IUCN
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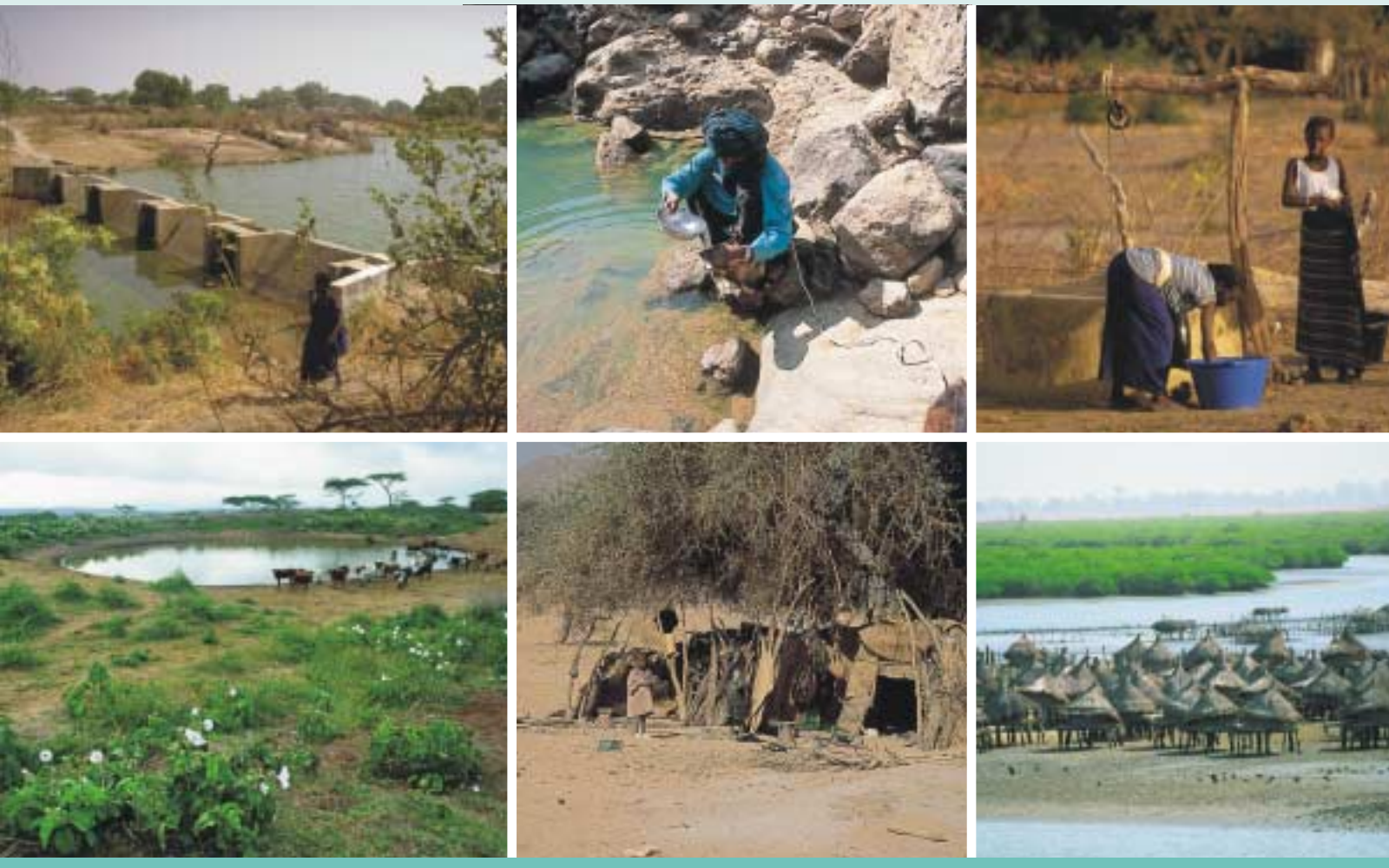
Reducing West Africa's Vulnerability to Climate Impacts on Water Resources, Wetlands and Desertification

Elements for a Regional Strategy for Preparedness and Adaptation

Edited by
Madiodio Niasse, Abel Afouda and Abou Amani



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Back: Dried up floodplain (delta) in the Diawling national park, Mauritania, *Lucas Chambers/IUCN WWRP*

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Foreword

The Regional Dialogue through and at the end of which the current document was developed has been a significant effort of inclusiveness and exchange. The initiators and facilitators of this Dialogue – the West Africa Regional Office of the World Conservation Union (IUCN-BRAO), the West Africa Water Partnership (GWP-WAWP) and the Permanent Inter-States Committee for Drought Control in the Sahel (CILSS) – have realised since the beginning that the sharing of available information is a pre-requisite for the success of the Dialogue, as it would help avoid a dialogue among deaf parties.

For this reason, since the beginning, it was decided to commission a synthesis of the state of knowledge concerning the impact of climate variability and change on water resources, wetlands and desertification in West Africa. This synthesis work has been carried out by Prof. Lekan Oyebande (University of Lagos), Dr Gil Mahé (French Institute for Development Research – IRD), Dr Isabelle Niang Diop (University Cheikh Anta Diop of Dakar) and Dr Abou Amani (CILSS-Agrhymet). This report was further revised and improved by CILSS (under Dr Amani's coordination) with a view to better addressing desertification dimensions. Later on, Dr Isabelle Niang Diop and Mr Mamadou Honadia (Burkina's National Climate Change Focal Point) were asked to look into national initial communications prepared by West African countries as part of the UN Framework Convention on Climate Change (UNFCCC). The aim of this exercise was to synthesise West African governments' assessments of their own level of vulnerability to climate variability and change, and document and analyse the adaptation measures suggested at the national level. Dr Winston Andah (Ghana's Water Resources Institute) provided a specific contribution on the energy crisis faced by Ghana in 1998 as a result of water deficits in the reservoir of the Akosombo Dam.

Prof. Abel Afouda (National University of Benin) compiled, synthesised and enriched all these contributions and played the role of facilitator throughout the dialogue process.

The success of the West Africa Regional Dialogue on Water and Climate and the development of this current strategy document owe a lot to the sharing of the essential information base made available through these expert reports.

This strategy document has also benefited from written contributions and illustrations (maps, figures) provided by Mr Oumar Ould Ali (Niger Basin Authority), Mr Lambert Tam (Lake Chad Basin Commission), Mr Bernard Gomez (The Gambia's National Climate Change Committee), Mr Adama Sanogo (OMVS-Senegal River Basin Development Authority), Dr Gil Mahé (IRD) and Mr Dam Mogbanté (GWP-WAWP). All these inputs along with the sustained support of the consultants, in particular Prof. Afouda and Dr Amani, have greatly facilitated the task of drafting this document.

I would like therefore, on behalf of IUCN and partner institutions (CILSS and GWP-WAWP) to thank all those who contributed directly or indirectly in the drafting of this strategy document which, I hope, will play an effective role in raising the awareness of the general public and decision makers in West Africa and help better conceive our region's responses to the challenges posed by climate variability and change in the water sector.

Madiodio Niasse

Executive summary

West Africa is among the most vulnerable regions to climate change worldwide. The often disastrous impact of climate variability and extreme events over the past thirty years is a striking illustration and a harbinger of this vulnerability. It is therefore urgent that decision makers and the general public in West Africa be fully sensitised on the climatic challenges facing the region and actions to be taken, to enhance the region's level of preparedness in order to cope with the predictable impacts of climate variability and change and the associated extreme events.

This document contributes to achieving this objective.

This document was prepared in a participatory manner through a process of open dialogue involving various categories of stakeholders. The process started during the last quarter of 2001 and was jointly conducted by the Permanent Interstate Committee for Drought Control in the Sahel (CILSS), the West African Water Partnership (GWP-WAWP) and the West Africa Regional Office of IUCN – The World Conservation Union (IUCN-BRAO). This dialogue is part of a global process of national and regional dialogues whose establishment was decided during the second World Water Forum in 2000. The overall objective of the dialogue in West Africa is to establish a regional forum enabling stakeholders from various backgrounds to exchange views on the impacts of climate variability and change on water resources and aquatic ecosystems in West Africa.

Significant vulnerability to climate change and variability

The concept of climate change and variability is defined in this document as *significant climate modification or variation of natural or of anthropogenic origin*.

West Africa is vulnerable to climate change and variability because some of its physical and socio-economic characteristics predispose it in such a way as to be disproportionately affected by the adverse effects of climatic variations.

One of the region's most noticeable characteristics is the highly visible contrast between wetlands and arid zones. Meanwhile, it is important to point out that this contrast is much attenuated by the drainage configuration of the hydrographical network. Indeed, the region's major watercourses (the rivers Niger, Senegal, Gambia and Volta and the Lake Chad hydrographical network) have their sources in high rainfall areas, before flowing through the Sahelian area prone to low rainfall. Thus, these watercourses ensure an interzonal transfer of freshwater from wet to arid areas. Thanks to these transfers, large Sahel areas, measuring up to 4.6 million hectares during years with good flow regimes, are flooded on a yearly basis. These Sahelian floodplains include the Inland Delta of the River Niger in Mali, the depressions of the middle valley of the River Senegal, the Hadéjia Nguru floodplain in the Komadugu Yobe Basin across northern Nigeria, the floodplains of Lake Chad, etc.

The interzonal transfers are an indication of the significant interdependence of West African countries in freshwater resources use and management. Another indication of this interdependence is the fact that the region's major river systems (Niger, Senegal, Volta, Lake Chad, Gambia, Comoé, etc.) are shared among several countries. With the

exception of Cape Verde, each country of the region shares at least one international watercourse.

In addition to the contrast between areas and the interdependence of countries, the third main characteristic of the region is its long sea front of approximately 15,000km. Out of the 17 countries of the region, only four are landlocked (Mali, Burkina Faso, Niger and Chad). The population of the region's coastal area (located within 60km from the coast) was estimated at 42.68 million in 1994, which represents a quarter of the population of countries with a sea front. The bulk of these countries' economic and communications infrastructures is concentrated on this coastal area.

The region's fourth distinctive characteristic is its extreme poverty. Out of the 30 countries with the lowest human development index, 14 are in West Africa, that is, all the countries in the region, with the exception of Liberia that has not been ranked, Ghana and Cape Verde. The 49 Least Developed Countries (LDC) listed worldwide include 14 West African States, that is all of them except Ghana, Nigeria and Côte d'Ivoire. Moreover, Africa's average GDP (USD700) is twice that of West Africa (USD340). This means that West Africa is the poorest region of the poorest continent in the world.

Despite the massive exodus to urban areas over the past four decades, the bulk of West Africa's population still lives in the countryside and their main source of livelihood depends heavily on agriculture, mainly rainfed. On average, two-thirds of the West African working population is engaged in agriculture. It accounts for about 30% of the region's Gross Domestic Product.

The region's hydro-agricultural potentials are currently underutilized. Water harnessing for agricultural, domestic, industrial uses and hydropower generation is estimated at less than 3% of existing renewable water resources. With an area almost equal to that of the United States and China, West Africa has only 110 large dams (15m high dams or having a reservoir volume of over three million cubic metres), compared to more than 6,000 and 20,000 for the USA and China respectively. West Africa accounts for one-third of Africa's surface area but possesses less than one-tenth of the continent's 1,300 large dams. Accordingly, the level of freshwater control in West Africa is particularly poor.

Impacts of climate change and variability

The climate of West Africa, particularly in its Sahelian part, has been undergoing recurrent variations of significant magnitude, particularly since the early 1970's. The region has experienced a marked decline in rainfall and hydrometric series around 1968–1972, with 1970 as a transitional year. The decline in average rainfall, before and after 1970, ranges from 15% to over 30% depending on the area. This situation resulted in a 200km southward shift in isohyets. Average discharge in the region's major rivers underwent concomitant and highly pronounced variations compared to rainfall values. An average decline in the range of 40–60% in discharge has also been observed since the early 1970s.

The recorded decline in the discharge of major watercourses has resulted in the significant reduction in surface area of the main natural wetlands. The average area of the Hadéjia Nguru floodplain (on the Komadugu Yobe river system in northern Nigeria) decreased from 2,350km^2 in 1969 to less than 1,000km^2 in 1995. That of the Inland Delta of the Niger River decreased from 37,000km^2 in the early 1950s to about 15,000km^2 in

1990. The surface area of Lake Chad evaluated at 20,000km^2 during the wet years before 1970, has shrunk to less than 7,000km^2 since the early 1990s, leading to the splitting of the lake into two parts. Today, only the southern part contains water permanently.

The proliferation of floating weeds (water lettuce, water hyacinth, *Typha*, etc.) results from the general disruption of the climate in the region. This is particularly due to the reduced flow velocity in watercourses, temperature change as well as the deterioration of water quality. These weeds hinder fishing, navigation, the functioning of irrigation schemes, hydroelectric developments. Furthermore, they provide favourable conditions for the multiplication of vectors of water-borne diseases, such as malaria and the outbreak of new diseases (e.g. the Rift Valley fever). They also choke several water bodies of the region, including wetlands with biological diversity of global importance.

The recharge of the region's aquifers has also noticeably decreased, often due to the decline in rainfall and surface runoffs. For instance, on the Bani sub-watershed, across the upper reaches of the Niger River in Mali, water tables reached their lowest levels in 1997. The decline in water tables has significant consequences on the depletion coefficients (e.g. the Senegal River at Bakel or the Niger River at Koulikoro).

The variability of the climate has not spared the coastal areas. Very sensitive to erosion, beaches and dune ridges along West Africa's coastal area show evidence of retreat at variable paces: from 1–2m, to more than 20–30m per annum in Senegal and along the Gulf of Guinea, respectively. In Senegal, an accelerated retreat of the coastline was observed between 1987 and 1991 and resulted in the disintegration of the dune ridges.

The recurrent drought, resulting from climate change and variability, accelerates desertification, which in turn contributes to the persistence of drought. This cycle is likely to play a part in increased desert encroachment. The increase in discharge observed over some sub-watersheds such as the Nakambé, can be explained by increased runoff coefficient due to the degradation of the vegetative cover and the soil. As an illustration of the accelerated erosion, one can cite the case of the Niger River and its tributaries along its middle course, where important transport of solids was observed in the main riverbed, which consequently tends to silt up the latter.

Climate variability directly affects West African countries' national economies in general, and those of the Sahelian States in particular. Three main reasons account for the above situation: (a) the significant contribution of rainfed agriculture to the region's economy; (b) the poor level of water control; (c) the poor replenishment of reservoirs on which some countries sometimes depend heavily for the generation of hydropower and electricity supply to industry and households. The city of Ouagadougou, which is supplied from impoundments, experienced severe supply shortfalls in 2002 and 2003. In February 1998, Ghana was faced with a severe energy crisis as a result of the drop in water level in Lake Volta, sometimes below the required threshold for feeding the turbines of the Akosombo dam. This dam, together with the more modest one of Kpong, account for 95% of Ghanaian electricity consumption. Due to these various reasons, it is hardly surprising that at the regional level, a significant correlation exists between annual rainfall and flow conditions on the one hand, and economic growth rates on the other hand.

Extreme events (devastating floods, droughts and sharp temperature changes) characterize climate change and variability, and seem to occur more frequently in West Africa.

They sometimes entail very high environmental and socio-economic costs. In 1999, torrential rains over the Niger River and its tributaries located in Benin and Nigeria, led to the opening up of the floodgates of the Kainji, Jebba and Shiriro dams in Nigeria, resulting in a heavy human death toll and considerable material loss. During the same year, floods over the Ghanaian portion of the White Volta River claimed tens of lives and destroyed hundreds of houses. After experiencing a devastating flood that resulted in the displacement of several hundred thousand people in 1998, the Komadugu Yobe Valley (Northern Nigeria) was flooded again in 2001: the death toll was over 200, with over 35,000 displaced people. More recently, in January 2002, heavy torrential rains accompanied by a cold wave affected southern Mauritania and northern Senegal, leading to the loss of dozens of human lives and decimating more than 50,000 cattle and 500,000 small ruminants. Such numerous examples are henceforth part of the usual décor of the West African climate.

The drop in water availability or the degradation of its quality (due sometimes to climate change and variability) often resulted in exacerbated competition for access to water. The high degree of interdependence of West African countries with regard to water, combined with the poor level of awareness of decision makers and the general public of the impacts of climate, is conducive to tension and even conflicts among states over water resources. Potential conflict areas include the lower half of the Niger River and the Volta Basin. Other consequences of climate change and variability – devastating floods, the proliferation of floating weeds along watercourses, the deterioration of water quality, etc. – are likely to contribute to straining relations between countries in West Africa.

