance of eligibility procedures, poor technical and scientific skills of projects stakeholders and the meanness of the project. As such, the programmatic CDM approach which aims to group several small projects (in a country or between countries in the same sub-region for example) into one larger project could be feasible. In addition to the new institutional reforms that CDM requires, the regional approach could be a means that can foster the development of CDM projects in countries of the Union. In this line, a reflection on the regulatory, legal and institutional carbon market has already been initiated by the BOAD at a regional workshop held in Lome. This workshop which has been attended by representatives of appointed national authorities of UEMOA State-members is in the prospect of drawing profit from the carbon market through the development of a strategy at community level to quicken funds availability. Participants have come to the conclusion that the carbon market represents a real opportunity for countries to articulate their sustainability programs.

Conclusion

Climate change in Africa, leads to a general rise in temperature, variability of rainfall, floods, droughts, and a disturbing rise of the sea-level. Its negative impacts are already visible and obvious causing a reduction of agricultural, pastoral, forestry and fisheries productions, and generate conflicts because of the scarcity of farmland and pasture, and water resources. Future projections on climate and ocean evolution predict a more severe new climate and marine events which probable impacts on societies and economies, livelihoods and population lifestyles, infrastructure and the food security will be particularly devastating.

All these elements make Africa one of the most vulnerable continents to the negative impacts of climate change, due to its high dependence of his agriculture to climate and according to his a poor institutional capacity and adaptation.

Fortunately, many actions have been undertaken at political and institutional levels as well and at all levels (global, continental, regional, national) in order to develop urgent measures to assist the most vulnerable groups adapt to climate change with the ambition to preserve food security. In fact, current guidelines of economies and human development indicators show that additional efforts must be made regarding the adaptation of socio-economic systems of populations to climate change.

Regional approaches to be advocated concern mainly (i) the integration of climate risk management into development practice: development of early warning system and disaster managements, (ii) improving the resilience of farming, (iii) the introduction of insurance-systems to reduce vulnerability of populations, (iv) sustainable regional governance of food security, (v) sustainable forest management (vi) the carbon market, etc..

To implement these actions, it is necessary to strengthen existing systems and mechanisms at both regional and national levels, to develop capacity building actions for workers, share best practices and experiences on adaptation and mitigation, promote sub-regional consistent and innovative approaches, to remove constraints and barriers to have access to funds and investment in priority projects of adaptation to ensure food security.

Bibliography

Abdou A., Thierry Lebel T., A. Abu, 2008: Meaning and use of the "Sahel rainfall index. *Drought*, 19 (4): 227-235

Africa Progress Panel and al., 2009. : Climate change: a call for "action sent to the African leaders, 10 pages

Barnett, B. and O. Mahul 2007: Weather index insurance for Agricultural and Rural Areas in lower-income countries, *American Journal of Agricultural Economics* 89 (5): 1241-1247

Berg, A. Quirion, P. and Sultan, B. 2008: Can weather index insurance drought Benefit to Least Developed Countries' Farmers? A case study on Burkina Faso. Submitted to *Agricultural Systems*.

CEDEAO-CSAO/OCDE-CILSS 2008: Climate and Climate Change. The Atlas on Regional Integration in West Africa. Environment Series. January 2008. Available at: "www.atlas-westafrica.org".

Diop and al. 2009: Floods of 2009 in Senegal: Damages, Losses and Post-Disaster Needs (PDNA) in Dakar and within the country.

Mr. Diouf, A. Nonguierma Abu A. A. Royer Somé B. 2000: Fight against Drought in the Sahel: achievements and perspective AGRHYMET. *Drought Flight* 11, 4: 257-266

FAO 2009: The Challenges of Climate Change and Bio energy for "food and" agriculture. *Feeding the World in 2050*. Forum of "high-level experts. 24p.

FAO, 2008. : Statement by the High Level Conference on World Food Security. The Challenges of Climate Change and Bioenergy, 4 p. [www.fao.org / fileadmin / user upload / food climate / HLCdocs / declaration-E.pdf](http://www.fao.org/fileadmin/user_upload/food_climate/HLCdocs/declaration-E.pdf), accessed May 22, 2012

FPAUS, 2007: Africa and climate change. Overview # 1. September, 4p.

Giné, X., R. Townsend and J. Vickery: 2007: Statistical analysis of rainfall insurance payouts in Southern India, *American Journal of Agricultural Economics* 89 (5): 1248-54.

Ifremer Environment, 2002: Coastal erosion, concern for Africa in Johannesburg 28/08/2002. 2 p.

IPCC 2007: Climate Change 2007. Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ML Parry, OF Canziani, JP

Palutikof, PJ van der Linden and CE Hanson, Eds., Cambridge University Press, Cambridge, UK, 976pp

IRI. 2008: Index insurance for Ethiopian Farmers:

Le Barbé, L., and T. Lebel, 1997: Rainfall climatology of the HAPEX-Sahel Region During The years 1950-1990. J. Hydrol., 188-189, 43-73.

Mendelsohn R., Dinar A., A. dalfelt 2000: Climate change impacts on African agriculture / Preliminary Analysis Prepared for the World Bank, Washington, DC.

Met Office Hadley Centre, 2006: The effects of Climate Change in Developing Countries. CoP 12 November side event. By Michael Sanderson, Joseph Intsiful, Jason Lowe, Vicky Pope, Fiona Smith, 28 p.

Nair, C.T.S. and Tieguhong J., 2001: African Forests: An Overview, KSLA, AFORNET, FAO, 28 p.

Ndoye, O.; Tieguhong, J.C. 2004. Forest resources and rural livelihoods: the conflict between timber and non-timber forest products in the Congo Basin. Scandinavian Journal of Forest Research 19, Supplement No.4: 36-44.

NEPAD 2002: Detailed program for the development of the "African agriculture. 128 p.

Niang I. In 2007. Adaptation to Climate Change in Africa: Institutional framework in West Africa and central in climate change. International Development Research Center.

Mr. Niasse, 2007: Elements of regional strategy "adaptation to climate change based on" risk-sharing approach - Africa "West.

Mass M. 2008: Towards a regional strategy on adaptation to climate change in West Africa. International Development Research Center.

OCHA, 2009: West Africa flood Affected population, June to September 2009, OCHA, October 2009 OSS, 2009. The echoes of COP15. Africa in the negotiations. Letter "Information, No. 3, December, 4 p.

UNDP, 2007: Global Report on Human Development 2007/2008: The fight against climate change: Human solidarity in a divided world, 382 pages.

UNDP / Niger, 2009: Implementing NAPA priority interventions to build resilience and adaptive capacity of the Agriculture Sector to climate change in Niger, 132 pages.

B. Sarr S. Traore Salack S. 2007: Evaluation of the "impact of climate change on yields of cereal crops in Sudano-Sahelian Africa. Agrhymet Regional Centre, CILSS, Niamey.

B. Sarr, Lona I. 2009: Heavy rains and flooding in the Sahel during the "winter 2007: variability and / or climate change. 14th International Colloquium, SIFÉE "Climate Change and Environmental Assessment" Tools and challenges for the "impact assessment and the" development plans "adaptation, Niamey 26-29 May 2009.

Scholes, B., 1999: Will the terrestrial carbon sink saturate soon. IGBP Global Change Newsletter, March, 37.

Skees and Collier B. J.R 2008: The Potential of Weather Index Insurance for Spurring a Green Revolution in Africa, GlobalAgRisk, Inc... Paper presented at the AGRA (Alliance for a Green Revolution in Africa) Policy Workshop in Nairobi, Kenya, June 23-25, 2008. www.globalagrisk.com.

PK Thornton, PG Jones, T. Owiyo, Krusha RL, M. Herrero, P. Kristjanson, A. Notenbaert, N. Bekele, A. Omolo 2006: Mapping climate vulnerability and Poverty in Africa. Report to the Department for International Development. International Livestock Research Institute (IRLI), Nairobi: 33-36

WAEMU, 2006: Regional Economic Programme (PEP) 2006-2010: Volume 1, 2 and 3: Diagnosis, vision and strategy, in July 2006, 65 pages.

UNFCCC. 2008: Index of NAPA Projects by Country available at: National Action Plans for Adaptation (NAPA) in seven UEMOA countries, apart from the Ivory Coast, which is not considered among the least developed countries (non-Annex I of the Convention).

Glossary

The literature offers a multitude of definitions related to the concept on food security and climate change. In this course, it is agreed to use those recommended by FAO, 2007, the UNFCCC, 1992, IPCC 2007.

Food security: is access by all, constantly, to quality food in sufficient quantity to have a healthy and active life. The four pillars that contribute to achieving food security are: availability, stability, accessibility and utilization (nutrition). According to FAO, food security is the result of the food system works at global, national and local levels. It often depends directly or indirectly on the services of agricultural and forest ecosystems, including soil conservation and water management, watershed management, the fight against land degradation, protection of coastal and mangrove and biodiversity conservation.

Food Sovereignty: this concept refers to the right of peoples, their countries or unions to define their agricultural and food policy, without any dumping as regards to third countries. Different definitions or meanings of food sovereignty are in other public papers.

Most involve the following concepts:

- Sovereignty in the definition of agricultural and food policies, as these do not lead to practice of dumping on other agriculture;
- The national or community preference for the population's food supply;
- Autonomy (more or less important) and the sustainability of agricultural development models, through strong opinions as regard to Genetically Modified Organisms integration in food system.

Food system: it is a set of dynamic interactions occurring within and between biogeophysical and human environments which influences activities and their outcomes along the food chain (production, storage and processing, distribution, exchange, and cooking and consumption). Thus, food security would be the result of the food system works at global, national and local levels. It often depends directly or indirectly on the services of agricultural and forest ecosystems, including soil conservation and water management, watershed management, the fight against land degradation, protection of coastal and mangrove and biodiversity conservation.

Climate change: the United Nations Framework Convention on Climate Change (UNFCCC), in its first article, defines climate change as "a change which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability known over

comparable time periods ". This distinction is not taken up by the scientific community (IPCC) which defines climate change as the joint effect of human activity and natural variability.

Vulnerability: it expresses the degree to which a natural or human system can be affected and degraded or damaged by the negative effects of Climate Change and extreme weather events. It depends on both physical and socioeconomic factors. In other words "the degree to which a system is sensitive and unable to cope with the negative impacts of climate change, including climate variability and extremes.

Adaptation: all the answers (solutions) made in response to positive or negative effects of climate change.

We can distinguish different types of adaptation which are proactive or reactive adaptation, private and public adaptation, and autonomous adaptation and planned adaptation. It can occur naturally, or by a spontaneous reaction (e.g. facing a climate catastrophe) or early in the planning. In all cases, it reduces vulnerability to climate system or socio-economic sector.

Mitigation: measures or activities designed to reduce greenhouse gas emissions; it is a form of adaptation.

Preparation: emergency measures defined in advance and which can be activated in case of extreme hydro climate events to minimize the human damage that may result.

Resilience: The ability of a social or ecological system to absorb disturbances while retaining its basic structure and operating modes, the ability to organize and the ability to adapt to stress and changes.

Climate scenarios: are long-term visions of future climate change (i.e. climate parameters) and the main socio-economic parameters in a given locality. They are used to estimate the vulnerability of a region and anticipate by adaptation.