Thus, West Africa faces severe climate perils. Significant impacts have already been recorded. Therefore, worst-case scenarios can be expected if the climate variations observed in the recent decades continue or increase.

What future climate is to be expected?

Significant uncertainties surround the science of the future climate. Most climate change scenarios predict a decline in precipitation in the range of 0.5–40% with an average of 10–20% by 2025. Many of these scenarios portray a generally more pronounced downtrend in flow regimes and the replenishment of groundwater. As a result of the major droughts and a number of recent floods with unusual magnitudes, specialists expect exacerbated extreme climate events in some parts of West Africa. Most coastal countries also considered scenarios of increase in sea level (0.5. to 1m over a century), with more or less significant losses in housing zones and economic infrastructures and the disappearance of significant areas of mangrove and coastal wetlands. However, it is important to point out that the climate change scenarios used do not consist of definite predictions but rather present plausible future climates. Considering the many possible future scenarios, what matters is the ability to manage the uncertainty. This includes reducing current vulnerability to climate variability and extreme events as well as keeping management options open enough to deal with the worst-case scenarios and to take advantage of opportunities that may arise.

Is West Africa adequately prepared to cope with this situation?

West Africa has been faced with recurrent drought since the early 1970s. Many attempts have been made to respond appropriately to this situation. The most significant of them is unquestionably the creation of the Permanent Interstate Committee for Drought Control in the Sahel (CILSS). Since then, CILSS has been very active in the following fields: (a) agro-hydro-climatic data collection and management; (b) the setting up of an early warning system; (c) research and training, through its AGRHYMET Regional Centre (AGRHYMET: Regional Centre for Training and the Application of Agrometeorology and Operational Hydrology). Other initiatives include PRESAO (Seasonal Rainfall and Flow Forecast for West Africa) launched in 1998; the West and Central African component of the Global Hydrological Cycle Observing System (HYCOS-AOC) whose pilot phase is being implemented since 2000; the West and Central African component of the FRIEND Project (Flow Regimes from International Experimental and Network Data) set up since 1992; and more recently, the AIACC programme for assessing the impacts and adaptations to climate change which includes projects for West Africa. Finally, the project on Strengthening the Capacities of CILSS Member States to Adapt to Climate Change, which was launched in October 2002 at the AGRHYMET Regional Centre.

Alongside these research initiatives, efforts aimed at water control were also observed. For instance, Burkina Faso has built more than 1,500 small water reservoirs over the past three decades and is currently experimenting with artificial rainmaking. The latter is envisaged in other countries of the sub-region (e.g. Senegal). Likewise, countries such as Niger, Benin, Mali and Senegal have also implemented the policy of constructing small water reservoirs. As mentioned previously, the region comprises only few large dams but many projects are planned. For example, there are more than 20 large dam projects that are planned on the Niger River alone (Fomi, Tossaye, Kandadji, Zunguru, Onitsha, etc…).

Overall, the most noticeable responses to the recurrent drought and pronounced climate variability experienced for the past three decades in West Africa relate mainly to data collection and analysis. Indeed, this is very important, but is far from sufficient to significantly reduce the vulnerability of the region to climate change and variability.

With regard to the future climate, many countries of the region have proposed, in their national communications, structural and economic measures that should help them to strengthen their capacity to adapt to the predicted changes. Yet, the solutions proposed by the States are often technically, financially and/or politically unachievable by individual countries. Many of these adaptation measures may be relevant only at the regional level.

Why a regional adaptation strategy?

Considering the magnitude of the climate threat and the specific characteristics of the West Africa region, it is clear that there is a real need for a regional strategy, justified by the following reasons:

- the poor level of awareness of the threat posed by climate change and variability in the region and the lack of significant counter-action;
- there is no consultative framework on climate change in the region;

- many of the freshwater resources in the region are transboundary watercourses which are not appropriately accounted for as far as national strategies are concerned;
- the current exchange of adaptation experiences is poor, even when good practices are concerned;
- the current focus on national approaches to adaptation limits opportunities for achieving economies of scale;
- availability of expertise, considered on a per country basis, is sometimes insufficient to face up to the scientific and technical challenges posed by climate change;
- science and policy are sometimes disconnected at the regional level, while there is a great need to put science at the service of decision-making and ensure that the concerns raised by decision makers are taken into account by scientists.

From the above reasons, it is apparent that a regional strategy is the missing link in the efforts aiming at strengthening the level of preparedness of the region to tackle the impacts of climate variability and change, in the water sector in particular. This strategy takes into account, supports and complements the national initiatives aimed at reducing vulnerability to climate change.

General objective of the regional strategy

The general objective of the strategy is to strengthen the region's capacity to tackle the impacts of climate variability and climate change on water resources and aquatic ecosystems in West Africa.

Strategic objectives:

Four strategic objectives are defined as the pillars of the regional strategy:

Strategic Objective 1. *Improving and sharing basic scientific knowledge and decision-support information.* This objective will first of all consist of working to strengthen the systems of data collection and analysis and the broadening of research activities. The next step will in particular consist of helping to ensure that research increasingly meets the concerns of decision makers and water users, and that research results are appropriately disseminated, and better taken into consideration in development policies.

Strategic Objective 2. *Promoting IWRM principles and the ecosystem approach in managing water resources, continental and coastal wetlands*. This objective will first of all consist of promoting measures to mitigate the impact of climate variability and change on coastal and inland aquatic ecosystems, in order to enable them to continue to play their role as reservoirs and refuge for biodiversity. The next step will then consist of the rehabilitation and sustainable management of wetlands. Actually, through their multiple functions (water storage, flood mitigation, stabilisation of soil surface conditions, water purification, carbon sequestration, etc.), the latter constitutes an important means of building capacity in adaptation to climate variability and climate change.

Strategic Objective 3. *Identifying, promoting and disseminating appropriate adaptation technologies, techniques and measures*. The design and implementation of appropriate responses to climate change is a tremendous scientific and technical challenge such that

poor West African countries would do better by pooling their expertise and resources rather than going it alone. That is why this objective will consist of enhancing the exchange of good practices and fostering joint initiatives with a view to enriching West Africa's choices of responses to climate change and variability.

Strategic Objective 4. *Setting up a regional consultative framework*. This objective will consist of building an efficient communication link between research institutions, political, economic and community decision makers, river basin agencies, water users, civil society, development partners, etc. Actually, the objective consists of pursuing and formalising the regional dialogue on water and climate change.

It is also worth noting that through these four strategic objectives, efforts will be made to assist the countries in the design and implementation of their national adaptation plans of action (NAPA).

Modalities for implementing the regional strategy

The implementation of the strategy requires the setting up of an operational action plan. The action plan will identify the priority activities. For each one of these priority activities, or group of activities, project outlines will be developed. These outlines will feature the estimated budget, and the key institutional partners (see Annex).

The preparation of the action plan will be carried out by a *Working Group* made up of people and institutions represented in the Dialogue on Water and Climate.

The pioneering institutions of the process (CILSS, GWP-WAWP and IUCN-BRAO) are in charge of resource mobilisation and implementing the identified projects. For each of the envisaged projects, appropriate institutional partners will be identified.

List of acronyms

ACMAD	African Centre of Meteorological Applications for Development
ADB	African Development Bank
AGRHYMET	Regional Centre for Training and Application of Agrometeorology and Operational Hydrology
AIACC	Assessments of Impacts and Adaptations to Climate Change
AMMA	Multi-Disciplinary Analysis of the African Monsoon and its Impacts
CILSS	Permanent Interstate Committee for Drought Control in the Sahel
COP	Conference Of Parties
ECOWAS	Economic Community of West African States
EIER	Ecole Inter-Etats des Ingénieurs de l'Equipement Rural (Inter-State School of Rural Development Engineering)
FIBA	Fondation Internationale pour le Banc d'Arguin
FRIEND/AOC	Flow Regimes from International Experimental and Network Data/ Afrique de l'Ouest et du Centre (West and Central Africa)
GCM	General Circulation Models
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GWP	Global Water Partnership
GWP/WATA	Global Water Partnership/West African Technical Advisory Committee
GWP/WAWP	Global Water Partnership/West African Water Partnership
HYCOS/AOC	Hydrological Cycle Observing System/Afrique de l'Ouest et du Centre (West and Central Africa)
IHP	International Hydrological Programme (UNESCO)
IPCC	Intergovernmental Panel on Climate Change
IRD	Institut de Recherche pour le Développement (French Research Institute for Development)
ITCZ	Intertropical Convergence Zone
IUCN-BRAO	The World Conservation Union-West Africa Regional Office (Bureau régional pour l'Afrique de l'Ouest)
IWRM	Integrated Water Resources Management
LCBC	Lake Chad Basin Commission

LDC	Least Developed Countries
NAPA	National Adaptation Plan of Action
NBA	Niger Basin Authority
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental Organization
OMVG	Gambia River Basin Development Organization
OMVS	Senegal River Development Organization
PRESAO	Seasonal Forecast for West Africa
RCMP	Regional Coastal and Marine Programme
SAWEG	Sahelian Wetland Expert Group
SISCOA-IWRM	Secrétariat Intérimaire de Suivi de la Conférence Ouest Africaine sur la GIRE – Interim Secretariat for Follow Up of the West African Conference on Integrated Water Resources Management
SRES	IPCC Special Report on Emissions Scenarios
SRPA	Sub-Regional Plan of Action
TAR	Third Assessment Report
TWAS	Third World Academy of Sciences
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNO	United Nations Organization
USD	US Dollar
WAEMU	West African Economic and Monetary Union
WAM	West African Monsoon
WANBO	West African Network of Basin Organizations
WI	Wetlands International
WMO	World Meteorology Organization
WWF	World Wide Fund for Nature (World Wildlife Fund in North America)

Introduction

West Africa is one of the most vulnerable regions to climate change, but the level of awareness of the magnitude of the phenomenon is not commensurate with the risks to which the region is exposed. The sometimes disastrous impacts of climate variability and extremes of the last thirty years, are good illustrations of this vulnerability, as well as harbingers of the magnitude of the perils to be expected. In spite of this, climate change is a concern for only a few scientists and government experts involved in the implementation of the United Nations Framework Convention on Climate Change.

It is therefore urgent that West African decision makers and the public be sensitised on the climatic challenges facing the region. Furthermore, it is important to highlight the necessary actions aimed at enhancing the level of preparedness of the region to counter the future impacts of climate variability and change as well as associated extreme climate events.

The present document contributes to this objective. It is a regional strategy for preparation and adaptation to the impacts of climate variability and climate change on water resources, wetlands and desertification processes in West Africa.

The preparation of this document has been carried out in a participatory manner, through a process of open dialogue involving several categories of stakeholders. The process started in the last quarter of 2001, and it is jointly run by the Permanent Interstate Committee for Drought Control in the Sahel (CILSS), the West African Water Partnership (GWP-WAWP), and the Regional Office for West Africa of IUCN – The World Conservation Union (IUCN-BRAO).

The general objective of the dialogue process was to establish an exchange forum between stakeholders from various horizons on the impacts of climate variability and change on water resources and aquatic ecosystems in the region. Specifically, it aimed first at raising the level of awareness of the major stakeholders in the region through the sharing of available knowledge on the magnitude, forms and impacts of climate variability and change in West Africa. That is why the dialogue started with a review of the state of knowledge of the extent, patterns and impacts of climate variability and change on water resources, wetlands and desertification in West Africa.[1]

The next step of the process then consisted of assessing the level of vulnerability to climate variability and change of the different countries in the region and in analysing the anticipated response options and the forms of support to a regional initiative that could complement the efforts at the national level (see Diop, 2003 and Honadia, 2003). Based on the sharing of national scientific knowledge and experiences, such a dialogue should lead to the formulation of a regional strategy on preparedness and adaptation. The purpose of the strategy is to strengthen the capacity of the region to cope with and to counter the negative effects of climate change and variability in the fields of water resource management, preservation of wetlands and combating desertification.

The present strategy is built on the key concepts of climate variability, climate change, desertification, vulnerability and adaptation. These different concepts are defined in this document as follows:

[1] Reference: CILSS, 2002 : Oyebande, Lekan *et al*., 2002.

West Africa: In this document, the West Africa region is considered to include 17 countries, that is the 15 member states of the Economic Community of West Africa (Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo), Mauritania and Chad.

Climate variability: refers to the intra- and inter-annual natural variation of the climate.

Climate change: refers to the significant long-term modification (or variation) of the climate due to anthropogenic activities. This modification adds to the effects of the natural climate variability.

Climate change and variability: Considering the difficulty in distinguishing between the effects of climate change and those due to natural variability, the participants of the various workshops organised within the framework of the regional dialogue recommended the use of the concept of "climate variability and change" in order to better reflect the issue which is of concern to all in West Africa, and to steer the debate on the regional adaptation strategy away from complex and endless discussions on terminology. The concept of climate variability and change is herein considered as ***significant climate modification or variation of natural or of anthropogenic origin***.

UNFCCC and IPCC Definitions of Climate Change

The United Nations Framework Convention on Climate Change: the concept of climate change refers to climate change caused by direct or indirect human activity, modifying the composition of the global atmosphere and which adds to natural variability observed on a comparable time scale.

Intergovernmental Panel on Climate Change (IPCC): climate change refers to a statistically significant variation in the average condition of the climate or in its variability, a variation that persists over a long period of time (decades or more). Climate change can be due to internal natural processes or exogenous forcing or to persisting anthropogenic changes in the atmosphere or land uses.

It should be noted that the definition of climate change used here is a simplified wording of that of the UNFCCC. But by combining the concept of climate variability and change, this report also takes into account the definition of the IPCC whose concept of climate change refers to any long-term variation of the climate, whether of anthropogenic or of natural origin.

Desertification: refers to land and soil degradation in arid, semi-arid and dry subhumid areas due to various factors, among which climate change and human activities.[2]

Vulnerability: refers to the proneness of a natural or human system to be adversely affected by the negative impacts of climate change, variability or extreme events. It expresses the capacity of a person, community or natural milieu to anticipate, resist or adapt to the negative impacts of the climate or to recover from such impacts.[3]

[2] This is the definition given by the United Nations Convention on Desertification (Article 1).

[3] A definition borrowed from Kabat *et al.,* (2003) who also quoted IPCC definitions and other sources.

Level of preparedness: refers to pre-defined emergency actions that could be activated when extreme climate events or natural disasters occur in order to minimise damages, which are likely to result.[4]

Adaptation: refers to any adjustment in natural systems or in human activities, in response to actual or predicted climate change impacts – adjustment that enables the attenuation of the adverse effects or takes advantage of the opportunities. The UNFCCC distinguishes adaptation from mitigation. Mitigation refers to measures to reduce the emissions of greenhouse gases such as carbon dioxide, methane, nitrogen oxides, etc.

Whether adaptation is in anticipation (taken before the occurrence of initial impacts) or in reaction (developed and implemented in response to initial impacts), it enables the reduction of vulnerability to climate change of the system or sector concerned.

Considering that West Africa's contribution to global greenhouse gas emissions is very marginal, this strategy is built around preparedness to face extreme climate events and adaptation to climate variability and change, rather than the mitigation of climate change.

The document is structured as follows. Part one succinctly presents the West African regional context. Part two presents a synthesis of the state of knowledge on the experienced and anticipated impacts of climate variability and change in West Africa. Part three analyses the West Africa region's level of vulnerability and adaptation to, and preparedness for, climate variability and change as presented in the national communications under the auspices of the UNFCCC. Part four presents the justification of the regional strategy and formulates the general and specific objectives on which this strategy is built. Part five describes the planned activities for each component of the strategy. Part six, which is the last one, briefly presents the operational terms and conditions for implementing the strategy.

[4] A definition adapted from Kabat *et al*., op.cit.

1. Regional context

West Africa is highly vulnerable to climate variability and change, which has to do with some of its physical and socio-economic characteristics.

The region covered by this strategy is comprised of 17 countries. It measures 7,500,000km^2 with a population estimated at 250 million inhabitants (that is about 30% of Africa's total population).

1.1 Two major eco-geographical areas

The region's geography is characterized by the following two major entities: (a) the nine (9) countries of the Sahel comprising Burkina Faso, Cape Verde, The Gambia, Guinea Bissau, Mali, Mauritania, Niger, Senegal and Chad; (b) eight (8) countries located along the Gulf of Guinea consisting of Benin, Côte d'Ivoire, Ghana, Guinea, Liberia, Nigeria, Sierra Leone and Togo.

In West Africa, rainfall, which is a determining factor of the climate, is associated with the latitudinal movement of the Intertropical Convergence Zone (ITCZ), i.e. the convergence zone between humid air masses from the south and dry air masses from the north. The ITCZ reaches its northernmost position in August, which corresponds to a period of maximum rainfall across the Sahel. This mechanism characterizes the Sahelian area's North-South annual rainfall gradient. Accordingly, annual rainfall amounts range from zero in the desert (Sahara) to over 900mm in the Sudanian sub-humid zone. In arid, semi-arid and sub-humid zones, there is a two to five-month wet season unlike countries located along the Gulf of Guinea, which have two rainy seasons. In that sub-zone, average annual rainfall amounts are in excess of 900mm.

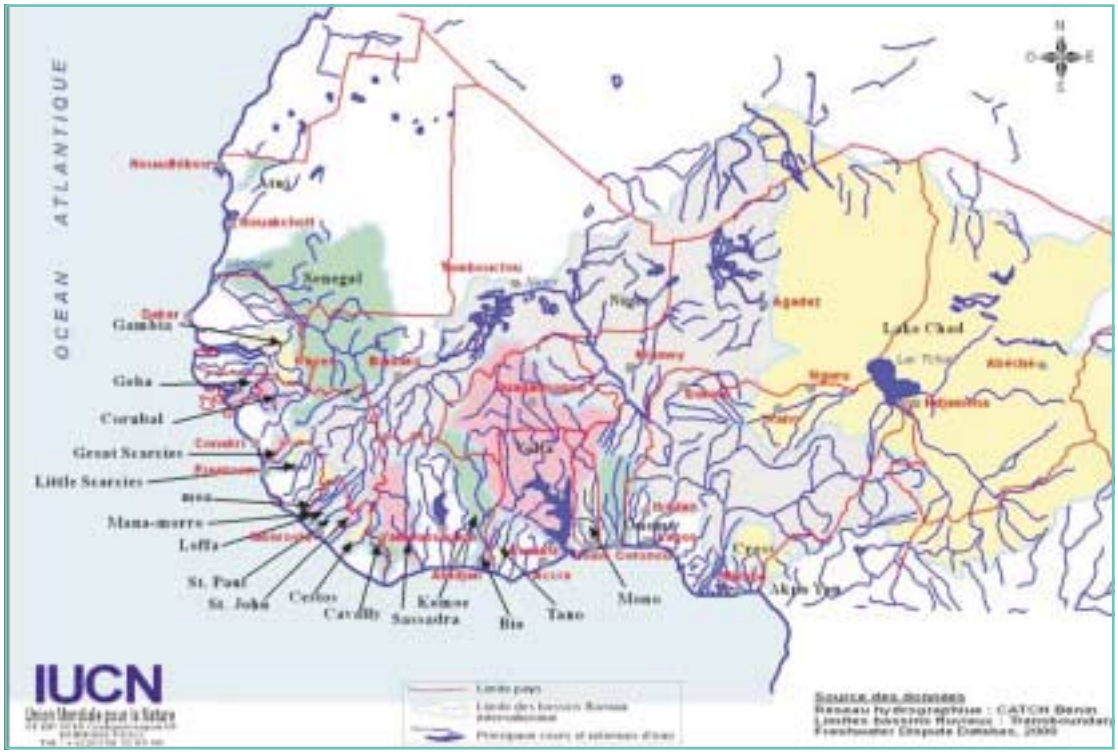
Most West African countries span several eco-geographical zones including: (a) the Saharan desert zone with average annual rainfall amounts below 150mm, (b) the Sahelian arid zone, which receives average annual rainfall amounts in the range of 150–400mm; (c) the Sudano-Sahelian semi-arid zone where average annual rainfall amounts range from 400 to 600mm; (d) the sub-humid Sudanian zone with average rainfall amounts in the range of 600–900mm; (e) the humid Sudano-Guinean and Guinean zone where annual rainfall amounts range from 900mm to over 1500mm.[1] This particular setting translates into a marked contrast between wet and dry sub-regions.

1.2 Interzonal freshwater transfer

However, this contrast is somewhat attenuated by the drainage pattern. The region's major watercourses (Niger, Senegal, Gambia, Volta, the hydrological network of Lake Chad) have their source in the Sudano-Guinean areas with a lot of rainfall and flow through the Sahelian zones where recurrent rainfall deficits occur. These watercourses enable a sort of interzonal freshwater transfer from wet to arid areas.

[1] Localized maximum precipitation values are recorded, for instance, on mountainous areas such as Fouta Djallon.

Fig. 1 West African transboundary river basins



1.3 Sahelian floodplains

Thanks to these transfers, large areas of the Sahel, measuring up to 4.6 million hectares during years with good flow regime, are flooded on a yearly basis. The largest Sahelian floodplains undergoing annual flooding include the Niger River Inland Delta (three million hectares), the Middle Senegal River Valley (500,000ha) and the Hadejia Nguru Plain across northern Nigeria (400,000ha), the Chari-Logone Plain between Cameroon and Chad (about 800,000ha). These plains, which play host to a rich biological diversity (plant, ichthyological and avian in particular), are also well-known for their considerable importance in supporting local production activities (flood recession cultivation, animal husbandry and fisheries).

1.4 Water interdependency

These interzonal transfers are an indication of the significant interdependency of West African countries with regard to freshwater resources use and management. Most of these countries have a dependency factor of above 40%.[2] Another manifestation of this interdependency is that the region's major river systems are shared by several countries: the Niger River (nine countries to which Algeria, which partially covers the hydrologically inactive portion of this hydrographical basin, can be added), the Senegal River (four countries), the Volta River (six countries), Lake Chad (five countries), the Gambia River (three countries), the Comoé River (three countries). With the exception of Cape Verde, each of the countries of the region shares at least one international watercourse with other countries.

[2] The dependency factor consists of the share or percentage of total renewable water resources generated outside the borders of a given country. It should be noted that countries such as Niger and Mauritania have a dependency factor in the order of 90%.

1.5 Concentration of populations and industries on the coastal area

Another distinctive feature of the region is the length of its sea front. It extends over 15,000km including Cape Verde. The 17 countries of the region include only four landlocked states (Mali, Burkina Faso, Niger and Chad). The region's population, concentrated on the coastal area (that is within 60km from the coastline), was estimated at 42.68 million in 1994, that is a quarter of the coastal countries' population (Hatziolos *et al*., 1996). Major urban areas such as Nouakchott, Dakar, Conakry, Abidjan, Accra, Cotonou, Lomé, Lagos, Port Harcourt, etc. are located along the coastline. This area experiences continuous rapid demographic growth due to the impoverished countryside and the concentration of economic infrastructures and investments in large coastal urban areas. In Senegal, 90% of industrial units are located along the coastline, mainly in Dakar and its suburbs. The same is true of countries such as The Gambia, Côte d'Ivoire, Nigeria, etc.

1.6 Extreme poverty in the region

Poverty is another distinctive feature of the West African region. According to the UNDP Report on Sustainable Human Development for the year 2000, the 30 countries with the lowest human development index include 14 West African countries, that is, all the countries of the region with the exception of Liberia (which was not ranked), Ghana and Cape Verde. Out of the 49 Least Developed Countries (LDCs) listed worldwide, 14 are located in West Africa, that is, all the West African countries with the exception of Ghana, Nigeria and Côte d'Ivoire. Even at a continental level, West Africa remains one of the poorest regions. A recent report by the African Development Bank (*Fostering Good Governance in Africa*, 2001) estimates West Africa's per capita Gross Domestic Product (GDP) at less than USD340 against the continental average of above USD700. In other words, West Africa is the poorest region of the poorest continent in the world.

1.7 Key role of rainfed agriculture

Despite the massive population exodus to urban centres over the past four decades, the bulk of West Africa's population remain in the countryside and its main means of livelihood still largely depends on agriculture. On average, two-thirds of the West African working population is engaged in agriculture. It accounts for about 30 % of the regional GDP (see Table 1 below). The region's dependence on the vagaries of the climate is better assessed by taking into account the fact that agriculture is mainly rain-fed, irrigation being very insignificant, both in terms of irrigated surface area and overall contribution to agricultural production.

1.8 Under-utilized hydro-agricultural potential

Water resources, wetlands and natural resources in general contribute significantly to West African countries' economies. The main sector using water resources is agriculture, particularly irrigated farming (76% of freshwater withdrawals), against 17% and 7% for domestic and industrial uses respectively. With regard to domestic consumption, in 1995, only 40% and 64% of the region's rural and urban populations respectively, had access to drinking water. Hydropower generation and navigation are non-consumptive water user sectors. The region's water resources are poorly developed

Table 1. Significance of the agricultural sector in West African national economies

	Pop. (2000) in thousands	% of the pop engaged in the agricultural sector (1996)	Contribution of agriculture to the GDP (%)
Benin	6,097	54	39
Burkina Faso	11,937	84	33
Cape Verde	428	35	12
Chad	7,651	72	40
Côte d'Ivoire	14,786	49	26
The Gambia	1,305	80	27
Ghana	20,212	52	10
Guinea	7,430	74	22
Guinea Bissau	1,213	79	62
Liberia	3,154	70	n.a.
Mali	11,234	80	47
Mauritania	2,670	45	25
Niger	10,730	86	41
Nigeria	111,506	64	32
Senegal	9,481	77	17
Sierra Leone	4,854	61	44
Togo	4,629	67	42
TOTAL	**229,317**	**66**	**29**

Source: Based on UNDP, 2000; ADB, 2001.

The Manantali Dam on the upper Senegal River, *Ibrahim Thiaw*

and their low level of exploitation (below 3%) testifies to it. Another indicator of the poor optimization of water resource use is that West Africa has not invested much in the construction of dams. The region includes less than one-tenth of the 1300 large dams built in Africa while it accounts for one-third of the surface area of this continent. The region's 110 large dams[3] are mainly intended for irrigation, hydropower generation and water supply for domestic consumption.

1.9 Insignificant greenhouse gas emission

Due to its poverty and the poor development of the industrial sector in its economy, West Africa – and Sub-Saharan Africa as a whole – emits little greenhouse gases in the atmosphere and therefore does not contribute much to the current global climate change, which is defined as human-induced climate modification. As a matter of fact, Sub-Saharan Africa accounts for only 2% of global carbon dioxide emissions, which is the main greenhouse gas. This means that Africa is affected and will continue to be affected over the coming decades by climate change for which it is not accountable (see Table 2). Consequently, it is quite understandable that during debates on climate change, the region places greater emphasis on issues related to adaptation rather than the mitigation of greenhouse gas emissions.

Table 2. Carbon dioxide emissions worldwide

	Share of worldwide total (%)	Per capita (tons)
Sub-Saharan Africa	2.0	0.9
Total for developing countries	36.4	2.1
Total worldwide	93.8*	4.1

* Below 100% due to some countries not being taken into account.

Source: UNDP, 2000. p.234.

1.10 Significant efforts for regional integration

West African countries belong to various political and economic sub-groupings aiming for regional integration. With the exception of Chad and Mauritania, all of them are member countries of the Economic Community of West African States (ECOWAS). Countries referred to as Sahelian are grouped together into the Permanent Interstate Committee for Drought Control in the Sahel (CILSS), while the West African Economic and Monetary Union (WAEMU) includes Burkina Faso, Benin, Côte d'Ivoire, Guinea Bissau, Mali, Niger, Senegal and Togo. In addition, there are transboundary river basin organizations composed of two or more States: the Niger Basin Authority (ABN), the Senegal River Development Organization (OMVS), the Gambia River Basin Development Organization (OMVG), Lake Chad Basin Commission (LCBC), etc. Therefore, the sub-region has several co-operative organizations within which joint responses to transboundary challenges such as climate change can be envisaged.

[3] A large dam is defined by the International Commission on Large Dams as a dam with a height of 15m or more from the foundation. If dams are between 5–15m high and have a reservoir volume of more than three million m^3 they are also classified as large.

2. Impacts of climate change and variability on water, wetlands and desertification: current state of knowledge

This section succinctly analyses two issues: first, the cumulative impacts of climate change and variability as experienced in recent years; and second, the projected impacts over the coming years based on the most plausible climate change scenarios.

2.1 Impacts of climate change and variability observed in West Africa

In the northern half of West Africa, referred to as the Sahel (or area bordering the desert), climatic conditions, which have always been characterized by spatial and temporal variability, have become prone to disturbances of significant magnitude, particularly since the early 1970s. The series of droughts that affected the Sahel over the past three decades consisted of declining rainfall, great uncertainty about its distribution in time and space, a drop in river discharges, etc. This situation translated into the accelerated desertification process, major crises in cereal production, massive migration of rural populations to urban centres etc. The Permanent Interstate Committee for Drought Control in the Sahel (CILSS) was created in 1973 in response to this situation. The adoption of the United Nations Action Plan on Desertification in 1977 and the entry into force of the United Nations Convention on Desertification in 1996 resulted mainly from the Sahelian crisis.

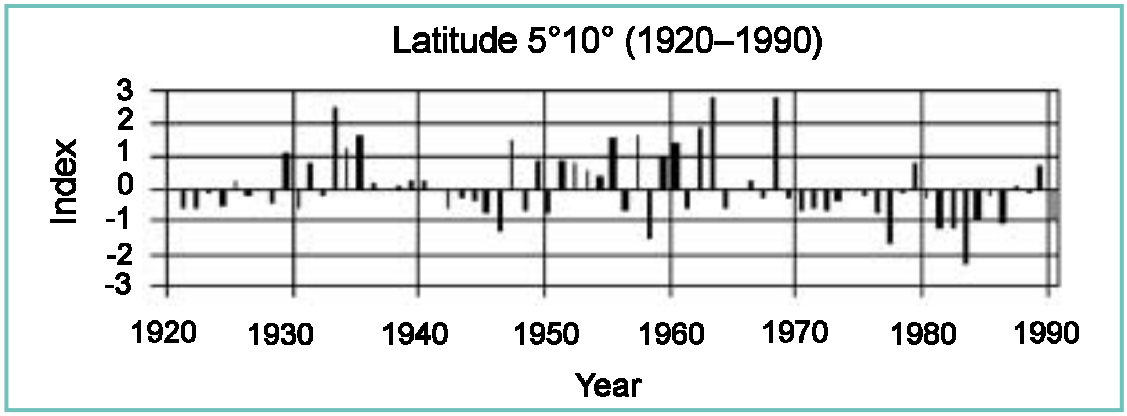
Thus, across the Sahel in particular and West Africa in general, climate change and variability are not only issues for the future. Whether they are referred to as climate variability and change or extreme climatic conditions, these new conditions have had an impact on all sectors.

2.1.1 Decline in rainfall

As already noted, West Africa has experienced a significant decline in rainfall in recent decades. A noticeable decline in rainfall series was observed around the years 1968–1972, with the year 1970 as a transitional year.

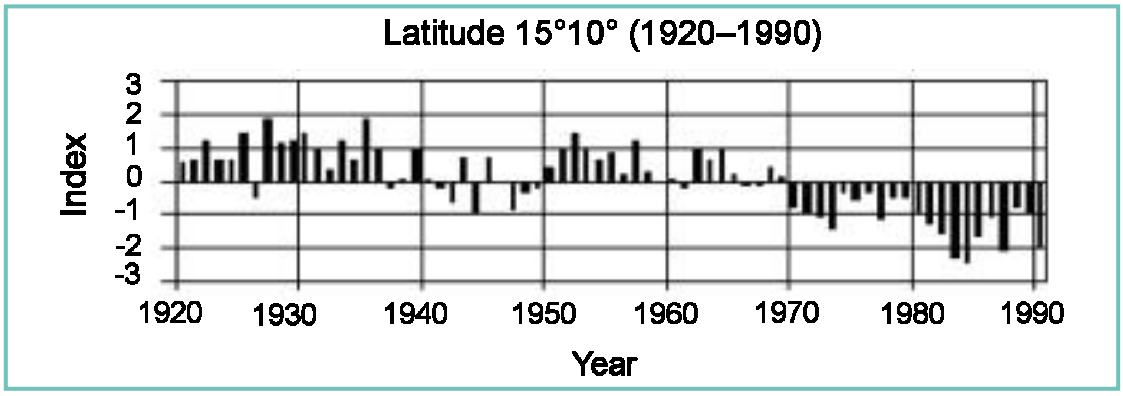
The drop in average rainfall, before and after 1970, ranges from 15% to over 30%, depending on the area. This situation has resulted in about 200km southward shift in isohyets. In the whole region, the decline in rainfall results from reduced number of rainy events. The causes of this anomaly (reduced number of rainy events) have yet to be clarified (Lebel *et al*., 1999).

Fig. 2 Annual rainfall variation index for wet lower latitudes (West Africa)



Source: Onibon, 2001.

Fig. 3 Rainfall variation index for arid and semi-arid higher latitudes (West Africa)



Source: Onibon, 2001.

2.1.2 Decline in the discharge of major watercourses

As in the case of the annual rainfall series, a significant variation in annual average discharge has been observed since the 1970s in most rivers. Across the region's major basins, the variation in discharge time is generally concomitant to that of rainfall. However, the decline in flow is more significant than that of rainfall: 40% to 60% average decline since the early 1970s against 15–30% for rainfall (Servat *et al.*, 1997 and Paturel *et al.*, 1997).[1] The table below shows around a 60% decline in the discharge of the Senegal and Gambia Rivers over the period 1971–1989 compared to the period 1951–1989 against a drop in the order of 25% in average annual rainfall across the same basin and for the same reference periods. With regard to the region's large drainage basins, the reduction in discharge ranges from 25–50% for the same periods. That is the case for the Niger River – the largest river in the region – where in addition to a drop in surface runoff, severe low flow conditions that resulted in the stoppage of flows were observed in 1983, 1984 and 1987 over the Bani tributary at Douna, Mali or in 1985 in Niamey. In 2002, the volume of water discharged at Koulikoro (upper reaches of the

[1] As will be seen later on, across some small basins the decline in rainfall did not necessarily result in a drop in discharge. Yet this does not contradict the general downward trend in the discharges of the region's watercourses.

river in Mali) was 29.7 billion cubic metres, that is, a 14% decrease in relation to the average for the period 1971–2001 consisting of a mean annual volume of 34.4 billion cubic metres. There is a 40% drop in the 2002 discharge compared to the average for the period before 1970 (over 49 billion cubic metres per annum).

Table 3. Ten-year variations in precipitation and average discharge across the five largest drainage basins of West Africa: deviation from the average for the period 1951–1989 in %

Drainage basins		1951–60	1961–70	1971–80	1981–89	Total 1971–89
The Senegal, Gambia, Corubal and Konkouré rivers (Northern Guinea)	Rainfall	+23.0	+13.0	-8.5	-16.5	-25.0
	Discharge	+32.6	+23.6	-24.1	-35.7	-59.8
Rivers of Southern Guinea, Sierra Leone and Liberia	Rainfall	+10.3	+5.2	-3.5	-13.3	-26.8
	Discharge	+19.6	+15.7	-9.3	-28.8	-38.1
Lower reaches of the Niger River Delta (Onitsha, Benué)	Rainfall	+11.3	+3.1	-4.2	-11.2	-15.4
	Discharge	+14.8	+13.4	-8.7	-21.5	-30.2
Rivers of Côte d'Ivoire, Ghana, Togo, Benin	Rainfall	+9.3	+4.6	-5.5	-9.4	-14.9
	Discharge	+23.4	+21.8	-18.4	-29.9	-48.3
Coastal rivers of Nigeria and Central Cameroon: Wouri, Mungo, Sanaga	Rainfall	+3.1	+7.4	-1.4	-9.6	-11.0
	Discharge	+10.5	+12.6	-9.3	-15.3	-24.6

Source: Mahé and Olivry, 1995.

2.1.3 Threatened continental wetlands

The decrease in discharge recorded in the region's largest watercourses since the early 1970s gave rise to a significant reduction in the area of major natural wetlands. The shrinkage in the average area of the Hadéjia Nguru Floodplain (on the Komadugu Yobe river system in northern Nigeria) ranges from 2,350km^2 in 1969 to less than 1,000km^2 in 1995. A similar trend was observed over the Niger River Inland Delta, which is the second largest wetland of the continent after the Okavango floodplain in Southern Africa.

The maximum area flooded in the Inland Delta has decreased significantly from 37,000km^2 in the early 50's, down to about 15,000km^2 since 1990. The area flooded for at least four months in the year (an important biological parameter) declined from 23,000km^2 to less than 2,000km^2 during the same period. The area of Lake Chad estimated at more than 20,000km^2 during wet years before 1970, shrunk to less than 7,000km^2 in the 1990s. A consequence of this situation is the splitting of the Lake into two parts (northern and southern basins). Today, only the

Drying out of a watercourse (eastern Burkina Faso), *Mahé/IRD*

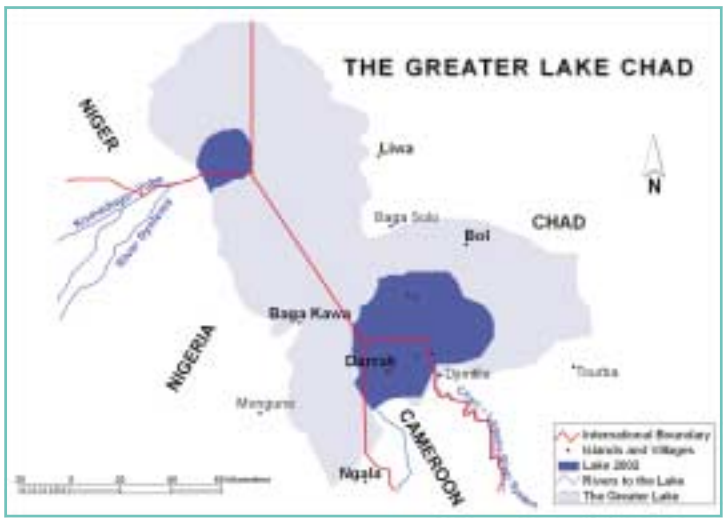
southern part contains water permanently. Over the past decade, a slight regeneration of the lake has been observed due to improved rainfall conditions.

2.1.4 Degradation of water quality

One of the consequences of the general deterioration of climatic conditions in the subregion is the proliferation of invasive weeds (water lettuce, water hyacinth, *Typha* etc.). Favourable conditions for invading weeds are created by the decline in flows, warming and eutrophication, which reduces the velocity of flood propagation and sometimes causes the virtual stagnation of water in some places. Floating weeds hinder fishing, navigation, the functioning of irrigation schemes and hydroelectric developments. In addition, they create an environment conducive to the multiplication of vectors of waterborne disease such as malaria. These invading weeds choke several water bodies of the region, including wetlands whose biological diversity is recognised as being of global importance. In recent years, the water hyacinth has been proliferating on the Otti subcatchment across the Volta and the *Typha* has been significantly expanding over the Komadugu Yobe Basin (Northern Nigeria), including Lake Nguru classified as a Ramsar site. Upstream of the Diama Dam at the mouth of the Senegal River, on the edges of the Djoudj and Diawling Ramsar sites, the expansion of *Typha* was compared to a giant carpet spread over the river.

The disposal of untreated wastewater from big urban areas into the river and increased use of agricultural inputs contribute dangerously to degrading water quality and spreading waterborne diseases.

Fig. 4 Shrinking and splitting of the Lake Chad



Source: Based on map by LCBC Remote Sensing Unit; May 2002

2.1.5 Decline in groundwater recharge level

The recharge of the area's aquifers has significantly decreased and often because of the decline in rainfall and surface runoffs. In arid and semi-arid zones, aquifers are often present in large sedimentary basins in fossil form. In some areas such as the subcatchment of Bani – upper reaches of the Niger River in Mali – water tables reached their

lowest level in 1987. The decrease in the water table has noticeable consequences on depletion coefficients, which as a result reduces the input of groundwater into major watercourses (Olivry, 1997). In humid and sub-humid areas, groundwater reserves are often limited in quantity in the Precambrian formations, in the form of fault waters, fissure waters or merely arenaceous waters. They are fed through direct infiltration in alteration layers and fluctuate according to seasonal rhythms. Consequently, they are directly affected by the decline in rainfall.

2.1.6 Threats to ecosystems, housing and infrastructure in coastal areas

Very sensitive to erosion, beaches and dune ridges along Africa's coastal area tend to retreat at variable rates: from 1–2 metres to more than 20–30 metres per annum in Senegal and along the Gulf of Guinea respectively (UNEP/UNESCO/UN-DAESI, 1985). Likewise, in Senegal, an accelerated retreat of coasts was observed between 1987 and 1991, which resulted in the splitting of dune ridges of which Sangomar Point (Pointe de Sangomar) is the most well known. This coastal erosion or sea advance often leads to degraded coastal ecosystems such as mangrove populations (which still cover an area of 28,000km^2 in West Africa). For example, there have been many changes in the layout of the Cotonou-Lomé road in the region of Grand-Popo, Benin; and hotel facilities and houses in the residential area of Akpakpa in Cotonou have been destroyed. The town of Rufisque (suburbs of Dakar) has also witnessed repeated destruction of houses along the seashore in recent years.

2.1.7 Climate change and variability as driving forces of desertification

The recurrent drought resulting from climate change and variability accelerates desertification and deforestation, which contributes to the persistence of drought. For instance, the overgrazing prevailing in the event of poor rainfall, which entails low fodder production, strips the soil bare and consequently increases the albedo.[2] This situation results in exacerbated and expanded atmospheric subsidence over the Sahara, which in turn, prevents rain from falling over the Sahel and therefore accelerates the disappearance of the vegetation. This feedback loop is likely to play a part in increased desert encroachment (Charney *et al.*, 1977). The increase in discharge observed over some small catchment areas such as some tributaries of the right bank of the Niger River as well as some portions of the Nakambé[3] – which is in contradiction to the general situation observed, particularly in the region's watercourses – can be explained by increased runoff coefficient during the dry period as a result of the degradation of the vegetative cover and the soil. Changes in land cover, hence the desertification process, seem to have a great impact on the hydrological cycle and rainfall-runoff relations. The Niger River whose bed tends to silt up is an illustration of this accelerated erosion.

[2] The ratio or fraction of the incident sunlight that is reflected by a given surface.

[3] Mahé *et al.,* 2002; Amani *et al*., 2002.

Banjul beach (The Gambia) showing coastal erosion, *Ibrahim Thiaw*

2.1.8 Climate variability: a determining factor and barometer of the performance of the regional economy

In West Africa, perhaps more than elsewhere, the climate plays a central role in the economy, and its vagaries (intra- and inter-annual variability of rainfall and flows in watercourses) often have immediate consequences on the economy of the various countries of the region. The relation between inter-annual rainfall variability and economic growth and the socio-economic impacts due to deficient replenishment of dam reservoirs testify to it.

Rainfall variability, agriculture and economic growth

Climate variability directly affects the national economies of African countries. As an illustration of this situation, in Zimbabwe for example, a significant correlation was observed between annual rainfall performance and the economic growth rate (Gray, 2002). This situation is all the more striking since Zimbabwe ranks second after South Africa, in terms of number of large dams. Most of the 250 large dams in this country are intended for irrigation (as a reminder there are 110 dams altogether in West Africa). In West Africa in general and in the Sahel in particular, the great weight of annual rainfall in economic growth can be explained by two main factors. The first one concerns the key role of agriculture, which accounts for 29% and 66% of the regional GDP and working population respectively (see Table 1). The second factor relates to poor water control. The case of Senegal eloquently testifies to the decisive role of the climate in the performance of West African national economies. Senegal's economic growth rate dropped from 2001 (5.7%) to 2002 (-1.1%) before increasing again in 2003 (6.3%). The 2002 situation mainly resulted from the much reduced primary sector activities mostly

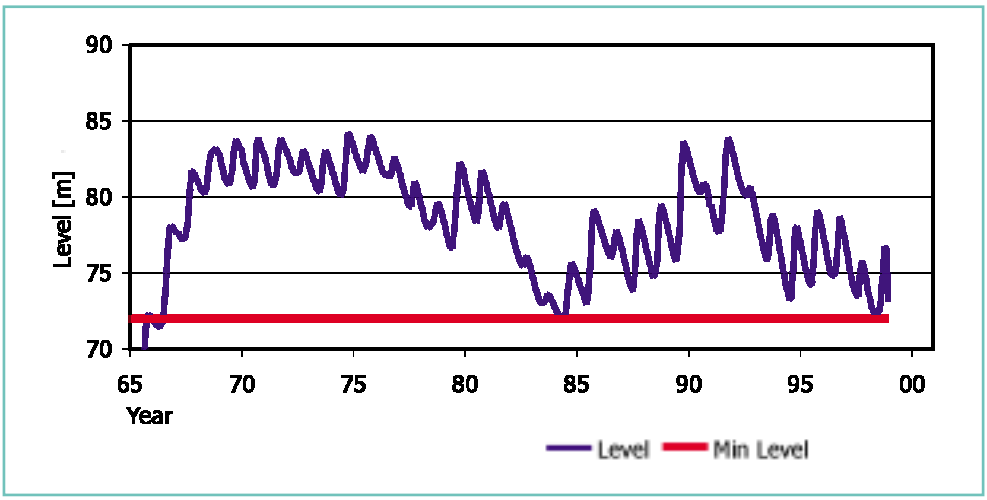
due to the vagaries of the climate, and particularly the bad weather, which affected some areas of the northern part of the country.[4]

From climate change to deficient replenishment of water reservoirs

The drop in the flow of the large rivers in the region mentioned earlier has had direct consequences on the replenishment of most dam reservoirs in West Africa. Built mainly in the 1960s and 1970s, these dams were in general designed according to the prevailing hydrological standards of the previous decades, which were relatively wet. As mentioned above already, the area has been subject to recurrent rainfall and hydrometric deficits since the beginning of the 1970s. The frequent poor replenishment of reservoirs had serious socio-economic impacts. Among those, one can note the reduction in the level of urban water supply: the town of Ouagadougou for example, which is primarily supplied from surface water reservoirs, had to face serious water supply shortage, particularly in 2002 and 2003.

In other cases, widespread flooding brought about disruptions in the operation of hydroelectric dams: such was the case of the Kainji dam in Nigeria, in September 1999. In February 1988, Ghana faced a severe energy crisis following the fall in the water level of Lake Volta, to below the threshold level needed to feed the turbines of the Akosombo dam (red line in Figure 5 below). This dam (of 912MW built capacity) together with the Kpong Dam (160MW) located downstream provide 95% of the electricity consumption in Ghana and part of the electricity consumed in Togo and Benin. The resulting power cuts seriously affected the economic activity, with the most affected sectors being industry and mining.

Fig. 5 Fluctuation in the water level of the Akosombo dam reservoir



Source: GLOWA Volta Project.

[4] *Jeune Afrique l'Intelligent*. L'Etat de l'Afrique. 2004. Hors-Série N° 6. p.185.

Water shortage in Ouagadougou in 2003, ***National daily newspaper*** **Sidwaya**

2.1.9 Social and economic costs of extreme climate events

Extreme events (devastating floods, droughts, sharp temperature changes) punctuate climate variability and climate change and seem to have become more frequent in West Africa. Their environmental and socio-economic costs are often high. In September 1999, torrential rains in the Niger-Nigerian and Benin sections of the Niger River led Nigerian authorities to open the floodgates of the Kainji, Jebba and Shiriro dams (approximately 300km north of Lagos). This resulted in enormous losses: 60 villages were destroyed, tens of recorded deaths, nearly 80,000 homeless people, 100,000 hectares of destroyed millet, rice and maize fields.[5] During the same period, strong and sharp increases in the flow of the White Volta (Nakambé) led, according to certain sources, the managers of the Bagré dam in Burkina Faso to open the floodgates of the dam in order to lower the pressure on the dam. This resulted in catastrophic floods in the Ghanaian part of the river. According to information released at the time, forty villages were affected and nearly 50 people died (Pearce, op.cit.).

Following the experience of devastating floods, which displaced several hundred thousand people in 1998, Northern Nigeria was again under the waters of the Hadéjia and Jama'are tributaries in September 2001. The floodgates of the Tiga and Challawa dams had to be opened, causing a heavy death toll: nearly 200 people died (25 in Kano State and 180 in Jigawa State) according to some sources; more than 35,000 displaced people, as well as material losses.[6]

A village under the floods: Inner delta of the Niger River (Mali), ***Mahé***

[5] Pearce, 2001; BBC,1999.

[6] Johnson, 2001. Asaju, 2001.

More recently, in January 2002, torrential rains accompanied by an unprecedented cold wave fell on northern Senegal and southern Mauritania. In northern Senegal, more than 50,000 head of cattle and 500,000 small ruminants were killed. More than 20,000 houses were destroyed, in one of the three affected districts alone. More than 30 people died instantly, notwithstanding subsequent cases of suicides.[7]

Such examples (many more could be given) are part of the normal behaviour of the West African climate. In spite of their greater frequency, they still take decision makers and the general public by surprise. Each disaster is managed in great confusion, thus increasing their social and economic impacts.

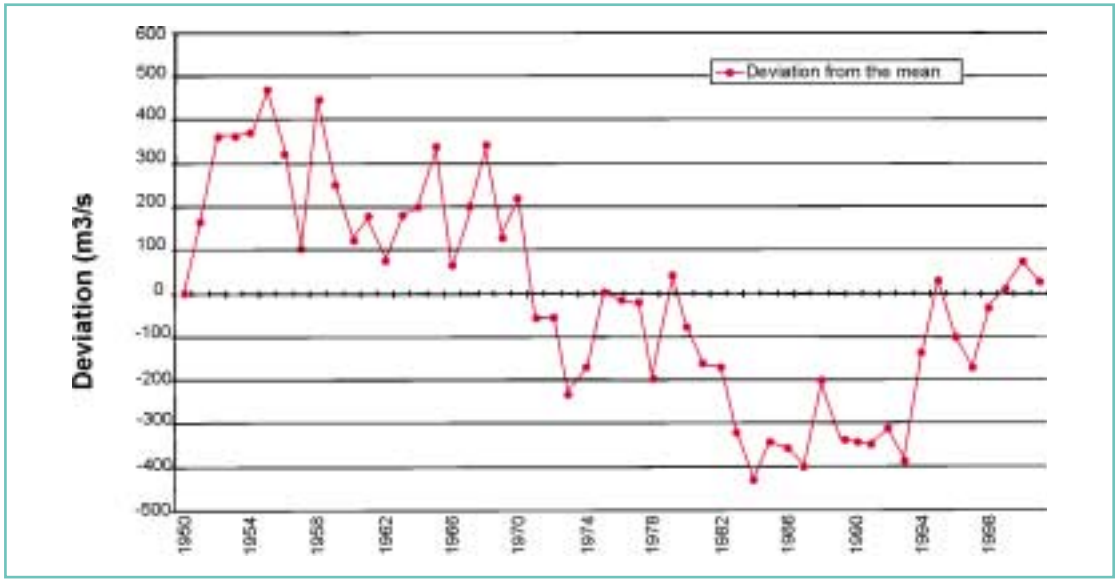
2.1.10 Risks of multiple conflicts over water

Climate variability and change often result in the decrease of water availability or in the degradation of its quality. These consequences often lead to the exacerbation of the competition for access to water.

In the middle and lower valleys of the Komadugu Yobe (Northern Nigeria), reduction of water availability due to climate variability and change, but also to construction of dams upstream, created strong tensions among riparian populations. In order to secure water supply for their flooded crop fields, several village communities had to dig channels in order to divert water to their advantage. Today, these various initiatives have deeply disorganized the natural drainage network of the basin.

At the international level, the high degree of interdependence of the West African countries with regard to water, combined with the low levels of awareness amongst decision makers and the general public on the impacts of climate, create a favourable ground for tension and even inter-state conflicts over water resources. For example, Nigeria, which has invested heavily in irrigation schemes and hydro-electric development in the downstream part of the river Niger (Kainji and Jebba dams, 1.6 million hectares of irrigated land, river transport installations, and urban water supply), fears

Fig. 6 The Niger River's annual discharge in Niamey: deviation compared to the average for the period 1950–2001



[7] UN, 2002.

today that the realization of dam projects upstream (Kandadji in Niger and Taoussa in Mali) will lead to a fall in the flow of the river in its Nigerian part. Thus, on several occasions the Nigerian authorities have expressed their concern over any hydroelectric project on the Niger River, which would involve a reduction of more than 10% in the annual volume of water received in Nigeria.[8] Considering what happened in the recent past, (drops of 20–50% in average flows) and the predicted climate, one can wonder whether climate variability and change are not going to "withdraw" more water from the Niger river than downstream countries such as Nigeria would consider acceptable (see above). One would even fear the occurrence of misunderstanding that could lead to upstream irrigation schemes being blamed for changes due to climate variations.

The energy crisis experienced by Ghana in 1998 (see Box 1) illustrates the serious implications that ignorance of climate change and variability as increasingly significant factors in the management of water resources could bring about.

Box 1. Energy crisis in Ghana in 1998: acknowledging climate as a "user" of water to avoid conflicts between riparian countries

At the time of the energy crisis which hit Ghana in 1998, following the water shortfall in the Volta Lake (a lake which is also the reservoir of Akosombo hydroelectric dam), some part of the general public and even some of the leaders of the country suspected Burkina Faso of being at the root of the problem. Some indeed thought that the drop in the water level of Lake Volta was the result of increased pumping of water by Burkina Faso from the upstream sections of the White Volta and the Black Volta – these two tributaries contributing 56% to the water supply in an average hydrological year. This thesis seemed all the more plausible since between the end of 1960 and the mid 1990s, Burkina Faso had built 1,500 small water reservoirs, three major dams and had increased its irrigated surfaces from 2,000ha to 25,000ha in the upper basin of the Volta. But analyses showed that the total water storage capacity of all the small and large dams of Burkina Faso (even including three other dam projects) represented only 1.49 billion cubic metres, i.e. less than 5% of the normal volume of Lake Volta. Thus, there was obviously another more credible cause to explain the water deficits in Lake Volta: climate (Andreini *et al*., 2000; van de Giesen *et al*., 2001).

Other consequences of climate variability and change – devastating floods (the Ghanaian part of the White Volta in 1999), migrations of floating plants along the water courses, the degradation of water quality, etc – are likely to contribute to the deterioration of relations between neighbouring States, especially because of the great interdependence of West African countries in relation to fresh water.

2.1.11 Conclusion

Climate perils in West Africa are thus serious. The impacts already recorded are significant. One could thus expect the worst if climate variations observed over the last decades were to remain the same or worsen.

[8] ABN, 2002. See Annex 7 in particular: "Position du Nigéria sur les projets de barrages de Taoussa (Mali) and Kandadji (Niger)".

2.2 Future impacts of climate variability and change in West Africa

2.2.1 Climate change scenarios used in West Africa

The Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC) provides new forecasts on the expected concentrations of greenhouse gases (GHG), on the profiles of changes in the world, the rate of variations in temperature, precipitation, sea level, and the modification of the frequencies and amplitudes of extreme climate events. It also examines the risks of abrupt and irreversible changes and evaluates the biophysical effects and socio-economic climate changes.

At the regional level, the TAR confirms that Africa is very vulnerable to climate change. The impacts identified on this continent relate to water resources, food production, human health, desertification and coastal areas, particularly in relation to extreme events. However, it is worth noting that water resources are an increasingly fragile key sector in Africa because of the increasing needs of households, agriculture, livestock, industry, energy, etc. The evaluation of this vulnerability is, however, plagued by uncertainties due to the diversity of the climate and the great variability of precipitation. Added to this the observation networks are often poorly maintained, rendering climate change forecasts inaccurate at the regional and local levels.

Most recent impact studies carried out in the region (particularly within the framework of the national communications) are conducted on the basis of scenarios using General Circulation Models (GCMs). Regional evaluations are generally obtained from GCMs rough resolution outputs. Up to now, the most widely used GHG emission scenarios are the first generation developed by IPCC.[9] The most recent national communications, such as that of Mauritania, considered the second generation of scenarios, the SRES. Almost all the studies on vulnerability and adaptation made at national level in the region used pre-existing climate change scenarios. The horizons of selected time frames vary from the years 2020 to 2100, most scenarios being focused, however, on 2025 and 2050 in terms of time horizon. This undoubtedly translates the concern of getting closer to nearer futures and of taking into account the concerns of the decision makers and the national forecasts made by economists/planners.

The majority of the coastal countries also considered one or more assessment scenarios of sea level. The results obtained show the vulnerability of the coastal areas and the ecosystems.

2.2.2 Impacts on fresh waters and continental wetlands

Rainfall

Even if model simulations are not consistent from one model to the other, with regard to West Africa, it is to be noted that the evolutions in future rainfall by the majority of GCMs are relatively modest, at least compared to the variability of current rainfall. Most climate change scenarios consider a reduction in precipitation, which varies from 0.5–40% with an average of 10–20% for the horizons 2025. In Senegal for example, the study done in the framework of the national communication, expects a reduction of the annual rainfall from 7–24%, compared to the average annual rainfall of 1961–1990. In

[9] The IS92 scenarios are the first generation of emission scenarios of greenhouse gases of IPCC, the last generation being those of SRES. The IS92a scenario is based on hypotheses corresponding to the maintaining of current emission trends.

Mauritania, rainfall would drop according to the latitude and will be 1% in the north and 30% in the south. Togo considers very limited variations of precipitation (lower than 1%). In addition, some countries took into account a hypothesis of precipitation increase (Mali, Burkina Faso).

Surface and ground waters

Although the forecasts, with regard to streamflow and ground water recharge, vary at the regional level according to the envisaged changes in precipitation, the majority of climate change scenarios report a decrease in flow and recharge of ground water tables in the arid and semi-arid countries of the region. In general, river flow is expected to decrease in proportions varying between five and 34% according to the time horizon and the country. Furthermore, there will be a fall in the ground water level following the reduction in their recharge as well as a reduction in the number and size of ponds and watering points. As an increase in the demand for human consumption and irrigation is expected (five times by 2025, according to the West African Water Vision), some countries such as Burkina Faso, Cape Verde and Niger could experience water shortage.

Extreme events

There is lack of information to confirm or invalidate the common assumption that a fall in the magnitude of floods in much of the region and their localized increase in the Sahelian areas are subject to man-made activities. However, the major droughts and a certain number of recent floods of unusual magnitude in the Sahel and in other regions cause many specialists to expect exacerbated climate extremes in some parts of West Africa. Seasonal low flows could drop in many areas because of lower groundwater levels and greater evaporation.

Socio-economic impacts

In the agricultural sector, a reduction in the yield of the major crops is expected (maize, early and late millet, sorghum, rice, cowpea), and therefore a reduction in cereal production in particular. The Gambia, however, anticipates a 15–47% increase in the production of groundnut because that crop adapts better to land degradation and to decreasing rainfall resulting from the expected climate change.

In the livestock sector, countries like Cape Verde and The Gambia simulated fodder production. Thus, deficient fodder productions are expected (with some uncertainties about time horizons) and livestock health problems, while in Niger, the models predict a reduction in the livestock. The amplitude of livestock transhumance movements is expected to increase.

The shrinking of continental wetlands (Niger River Inland Delta, floodplain of the Senegal River Valley, Lake Chad) is expected to continue and, combined with the decline in the rate of river flow, will consequently lead to the modification of the ecological niches and the life cycles of aquatic animal species, fish in particular. In the case of Lake Chad, it is already observed that fish catches dropped from 100,000 tonnes per annum in the 1970s to less than 60,000 tonnes today. With regard to forests, Burkina Faso and Côte d'Ivoire have not recorded any effects of climate changes, whereas other countries, located further north (Niger) anticipate the disappearance of some natural forests. The Gambia estimates that by 2075 the country will be covered by dry and very dry tropical forests.

The energy sector (hydroelectric power generation) could be affected, as in the case of Ghana mentioned earlier in this document. The reduction in river flow will also affect hydroelectric power generation in countries such as Côte d'Ivoire, Togo and Benin.

Climate change could also seriously affect the health sector, even if few countries (Niger and Togo for example) have tackled this issue systematically. Niger and Togo anticipate the resurgence of malaria, an upsurge in the epidemics of meningitis and measles as well as respiratory diseases.

2.2.3 Impacts on coastal areas according to climate change scenarios

In the first global analysis of vulnerability to the impacts of sea level rise (IPCC/RSWG, 1990), eight out of the 50 countries classified as the most vulnerable in the world, are located in West Africa: Guinea Bissau (6th most vulnerable country), Liberia (16th), The Gambia (17th), Sierra Leone (23rd), Togo (36th), Benin (39th), Senegal (45th) and Ghana (46th).

The tables below show the results of simulations of some impacts of climate change on the coastal zones of West Africa.

Table 4a. Effects of climate change on the coastal zones of some West African countries: scenario of rise in sea level of 0.5m by the year 2100

	Land lost by erosion (km^2)	Areas to be flooded (km^2)	Population at risk (thousands)	Value of properties affected (millions of US$)
Senegal	28–44	1,650	69–104	345–464
Côte d'Ivoire	n.a.	(281.3) 471	1,475	4,710[10]
Benin	22.5	17.5		
Nigeria	78–145	8,864	1,600	9,003.3

Table 4b. Effects of climate change on the coastal zones of some West African countries: scenario of rise in sea level of 1m by the year 2100

	Land lost by erosion (km^2)	Areas to be flooded (km^2)	Population at risk (thousands)	Value of properties affected (millions of US$)
Senegal	55–86	5,987	112–183	499–707
Côte d'Ivoire	n.a.[11]	(562.5) 924	2,455	9,240
Ghana		1,110	132.2	
Benin	145	85		
Nigeria	156–428	17,968	3,180	18,134.1

Sources: Senegal: Denis *et al*., (1995); Côte d'Ivoire: Jallow *et al*., (1999) and Initial National Communications (the values in brackets relate to the Abidjan area alone); Ghana: Initial National Communication: Benin: Adam (1994); Nigeria: French *et al*., (1995).

[10] This value was equivalent to Cote d'Ivoire's budget!

[11] Only the retreat of the coast has been evaluated (between 35 and 62m) (Jallow *et al*., 1999).

One of the most immediate major impacts of the rise in sea level will be the flooding of the lowest coastal zones (the deltas and estuaries in particular). This will result in the loss of significant housing areas and industrial and communication facilities, as well as cultural sites in and close to large cities like Banjul, Abidjan, Lomé, Cotonou, Lagos, Port Harcourt, etc.

Significant areas of mangroves and coastal wetlands will also disappear. In countries such as Senegal, The Gambia and Nigeria, some studies estimate that all the mangrove areas will be decimated in the event of a rise in sea level of one centimetre per annum (i.e., one metre in a century) (Nicholls *et al*., 1995). In Senegal, it is estimated that 37% of the surface areas of mangroves would be lost, in the event of a rise in sea level of 0,5cm, by the year 2100 (Dennis *et al*., 1995). The loss of the coastal wetlands and the mangroves, among other things, will affect the local economy which depends on them (for example, oyster fishing) and will disturb the migration cycle of millions of migratory birds. Sea encroachment will also result in the increase in salinization of soils, ground water and surface water in the coastal countries of the region. This concern was mentioned in the national communications and adaptation strategy documents of countries such as Cape Verde, Ghana, Togo, Benin, The Gambia and Senegal. In the latter country, a recent study shows that salt water intrusion will further affect the aquifer of Dakar (Faye *et al*., 2001).

In addition to infrastructure and housing, the most plausible scenarios of climate change and their expected rate of the rise in sea level will seriously affect sensitive sectors of the economies of the coastal countries in the region: agriculture (with the loss of cultivated lands or land salinization), tourism (whose infrastructures are located essentially along the coast), fishing and marine transport.

2.2.4 Conclusion

Significant uncertainties surround the science of the future climate. Most climate change scenarios predict a decline in precipitation in the range of 0.5–40% with an average of 10–20% by 2025. Many of these scenarios portray a generally more pronounced downtrend in flow regimes and the replenishment of groundwater. As a result of the major droughts and a number of recent floods with unusual magnitudes, specialists expect exacerbated extreme climate events in some parts of West Africa. Most coastal countries also considered scenarios of increase in sea level (0.5.–1m over a century), with more or less significant losses in housing zones and economic infrastructures and the disappearance of significant areas of mangrove and coastal wetlands. However, it is important to point out that the climate change scenarios used do not consist of definite predictions but rather present plausible future climates. Considering the many possible future scenarios, what matters is the ability to manage the uncertainty. This includes reducing current vulnerability to climate variability and change as well as keeping management options open to deal with the worst-case scenarios and to take advantage of opportunities that may arise.

3. West Africa's preparedness level: current situation and measures envisaged

3.1 Current situation

The review of the state of knowledge on the impacts of climate variability and change in West Africa, in the preceding chapter, highlights the great vulnerability of the region. If the trends observed over the last three decades were to remain or become aggravated, the environmental and socio-economic impacts could be enormous for West Africa, unless necessary steps were taken in time to lessen the shocks.

West Africa, and the Sahel in particular, has been facing drought since the sixties, with the serious food crisis of 1972 in particular, which resulted in major changes in the natural environment and the livelihood of the communities. In response to this situation, a great number of initiatives were carried out or are underway.

3.1.1 At a regional level

CILSS. Probably the most significant of these initiatives was the creation, in 1974, of the Permanent Interstate Committee for Drought Control in the Sahel (CILSS). CILSS comprises 9 countries (Mauritania, Senegal, Cape Verde, Guinea Bissau, The Gambia, Mali, Burkina Faso, Niger and Chad). Since its creation, CILSS has carried out a broad range of activities, particularly in the following fields: (a) the collection and management of data on climate, hydrology, soils, and on certain socio-economic aspects; (b) the dissemination of climatic information to Member States and other target groups; (c) the setting up of an early warning system based on weather data, agro-ecosystem models and geographical information systems; (d) research and training, through its AGRHYMET Regional Centre (Regional Centre for Training and the Application of Agrometeorology and Operational Hydrology). All these actions contribute to the attainment of food security, a better management of natural resources and poverty alleviation.

The AGRHYMET Regional Centre runs a project entitled "Strengthening the Capacities of the CILSS Member States to Adapt to Climate Change in the Sahel". This project is funded by the Government of Canada. Studies on the assessment of climate change impacts will be carried out for sectors such as water, pastoralism, land degradation, and food production. Adaptation strategies will be proposed in order to face the variations related to climate change. Pilot activities are implemented within the framework of this project in close cooperation with the communities, in order to make an inventory and evaluate indigenous knowledge with respect to adaptation to climate variability.

It is worth noting that CILSS prepared a Sub-Regional Action Programme on Desertification Control including eight topics. One of them deals with transboundary water. Its group leader is OMVS.

The PRESAO Initiative. The PRESAO Initiative (Seasonal Forecast for West Africa) was launched in 1998 by a consortium including particularly the African Centre of Meteorological Applications for Development (ACMAD), the AGRHYMET Regional Centre and the Niger Basin Authority (NBA). PRESAO aims to build capacity in the

field of seasonal climate forecasting. Within this framework, at the onset of each rainy season, PRESAO issues a forecast on the probable rainfall conditions for the whole sub-region (ACMAD/WMO, 1998). Since 1999, the seasonal flow forecast of major rivers of the sub-region has been added to the activities of PRESAO (ACMAD/WMO, 1999).

HYCOS-AOC. Since January 2000, the NBA and AGRHYMET have been carrying out the pilot phase of HYCOS-AOC, which is the West and Central Africa Component of the World Hydrological Cycle Observing System (WHYCOS) of WMO (WMO/MAE, 1997). It covers eleven countries. The objective of the HYCOS-AOC project is to create an information system on surface water resources by setting up a mechanism of data collection and transmission, providing real time, or near-real time, information on the availability of surface water resources in the sub region. The relevance of such a mechanism consists of contributing to a better management of water resources, exchange of information among countries sharing the same catchment area and providing warnings in the event of floods and/or deficient flow. Funds are being collected for the extension of the project to all the countries of the sub-region through a basin approach (Niger-HYCOS, Volta/HYCOS, Senegal/HYCOS, Lake Chad HYCOS) for a period of at least five years. The project documents for Niger-HYCOS and Volta-HYCOS are the most advanced ones.

FRIEND-AOC. This is the component of the FRIEND project (Flow Regimes with International and Experimental Network Data) for West and Central Africa, which is a component of UNESCO's IHP (International Hydrological Programme), another initiative related to the hydrological cycle. The main objective is the promotion of scientific research into water cycles through the creation of a network of scientists working in the field (UNESCO, 2002). It aims at increasing knowledge of spatial and temporal variability of rainfall and hydrological regimes by using regional datasets and placing this variability in its historical context. It contributes to improving our knowledge of the sub-region's hydrological cycle and its impacts. This is based on the sharing of a sub-regional hydro-climatological database to meet the needs of the researchers within the network, the organization of scientific workshops and training support. The AGRHYMET Regional Centre coordinates this project.

AIACC. The AIACC Programme (Assessment of Impacts and Adaptation to Climate Change), launched in February 2002, is an initiative of the IPCC (Intergovernmental Panel on Climate Change) financed mainly by GEF (Global Environment Facility). Its objective is to advance research on climate change in the developing countries by putting a particular emphasis on adaptation. This programme finances projects at a sub-regional level in general and provides, in addition to financial assistance, technical aid and training. The programme is implemented by UNEP and is jointly carried out by START and TWAS. Altogether 23 projects have been accepted to date, including 12 for Africa. Among these projects, four are of particular interest for West Africa: (a) the project for the development of regional scenarios of climate change in West Africa (Project AF07); (b) the project for the assessment of global and regional scenarios of climate change for West Africa (Project AF20); (c) the food security and climate change project in sub-Saharan Africa (Project AF23); (d) capacity building in analytical tools

for estimating and comparing costs and benefits of adaptation projects in Africa (AF47).[1]

AMMA. The AMMA Programme (Multi-Disciplinary Analysis of the African Monsoon and its Impacts) is an international research programme, which is being implemented by the international scientific community. The two main aims of the AMMA programme consist of: (a) improving the understanding of the WAM (West African Monsoon) and its influence on the physical and chemical environment and on the biosphere at regional and global levels; (b) generating knowledge that would enable relationships to be established between climate variability and health, water resources and food security issues in West African countries and appropriate monitoring strategies to be formulated.

3.1.2 At a national level

Responses implemented at a national level include:

National communications. To date, 11 countries out of the 17 considered as part of the Dialogue on Water and Climate Change have presented their initial national communications to the United Nations Framework Convention on Climate Change. These communications were presented between 1997 and 2002 (see Table 5 below).

Table 5. Date of submission of initial national communications to the UNFCCC

Country	Date of submission
Benin	22-10-2002
Burkina Faso	16-05-2002
Cape Verde	13-11-2000
Côte d'Ivoire	02-02-2001
Guinea	28-10-2002
Mali	13-11-2000
Mauritania	30-07-2002
Niger	13-11-2000
Senegal	01-12-1997
Chad	29-10-2001
Togo	20-12-2001

Water control infrastructures. Significant investments were made in water infrastructure and irrigation schemes aimed at regulating water regimes in West Africa. Burkina Faso, for instance – a country located on the Precambrian basement with limited groundwater resources – has invested a lot in small water retention reservoirs. This country has constructed more than 1500 water retention reservoirs during the past three decades. Other countries of the region (Benin, Niger, Mali, Senegal) have followed suit. As mentioned earlier, the region currently has only 110 large dams, whereas countries such as the United States and China with similar surface areas have 6,000 and over 20,000 large dams respectively. India (one-third of the surface area of West Africa) has

[1] Website: www.start.org.Projects/AIACC_Project/aiaxx.html

more than 5,000 large dams. Yet, it should be pointed out that each country of the region has at least one large dam construction project that lies in the bottom of a drawer. On the Niger River alone, there are twenty large dam construction projects at an advanced planning stage. Overall and taking into account efforts aimed at promoting irrigation (5% of cultivated lands in Africa as compared to a global average of 17%), West Africa controls water poorly and remains therefore highly subject to the vagaries of the climate.

Artificial rains. This technique consists of encouraging rain to fall by seeding the clouds. It has been tested in Burkina Faso since 1999 in collaboration with Morocco. Unfortunately, this technique is cumbersome and costly, often with uncertain results.

Although there are various other initiatives that could be listed here, generally speaking, the most notable West African solutions to the recurrent drought and exacerbated climate variability affecting the region since three decades, consist mainly of research, that is data collection and to a lesser extent its analysis. This is very important though research efforts are still inadequate. In either case, significant reduction in the vulnerability of the region to climate variability and change require that research activities be supplemented by concrete adaptation measures in the field.

3.2 Measures envisaged in order to strengthen West Africa's preparedness and adaptation level

In their national communications prepared as part of the implementation of the United Nations Framework Convention on Climate Change, the countries of the region generally just identified a number of adaptation measures, which in many cases had neither been assessed economically nor prioritized.

With regard to adaptation measures proposed in the water resource sector, there is a certain convergence of proposals, which could be explained by the relatively homogeneous situations in the various countries, but also their common experience in drought control over the past three decades.

The major measures generally proposed are the following:

a. *Promotion of Integrated Water Resource Management (IWRM)*. In most national communications, this measure particularly aims at managing water at the level of drainage basins. It is recommended that basin organizations be strengthened in terms of institutional capacities, where they exist (OMVS, ABN, OMVG, etc.) and created where they do not (for example the Volta River). It should be noted that national communications do not clearly explain to what extent IWRM could contribute to reducing vulnerability to climate change in the countries concerned. Moreover, since the region's major watercourses are transboundary water resources, such a measure should be envisaged at national and interstate levels, and even at a regional level, with focus on river basins.

b. *Enhancement of knowledge of water resources*. First and foremost, this measure concerns quantitative information (assessment of the availability of the resource and the variations it undergoes in time and space) but also qualitative data on surface and ground waters. In accordance with this measure, many communications advocate the extension and/or setting up of observation networks and increased support to research. It is clear that individual states can contribute significantly toward the implementation of this measure (support to research,

Wetland in Guinea Bissau, *IUCN*

strengthening of the data collection network). Yet, due to the aforementioned reasons (significant regional interdependence in the field of water), the effective and sustainable achievement of this measure requires co-ordination at basin or regional levels. In some river basins, (in particular those that do not have any basin organizations) riparian States have sometimes set up their own data collection and processing networks (using GIS for example) without any consultation with the other States. In some instances, information is held by one State without the knowledge of the others, thereby limiting its use.

c. *Erosion and deterioration of water quality control by reforesting catchment areas*. As mentioned previously, the region's watercourses are subject to erosion, silting up and even water pollution (as in the middle reaches of the Niger River). Existing small and large water retention reservoirs are under threat of silting up by sedimentary deposits (it has been noted that small water retention reservoirs in Burkina Faso have experienced a significant decline in their capacity because of sedimentation).

d. *Better legislation or implementation of legislations in force*. Many national communications have also proposed the actual enforcement of existing legal instruments in the management of the environment and natural resources, particularly the execution of national policies on water. The need for implementing international conventions on the environment (wetlands, biological diversity and desertification) is often underscored as an appropriate response to climate variability and change. In this respect, it should be recalled that all the countries of the region, with the exception of Cape Verde, have adhered to the Ramsar

Convention on Wetlands and that only Sierra Leone is not yet a party to the Convention on Biological Diversity.

The national communications have also come up with more specific adaptation measures with regard to climate variability and change in the sector of water resources. These include: (i) water transfer among basins; (ii) combined use of surface and ground waters; (iii) artificial recharge of aquifers; (iv) utilizing closed conduits in water supply systems; (v) dissemination of cost-efficient technologies and behaviours in the field of water, (vi) waste water recycling (domestic and industrial); (vii) sea water desalinization; (vii) rain water harvesting; etc.

Some of the measures proposed for agriculture are also relevant for the water resource sector. These include: (a) constructing structures for harvesting runoff and rain water in order to prevent it from being lost and also to curb phenomena such as erosion and flooding, while enabling the recharge of aquifers; (b) better mastery of irrigation in order to render it more effective and cost-efficient; (c) strengthening early warning systems in the event of extreme events (droughts, floods) and agro-hydro-meteorological monitoring.

Finally, some national communications have underlined the dual role of some adaptation options, which could also help to sequester carbon (through afforestation and reforestation activities) and thus contribute to reducing greenhouse gas emissions.

Ziga Dam (Burkina) before the filling of the reservoir, *Mahé*

3.3 Conclusion

The West African countries are not prepared to face the adverse effects of climate change because the prerequisites for setting up an integrated system for combating these effects are not yet satisfied.

At a national level, inadequate collaboration and exchange of views among experts and institutions, lack of validated models specific to the Sahel and coastal areas in Africa

and poor financial commitment from States, constitute major handicaps in the formulation of a good response policy.

Solutions proposed by the States, as part of their national communications, are not always explained convincingly (economic justification, IWRM, etc.), which may be an indication of inadequate capacity. Some of the measures proposed are often technically, financially and/or politically unachievable at an individual country level. Many of these adaptation measures are relevant at a regional level only.

At a regional level, there are a number of research initiatives on the climate and water resources. However, the results of these research initiatives are poorly exploited in order to support decision-making aiming at contributing to enhancing the region's level of preparedness.

4. Goal and objectives of the regional strategy

During the various meetings organized as part of the dialogue on water and climate change in West Africa, a much discussed issue related to what could constitute the niche and added value of the regional strategy in relation to ongoing and envisaged actions. A major concern of the stakeholders of the dialogue was to make sure that the regional strategy complements and backstops current efforts instead of competing against them.

4.1 Justification

This regional strategy is justified by the following observations made by the participants of the various meetings organized as part of the regional dialogue on water and climate change.

- The poor level of awareness of the threat posed by climate variability and change in the region and the lack of significant action to address this issue.
- There is no consultative framework on climate change in the region, which results in poor co-ordination among countries and institutions involved in climate change issues.
- Many of the fresh water resources in the region are transboundary watercourses which are not appropriately accounted for as far as national strategies are concerned.
- The current exchange of adaptation experiences are poor, even when good practices are concerned.
- The current focus on national approaches to adaptation limits opportunities for achieving economies of scale.
- Availability of expertise, considered on a per country basis, is sometimes insufficient to face scientific challenges posed by climate change; hence the need to pool regional expertise.
- At a regional level, appropriate policies (including the required legal and institutional frameworks) to face climate variability and change have not been put in place. There are few significant initiatives aimed at solving this problem and the existing ones are not coordinated.
- In the field of climate variability and change, science and policy are often disconnected at the regional level. On the one hand, there are research institutions dealing with the production of scientific knowledge and on the other hand, the policy makers who make laws and decisions at national and regional levels and engage in negotiations on climate change issues at international level. There is a great need to put science at the service of decision making and ensure that the concerns raised by decision makers are taken into account by scientists.

These various issues show that a regional strategy is the missing link in the efforts aimed at strengthening the region's preparedness level to face the impacts of climate variability and change, particularly as regards the inland and coastal water resources.

4.2 Objectives

Overall objective

The overall objective of the strategy is to strengthen the capacity of the region to adapt to the impacts of climate variability and change on water resources and aquatic ecosystems of West Africa.

Strategic Objectives (SO)

SO1. To improve and share basic scientific knowledge and decision-support information;

SO2. To promote the IWRM principles and the ecosystem approach in the management of water resources, and continental and coastal wetlands;

SO3. To identify, promote and disseminate appropriate adaptation technologies, techniques and measures;

SO4. To set up a regional consultative framework.

5. Components and activities

5.1 Knowledge sharing (SO1)

Though there is still a lot to do, significant efforts have already been made in the region with regard to climate data collection and analysis. West African climate research institutions include the AGRHYMET Regional Centre of CILSS, the African Centre of Meteorological Applications for Development (ACMAD) or research projects and networks such as HYCOS-AOC (Hydrological Cycle Observing Systems for West and Central Africa), AIACC (the West African Components of the Assessment of Impacts and Adaptation to Climate Change Programme), the West and Central African Component of the Flow Regimes from International Experimental and Network Data Project (FRIEND-AOC) and AMMA (Multi-disciplinary Analysis of the African Monsoon Programme). Accordingly, it is essential to encourage research initiatives and help them to further meet the concerns of decision makers and water users and contribute appropriately to disseminating their results. Objective 1 of the adaptation strategy is to meet this need to strengthen regional collaboration in the field of research and dissemination of scientific knowledge on climate variability and change and their impacts on water resources and ecosystems.

The following activities envisaged aim at achieving this objective:

- to conduct studies leading to the identification of information needs on the climate and its impacts, as expressed by:
  - water users (including grassroots communities) by conducting rapid appraisal methods and holding scoping workshops;
  - political, economic and community decision makers through scoping workshops and interviews of leaders and target groups;
  - basin organizations through meetings with the authorities and technical personnel of the region's major basin organizations: OMVS, OMVG, LCBC, NBA.
- to promote decision-support scientific research by:
  - putting at the disposal of researchers, the information needs of water users, basin organizations and decision makers;
  - helping in resource mobilization for research efforts dealing with identified needs for scientific information;
  - putting research results at the disposal of decision makers and water users;
- to promote research on indigenous knowledge (climatic information collection and interpretation systems) by:
  - conducting basic studies on indigenous knowledge relating to the collection and interpretation of information on the climate and its impacts;
  - sensitizing researchers and putting at their disposal the results of studies on indigenous knowledge;
  - helping in resource mobilization for research on indigenous knowledge;
- to promote research on the impacts of climate variability and change on ground water (availability and quality);

- to encourage regional collaboration between researchers and research centres on water, ecosystems and the climate by:
  - assisting in networking and exchanging information;
  - assisting in harmonizing research protocols, where necessary (e.g. GIS on international river basins, transboundary ecosystems, etc.);
  - conducting joint research activities;
- to undertake sensitization activities among States, organizations for regional integration (ECOWAS, WAEMU) and development partners (bilateral cooperation agencies, ADB (African Development Bank), the World Bank, UN etc.) for increased funding of research on water and the climate in West Africa, with particular emphasis on:
  - improving climate information collection networks;
  - creating databases and strengthening existing ones;
  - training of researchers;
  - strengthening and broadening networks of experts and research projects such as HYCOS-AOC and FRIEND-AOC, AMMA, AIACC;
  - extending the Sahelian IPCC (CILSS) to the whole of West Africa;
- to support basin organizations in strengthening their internal capacities with regard to the collection, analysis and utilization of scientific data associated with the climate;
- to support activities conducted in West Africa by the recently created Network of Basin Organizations, for it to serve as a forum for exchange of views among basin organizations in climate information collection and management.

5.2 Promotion of IWRM and the ecosystem approach (SO2)

As underlined above, West African countries are strongly water-interdependent because the bulk of surface water is located in shared basins. As a reminder, except for the Cape Verde Islands, each country of the region shares at least one transboundary basin with others. Considering that these transboundary basins consist of a unique ecosystem shared among several political areas, it is necessary to implement the principles of Integrated Water Resources Management (IWRM) and the ecosystem approach in the management of these catchment areas.

Coastal and inland aquatic ecosystems play host to a significant portion of the biodiversity of the world in general and West Africa in particular. This function strongly depends on the variation of water level and quality in time and space. It is therefore essential to promote measures aimed at reducing the impacts of climate variability and change on these ecosystems to enable them to continue to play their role of reservoirs and refuge of biodiversity.

There are other reasons for ensuring good wetland management. Their essential functions include water storage, groundwater recharge, abating the magnitude of floods, stabilizing soil surface conditions and erosion control, water purification and carbon

Box 2. IWRM and the ecosystem approach

The IWRM principles are as follows: (a) the recognition that water is a limited, vulnerable and essential resource for life, development and the environment; (b) the need for a participatory approach in its management; (c) the recognition of the importance of women's role in water management; (d) the need to recognise that water is an economic good.* The ecosystem approach is defined as a strategy for the integrated management of lands, water and living resources in order to promote sustainable and equitable conservation and use. This approach aims at: (a) maintaining the functions and services of ecosystems; (b) equitably sharing the products and benefits generated; (c) promoting adaptive management strategies; (d) decentralized management; and (e) encouraging intersectoral and decentralized cooperation.**

* Global Water Partnership 2000

** Convention on Biological Diversity. COP5

A Ramsar site invaded by *Typha* grass, North Nigeria, *M. Niasse*

sequestration. As the climate changes, these various functions become increasingly important. Consequently, the rehabilitation and sustainable management of wetlands constitute an important measure in adapting to climate variability and change.[1]

The West African context is relatively favourable to increased efforts to protect wetlands. As a matter of fact, with the exception of Cape Verde, all the States of the region have adhered to the Ramsar Convention.[2] In pursuance of this Convention (Art. 3), contracting parties shall create favourable conditions for the conservation of wetlands included in the Ramsar list. Moreover, contracting parties shall undertake to

[1] With regard to this issue please refer to Bergkamp and Orlando 1999; see also : Klein 2001.

[2] The Ramsar Convention or Convention on Wetlands of International Importance of 1971.

promote the sustainable utilization of any wetland located on their territories, be they included in the Ramsar list or not. Today, West Africa has 46 Ramsar sites with a total surface area of 10,073,059 ha. What is needed is to help the States of the region to fulfil their commitments as contracting parties to the Ramsar Convention: i.e. good management of current Ramsar sites, identification and classification of new sites, etc.

The following activities envisaged aim at achieving specific objective 2:

- to help in strengthening basin organizations where they exist and setting them up where they do not;
- to conduct inventories of wetlands on river basins and identify those whose restoration and conservation can significantly reduce vulnerability to climate variability and change;
- help in classifying wetlands as Ramsar sites, preparing and implementing their management plans;
- in collaboration with river basin organizations and international institutions concerned (IUCN, Wetlands International, Worldwide Fund for Nature), to initiate pilot experiments for sustainable restoration and conservation of wetlands;
- to promote research on environmental flows in order to better understand water requirements of aquatic ecosystems for maintaining their essential functions;
- to promote additional research activities on the interaction between wetlands and climate variability and change: impacts of climate variability and change on wetlands; importance of wetlands as a means to adapt and mitigate climate variability and change;
- to encourage the NBA, Mali, institutions concerned and development partners to launch a major initiative aimed at restoring and conserving the Niger River Inland Delta, which is the largest West African wetland;
- to encourage LCBC, institutions concerned and development partners to increase efforts aimed at restoring and conserving Lake Chad;
- to back the component on transboundary waters of the Subregional Action Plan on Desertification Control (programme spearheaded by CILSS);
- to undertake studies on the efficiency of IWRM as a strategy to adapt to climate variability and change;
- to help States in the formulation and implementation of national policies on water, which take into account the IWRM principles and ecosystem approach. In this context:
  - to back the SISCOA-IWRM process and help in implementing the regional IWRM Plan of Action;
  - to back pilot initiatives aimed at implementing IWRM (at subcatchment, catchment area and country levels);
  - to help in exchanging experience;
  - to help in capacity building;
  - to ensure coherence in the support provided to efforts undertaken as part of IWRM (European initiative etc.);

- to promote the integrated management of coastal areas by relying on the Regional Coastal and Marine Programme (RCMP) which is a joint initiative by FIBA, IUCN, WI, WWF;
- encourage States to ratify and implement the 1997 United Nations Framework Convention on the Non Navigational Uses of Transboundary Watercourses.

5.3 Identification and promotion of appropriate adaptation practices and techniques (SO3)

As previously mentioned, one of the important problems to be solved relates to the poor level of exchange of adaptation experience, including good practices. The current fragmented nature of adaptation efforts undertaken by the various States of the region reduces, among others, the opportunity for achieving economies of scale. Indeed the conception and implementation of appropriate responses to climate change is a huge scientific and technical challenge that the poor West African countries cannot take up individually. They will do better to pool their expertise and resources for greater efficiency. Finally, the great interdependence of countries in the field of water resources calls for a regional approach in the preparation and implementation of adaptation measures.

The following activities envisaged aim at achieving specific objective 3:

- to undertake an inventory and analysis of local experience related to adaptation to climate variability and change and identify best practices;
- to optimize the use, and disseminate at regional level, the best local strategies and techniques to adapt to climate variability and change (e.g. soil erosion control techniques, cereal varieties tolerant to drought or soil and water salinity, rain water harvesting techniques);
- to help the States and regional integration organizations (WAEMU, ECOWAS) in order to promote the exchange of strategies and techniques to adapt to climate variability and change (e.g. easing of tariff and non-tariff barriers to trade);
- to help basin organizations and the States in order to invest in and further support research on adaptation techniques and measures;
- to undertake sensitization and advocacy activities with development partners in order to increase support for development and efforts aimed at implementing adaptation measures at river basin or regional level;
- to seek the support of development partners for an effective North-South and South-South transfer of adaptation technologies;
- to support research on early warning systems related to drought (e.g. CILSS' experience in the Sahel to be strengthened and extended to the whole region) and floods;
- to support research efforts on adaptation capable of also playing the role of mitigative measures for greenhouse gas emissions (e.g. reforestation as carbon sink);
- to help in the rigorous application of the results of environmental and social impact studies in the planning of structural adaptation techniques and measures (e.g. dams, inter-region transfers, etc.).

5.4 Setting up the regional consultative framework (SO4)

The objective of setting up the regional consultative framework actually consists in furthering and formalizing the regional dialogue on water and climate change. It is interesting to note the recent creation of the Sahelian IPCC, which will contribute to the improvement of scientific output on climate in the Sahel. It would be desirable that such an initiative be widened, in order to cover the whole West African region. Within the framework of this objective, the adaptation strategy would meet the need for the creation of an efficient communication channel between research institutions on the one hand and the political decision makers, water users, civil society and development partners on the other hand.

The following activities envisaged aim at achieving strategic objective 4:

- to set up and run a regional water and climate change network to serve as a dialogue framework;
- to organize periodic meetings aimed at reviewing and discussing research results within " Open Science " forums;
- to organize preparatory meetings for the Conferences of Parties (COP) of the Convention on Climate Change in order to ensure a coordinated and strong participation of West Africa;
- to give an opinion and, where necessary, to write " Position Papers " on subjects of regional concern related to water and climate change;
- to organize on-site field visits and in countries where promising adaptation techniques and measures are taken;
- to organize targeted meetings (for example with WAEMU Parliamentarians, ECOWAS officials, NEPAD officials) to promote greater attention to climate in the regional and continental policies;
- to develop and implement an action plan of assistance to countries in the development and execution of their NAPA (National Adaptation Plans of Action);
- to undertake advocacy and lobbying activities for the funding of West African adaptation efforts;
- to organize seminars and workshops for reflecting and capitalizing on results related to adaptation. These meetings should be targeted on specific topics. The following is an indicative list:
  - management of natural disasters (floods, drought, desertification);
  - small and large dams as response options to climate variability and change;
  - taking climate variability and change into account in the design and construction standard of water infrastructures (problems of safety and flexibility of structures);
  - taking climate risks into account in poverty alleviation strategies;
  - alternative management of water resources: better management of the demand, greater efficiency of water distribution, greater productivity of water, etc.

6. Implementation

The strategy described above is a long-term strategy (15–20 years). Its implementation requires the development of an operational action plan, with a short to medium-term timeframe (3–5 years). The action plan (see Annex) identifies priority activities. For each activity or group of priority activities, project sheets are prepared. These sheets give the estimated budget, the key institutional partners and the implementation timeframe.

This action plan is developed by a Working Group including people and institutions represented in the Regional Water and Climate Change Network. This network serves as a special framework for consultation and dialogue, and could be organized around definite strategic objectives. This network includes:

- national focal points on climate change;
- experts from Government institutions responsible for defining and implementing national water policies;
- experts of river basin organizations;
- representatives of national focal points of the Ramsar Convention, the Conventions on Biodiversity and Desertification;
- university scientists or climate research centres;
- representatives of civil society (associations of water users).

In addition to the development of the action plan, the Working Group is also in charge of ensuring the coordination and monitoring of the implementation of the regional adaptation strategy and action plan.

CILSS, GWP-WAWP and UICN-BRAO which are the initiators of the process are in charge of setting up and running the Regional Water and Climate Change Network, resource mobilization and execution of the identified projects. As far as the implementation of each project is concerned, suitable institutional partnerships will be required.

Appendices

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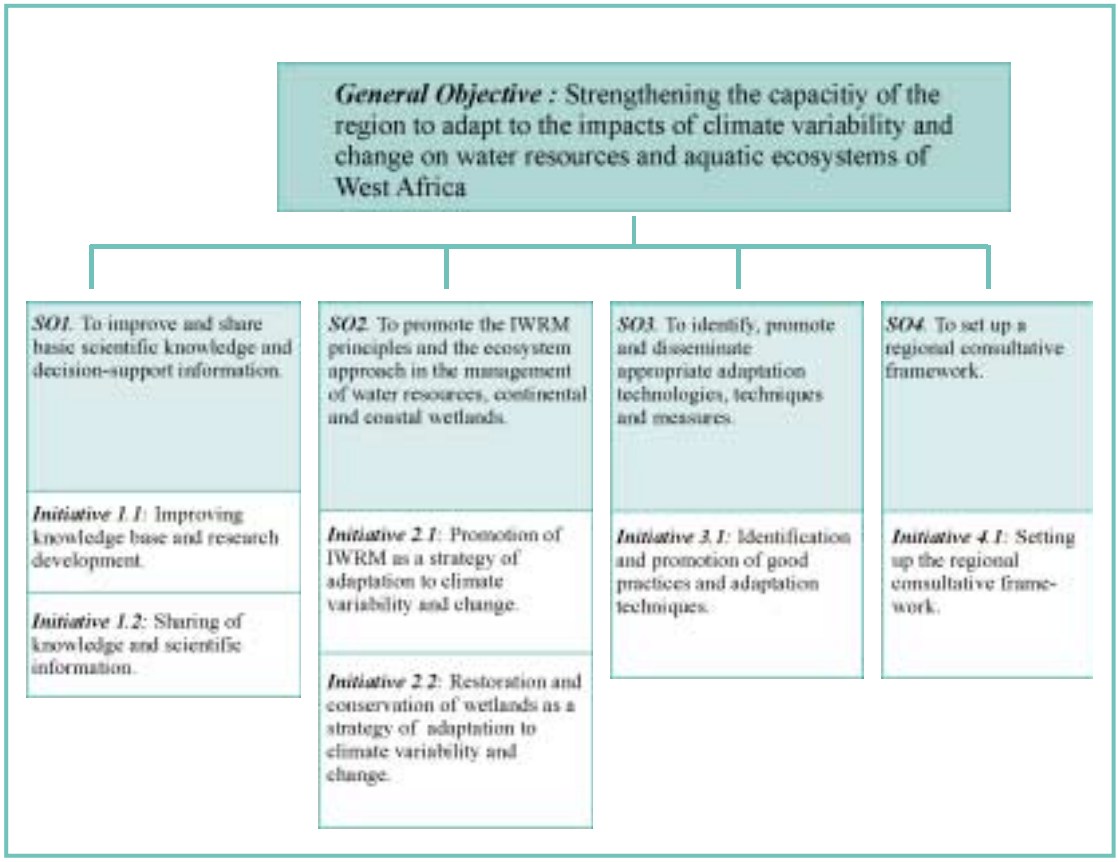
Annex

Action plan for implementing the adaptation strategy

The institutions that initiated the dialogue process (CILSS, GWP-WAWP and IUCN-BRAO) are responsible for setting in place and animating the regional network on water and climate change, and for mobilizing the necessary financial resources for the implementation for identified projects. For each of these projects appropriate institutional partners will be identified.

The regional adaptation strategy will be implemented through specific initiatives. These initiatives only take into account the actions that are considered to be of priority among those identified in the regional strategy.

Fig. 7 Structure of the strategy: strategic objectives and initiatives



Strategic Objective 1

Justification

Although there is still a lot to be done, significant efforts have already been made in the region with regard to climate data collection and analysis. West African climate research institutions include the AGRHYMET Regional Centre of CILSS, the African Centre of Meteorological Applications for Development (ACMAD) or research projects and

networks such as HYCOS-AOC (Hydrological Cycle Observing Systems for West and Central Africa), AIACC (the West African Components of the Assessment of Impacts and Adaptation to Climate Change Programme), the West and Central African Component of the Flow Regimes from International Experimental and Network Data Project (FRIEND-AOC) and AMMA (Multi-disciplinary Analysis of the African Monsoon Programme). Accordingly, it is essential to encourage research initiatives, help them to further meet the concerns of decision makers and water users and contribute appropriately to disseminating their results. Objective 1 of the adaptation strategy is to strengthen regional collaboration in the field of research (Project 1) and disseminate scientific knowledge on climate variability and change and their impacts on water resources and ecosystems (Project 2).

Project 1. Improvement of basic knowledge and research development

Objectives

General objective: Improve knowledge base and promote scientific research

Specific objectives:

- To identify data and information needs;
- To promote scientific research in support of decision making;
- To promote research on indigenous knowledge;
- To promote research on CVC (Climate Variability and Change).

Description

Activities

- Needs identification:
  - inventory, assessment of what exists, (survey data collection forms);
  - setting up of agricultural, hydrological, meteorological, demographic "metadata" etc.
- Promoting scientific research in support of decision making:
  - provision of information needs to scientists;
  - assistance in fund raising for research.
- Promoting research on indigenous knowledge:
  - national consultancies
  - to develop case studies on local adaptation practices.
- Promoting research on the impacts of CVC:
  - support for research activities (Incentive Fund for research on identified issues) is set up.

Expected outcomes:

- the needs for data and information are correctly identified at national and regional levels;
- scientific information necessary to decision making is available;

- indigenous knowledge is capitalized on and optimized;
- impacts of climate variability and change are assessed;
- suitable adaptation measures are proposed.

Target countries:
Benin, Burkina Faso, Cape Verde, Chad, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo

Duration: Five years

Estimated budget: USD600,000

Project 2. Sharing of knowledge and scientific information

Objectives

General objective: To put knowledge and scientific information at the disposal of all the stakeholders.

Specific objectives:

- to develop regional collaboration between scientists on the one hand, and scientists and stakeholders of water on the other hand;
- to build the capacity of scientists;
- to organize advocacy activities at the levels of States, decision makers, development partners, regional organizations, and local communities;
- to support the activities of Basin Organizations in West Africa, those of WANBO in particular.

Description

Activities:

- support to network research;
- organization of fora and development of extension tools;
- using opportunities offered by regional integration organizations in order to present research results on CVC;
- creation of an electronic newsletter;
- harmonization of research protocols;
- running of joint activities between scientists at regional level;
- common training activities (summer schools, postgraduate programme etc.);
- strengthening and extension of experts' networks;
- strengthening of research projects such as FRIEND-AOC, AMMA, AOC-HYCOS, etc;
- strengthening of basin organizations through the organization of common workshops.

Expected outcomes:

- scientific information is properly disseminated among decision makers;

- the various water stakeholders are sensitized;
- a real awareness of the populations is attained as regards CVC and its impacts;
- research protocols are harmonized and an electronic newsletter is created for the scientists;
- the WANBO is operational;
- adequate research capacity is established in the sub-region.

Target Countries:
Benin, Burkina Faso, Cape Verde, Chad, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo

Duration: Five years

Estimated budget: USD200,000

Strategic objective 2

Project 1. Promotion of IWRM as a strategy of adaptation to climate variability and change

Justification

West African countries are strongly interdependent on water because the bulk of surface water is located on shared basins. Considering that these transboundary basins consist of a unique ecosystem shared among several political areas, it is necessary to implement the principles of Integrated Water Resources Management (IWRM) and the Ecosystem Approach. The IWRM principles are as follows: (a) the recognition that water is a limited, vulnerable and essential resource for life, development and the environment; (b) the need for a participatory approach in its management; (c) the recognition of the importance of women's role in water management; (d) the need to recognise that water is an economic good.

The implementation of IWRM requires a dialogue between the various water users, water being regarded as the resource around which development activities are organized. In case of scarcity of the resource, as will probably be the case because of climate change, the coherent implementation of IWRM, contrary to sectoral utilization, allows, for example, to plan the use of water in such a way as to avoid conflicts between users and reduce the vulnerability of the most fragile populations.

There are significant initiatives of IWRM promotion in West Africa. Among these, one can note: (a) the SISCOA-IWRM process through which a regional IWRM action plan was prepared; (b) GWP/WAWP initiatives for the promotion of IWRM and dissemination of the IWRM kit; (c) the European water initiative which plans to support the States in the development of their national IWRM policies.

Objective

To promote and implement IWRM as an adaptation strategy to variability and climate change.

Description

Activities:

- to contribute to the strengthening of the basin organizations where they exist and to create them where they do not yet exist;
- to back the component on transboundary waters of the Sub-regional Action Plan on Desertification Control (programme spearheaded by CILSS);
- to undertake studies on the efficiency of IWRM as a strategy to adapt to climate variability and change;
- to help States in the formulation and implementation of national policies on water, which take into account the IWRM principles and ecosystem approach. In this context:
  - to back the SISCOA-IWRM process and help in implementing the regional IWRM Plan of Action;
  - to back pilot initiatives aimed at implementing IWRM (at subcatchment, catchment area and country levels);
  - to help in exchanging experience;
  - to help in capacity building;
  - to ensure coherence in the support provided to efforts undertaken as part of IWRM (European initiative etc.);
- to promote the integrated management of coastal areas by relying on the Regional Coastal and Marine Programme (RCMP);
- to encourage States to ratify and implement the 1997 United Nations Convention on the use of shared watercourses for purposes other than navigation.

Approach:

Most of these initiatives are taken into account, in one way or the other, within the framework of the processes run by SISCOA-IWRM or GWP/WAWP. As part of this document, what is needed is to implement the identified activities in close collaboration with the institutions above. The project will contribute to mobilizing resources and improving knowledge on the efficiency of IWRM as an adaptation strategy.

Target countries: West Africa (16 countries) and Chad

Duration: Five years

Budget: USD250,000

Project 2. Restoration and conservation of wetlands as a strategy of adaptation to climate variability and change

Justification

Coastal and inland aquatic ecosystems play host to a significant portion of the bio-diversity of the world in general and West Africa in particular. This function strongly depends on the variation of water level and quality in time and space. It is therefore essential to promote measures aimed at reducing the impacts of climate variability and change on these ecosystems to enable them to continue to play their role of reservoirs and refuge of biodiversity.

There are other reasons for ensuring good wetland management. Their essential functions include water storage, groundwater recharge, abating the magnitude of floods, stabilizing surface conditions and erosion control, water purification and carbon sequestration. As the climate changes, these various functions become increasingly important. Consequently, the rehabilitation and sustainable management of wetlands constitute important measures to adapt to climate variability and change.

The West African context is relatively favourable to increased efforts to protect wetlands. As a matter of fact, with the exception of Cape Verde, all the States of the region have adhered to the Ramsar Convention.[1] In pursuance of this Convention (Art. 3), contracting parties shall create favourable conditions for the conservation of wetlands included in the Ramsar list. Moreover, contracting parties shall undertake to promote the sustainable utilization of any wetland located on their territories, be they included in the Ramsar list or not. Today, West Africa has 46 Ramsar sites with a total surface area of 10,073,059ha. What is needed is to help the States of the region to fulfil their commitments as contracting parties to the Ramsar Convention: i.e. good management of current Ramsar sites, identification and classification of new sites, etc.

Restoration and conservation activities and the preservation of the areas under consideration in this project are part of the implementation of the ecosystem approach. The ecosystem approach is defined as a strategy for the integrated management of lands, water and living resources in order to promote sustainable and equitable conservation and use. This approach aims at: (a) maintaining the functions and services of ecosystems; (b) equitably sharing the products and benefits generated; (c) promoting adaptation management strategies; (d) decentralized management; and (e) encouraging intersectoral and decentralized cooperation.

Objective

To reduce the vulnerability of West Africa to climate variability and change through the restoration and conservation of wetlands.

Description

Activities:

- conduct inventories of wetlands on river basins and identify those whose restoration and conservation can help reduce vulnerability to climate variability and change significantly;
- help in classifying wetlands as Ramsar sites, preparing and implementing their management plans;
- in collaboration with river basin organizations and international institutions concerned (IUCN, Wetlands International, World Wide Fund for Nature), to initiate pilot experiments for sustainable restoration and conservation of wetlands;
- promote research on environmental flows in order to help better understand water requirements of aquatic ecosystems for maintaining their essential functions;
- promote additional research activities on the interaction between wetlands and climate variability and change: impacts of climate variability and change on

[1] The Ramsar Convention on Wetlands of International Importance of 1971.

wetlands; importance of wetlands as a means to adapt and mitigate climate variability and change;

- encourage NBA, Mali, institutions concerned and development partners to launch a major initiative aimed at restoring and conserving the Niger River Inland Delta, which is the largest West African wetland;
- encourage LCBC, institutions concerned and development partners to increase efforts aimed at restoring and conserving Lake Chad, which is the largest wetland in West and central Africa.

Approach

Within the framework of the Niger basin, the project will be implemented in collaboration with the already active institutions in the basin (e.g. WWF with the initiative of the Niger basin) and in connection with the framework agreement between NBA on the one hand and IUCN, WWF and WI on the other hand. The implementation of the project also requires collaboration with other specialized agencies such as IRD and the AGRHYMET Regional Centre. As far as the component of the lower delta of the Gambia River is concerned, activities will be carried out in close cooperation with the OMVG.

Areas of intervention:

Pilot activities in the Niger basin and the lower delta of the Gambia River.

Duration: Five years

Budget: USD2,000,000 (1.5 million for the Niger basin component; 0.5 million for the lower delta of the Gambia River)

Strategic objective 3

Project. Identification and promotion of good practices and adaptation techniques

Justification

As previously mentioned, one of the important problems to be solved relates to the poor level of exchange of adaptation experience, including good practices. The current fragmented nature of adaptation efforts undertaken by the various States of the region reduces, among others, the opportunity for achieving economies of scale. Indeed the conception and implementation of appropriate responses to climate change is a huge scientific and technical challenge that the poor West African countries cannot take up individually. They will do better to pool their expertise and resources for greater efficiency. Finally, the great interdependence of countries in the field of water resources calls for a regional approach in the preparation and implementation of adaptation measures. However, it is worthy of note that even an effective adaptation technique can have social and environmental consequences, which should be minimized.

Objective

To promote the implementation, on a large scale, of good adaptation practices in order to reduce the vulnerability of the area to climate variability and change.

Description:

Components and activities:

The project includes five components:

Component 1. Inventory of the indigenous adaptation strategies

- Carrying out an inventory and analysis of local adaptation experiences to climate variability and change.
- Eight (8) case studies will be undertaken and will cover the major eco-geographical zones in the area.

Component 2. Research activities on adaptation strategies

- Supporting research on early warning systems related to drought (e.g. CILSS' experience in the Sahel to be strengthened and extended to the whole region) and floods;
- Supporting research efforts on adaptation measures also capable of playing the role of mitigative measures of greenhouse gas emissions (e.g. reforestation used as carbon sink).

The implementation of these activities will be done in close collaboration with AGRHYMET Regional Centre (early warning related to agro-pastoral monitoring), NBA-Hydroniger (early warning system on flood propagation and flooding) and AIACC-Gambia (study on the costs and effectiveness of adaptation measures).

Component 3. Promotion and dissemination of adaptation techniques and practices

- Optimize the use, and disseminate at regional level, the best local strategies and techniques to adapt to climate variability and change (e.g. soil erosion control techniques, cereal varieties tolerant to drought or soil and water salinity, rain water harvesting techniques);
- Help States and regional integration organizations (WAEMU, ECOWAS) to promote the exchange of strategies and techniques to adapt to climate variability and change (e.g. easing of tariff and non-tariff barriers to trade);
- Seek the support of development partners for an effective policy of North-South and South-South transfer of adaptation technologies and measures.

Component 4. Support and mobilization of research funding

- Helping basin organizations and States to invest and further support research on adaptation techniques and measures;
- Undertaking sensitization and advocacy activities with development partners for increased support to efforts aimed at developing and implementing adaptation measures at river basin or regional level.

Component 5. Conduct and effectively implement impact studies

The implementation of this component will consist of ensuring the rigorous application of results from studies on environmental and social impacts in the planning of structural adaptation techniques and measures (e.g. dams, inter-basin transfers, etc.).

The following stages are envisaged:(a) study consisting of taking stock of the conduct of impact studies and the implementation of their recommendations; (b) capacity building in impact studies; (c) assistance to a better knowledge of international standards; (d) monitoring and implementation of impact studies.

Duration: Five years

Budget: USD1,700,000 allocated as follows.

Component 1: USD250,000

Component 2: USD800,000

Component 3: USD300,000

Component 4: USD100,000

Component 5: USD250,000

Strategic objective 4

Project. Setting up the regional consultative framework

Justification

The objective of setting up the regional consultative framework actually consists in furthering and formalizing the regional dialogue on water and climate change. It is interesting to note the recent creation of the Sahelian IPCC, which will contribute to the improvement of scientific output on climate in the Sahel. It would be desirable that such an initiative be widened, in order to cover the whole West African region. Within the framework of this objective, the adaptation strategy would meet the need for the creation of an efficient communication channel between research institutions on the one hand and political decision makers, water users, civil society and development partners on the other hand.

Objectives

General objective: Creation of an operational regional consultative framework on CVC.

Specific objectives:

- Setting up the regional network;
- Running the regional network;
- Resource mobilization.

Description

Activities:

- to propose a list of members of the network;
- to prepare draft constitutions of the network;
- to hold an inaugural meeting;
- to adopt the network's work programme;
- to set up a work plan to support the countries in the development of their national communications;
- to organize reflexion workshops on specific topics;
- to organize targeted meetings with WAEMU Parliamentarians, ECOWAS and NEPAD officials;
- to prepare concept papers;
- to undertake advocacy and lobbying activities aimed at funding West African efforts to adapt to CVC.

Expected outcomes:

- the statutes of the network are written under the responsibility of the three pioneer institutions (CILSS, GWP/WAWP, UICN-BRAO);
- the network is well structured: the committees are set up and the statutes adopted;
- a synergy is created with other existing networks;
- COP preparatory meetings are organized;
- the countries are assisted in the development of their national communication;
- lobbying is carried out at the level of the Sahelian IPCC project in order to extend the results of the project to the countries of the sub-region;
- a targeted periodic regional summit is organized in collaboration with the regional institutions at the highest level;
- research results on adaptation measures are capitalized on;
- a support fund is set up for adaptation efforts.

Countries concerned:
Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, the Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Chad, Togo

Duration: Five years

Estimated budget: USD450,000

Table. Summary of action plan elements

Strategic Objective	Project title	Specific objectives	Duration	Estimated budget (USD)	Potential key partners
SO1: Improving and sharing decision-support scientific knowledge and information base	Improving basic knowledge and promoting scientific research on CC impacts on water resources	(1) Identify data and information needs (2) Promote scientific research in support of decision-making; (3) Promote research on indigenous knowledge; (4) Promote research on Climate Variability and Change	5 years	600,000	CILSS-AGRHYMET; ACMAD; HYCOS-AOC; FRIEND-AOC; AIACC; AMMA; IUCN-BRAO; GWP-WAWP
	Sharing of knowledge and scientific information	(1) Develop regional collaboration between scientists on the one hand, and scientists and stakeholders of water on the other hand; (2) Build the capacity of scientists; (3) Organize advocacy activities at the levels of States, decision makers, development partners, regional organizations and local communities; (4) Provide institutional support to strengthen the West-African chapter of the African Network of Basin Organizations (ANBO)	5 years	200,000	CILSS-AGRHYMET; HYCOS-AOC; FRIEND-AOC; ANBO; IUCN-BRAO; GWP-WAWP
SO2: Promoting IWRM principles and ecosystem approach in the management of inland and coastal wetlands and water resources	Promoting IWRM as a strategy for adaptation to climate change and variability	(1) Strengthening the capacity of water professional and users in IWRM (GWP Tool box) (2) Institutional support to ECOWAS/SISCOA-GIRE (3) Encouraging the ratification of the UN Convention on transboundary waters through policy dialogues (4) Improving understanding of the effectiveness of IWRM as adaptation strategy	5 years	250,000	GWP-WAWP, ECOWAS/SISCOA-GIRE; IUCN-BRAO; GWP-WAWP

Strategic Objective	Project title	Specific objectives	Duration	Estimated budget (USD)	Potential key partners
	Restoration and conservation of wetlands as measure of adaptation to climate variability and change	(1) Improve understanding of role of wetlands as measure of adaptation to CC/CV (2) Restoration and conservation of selected wetlands in the Niger River Basin (3) Restoration and conservation of selected coastal wetlands in the lower Gambia River (4) Improving understanding of wetlands water needs through EFR studies	5 years	2,000,000 (1,5m for Niger River initiative; 0,5M for Lower Gambia Initiative	UICN-BRAO, NBA, OMVG, GWP-WAWP, CILSS
SO3: Identifying, promoting and disseminating appropriate adaptation technologies, techniques and measures	Identifying and promoting effective adaptation practices and techniques	(1) Improving understanding of and sharing knowledge on indigenous adaptation strategies (Component 1) (2) Promoting research activities on adaptation strategies (Early warning systems; and clean adaptation measures with no or low GHG emissions) (Component 2) (3) Promoting and disseminating adaptation techniques and practices (Component 3) (4) Supporting and mobilizing funding for research on adaptation responses (Component 4) (5) Improving capacity for effective implementation of impact studies for adaptation measures (Component 5)	5 years	1,700,000 Comp. 1: 250,000 Comp. 2: 800,000 Comp. 3 : 300,000 Comp. 4: 100,000 Comp. 5: 250,000	CILSS-AGRHYMET; UICN-BRAO, ANBO (NBA, OMVS, LCBC, OMVG); ECOWAS, WAEMU, GWP-WAWP
SO4: Setting in place a framework for consultation at the regional level	Setting up a regional consultative framework on water and climate change	(1) Establish regional network on water and climate (2) Improve coordination of West Africa input to COP meeting (CC, Ramsar and Biodiversity) (3) Improve coordination and experience sharing as part of NAPA efforts	5 years	450,000	UICN-BRAO, GWP-WAWP, CILSS, ANBO, OMVS, ABN, LCBC, OMVG, WAEMU, ECOWAS
Total strategy	Six projects		5 years	5,200,000	

IUCN – The World Conservation Union

Founded in 1948, The World Conservation Union brings together States, government agencies and a diverse range of non-governmental organizations in a unique world partnership: over 1000 members in all, spread across some 140 countries.

As a union, IUCN seeks to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable. A central secretariat coordinates the IUCN Programme and serves the Union membership, representing their views on the world stage and providing them with the strategies, services, scientific knowledge and technical support they need to achieve their goals. Through its six Commissions, IUCN draws together over 10,000 expert volunteers in project teams and action groups, focusing in particular on species and biodiversity conservation and the management of habitats and natural resources. The Union has helped many countries to prepare National Conservation Strategies, and demonstrates the application of its knowledge through the field projects it supervises. Operations are increasingly decentralized and are carried forward by an expanding network of regional and country offices, located principally in developing countries.

The World Conservation Union builds on the strengths of its members, networks and partners to enhance their capacity and to support global alliances to safeguard natural resources at local, regional and global levels.

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