

## **1. Introduction**

Climate change contributes to the long-term transformation of the climate at the local, national, regional and global levels. This transformation is manifested by changes in climatic parameters such as temperature, wind and precipitation. The consequences are changes in frequency and intensity of extreme weather events (droughts, floods, heat waves, rising sea level, etc.). Rising of sea level which ice melt is responsible for 30% and the increase in sea surface temperature at 70% will result in changes in the distribution of fishery resources and the erosion of marine and coastal biodiversity, which will have negative impacts on food security as fishery products are an important part of animal protein needed to feed people in Africa. In addition, environmental stress induced by climate change and overfishing will increase the pressure on fisheries, and will result in the depletion of fish stocks with the consequent emergence of conflicts over access to and control of resources fish at the local, national and regional.

Of their observed or expected impacts on the fisheries sector, climate change poses political scientific and technological challenges in Africa. Production information and knowledge, innovations and measures for decision making on adaptation and mitigation to climate change is the main Important.

REPAO (Network on Fisheries Policies in West Africa), through its program APPECCAO (Adaptation Policy Fisheries to Climate Change in West Africa, using scientific and indigenous knowledge), implemented from 2008 to 2011 participated in these challenges:

- Gathering and disseminating knowledge on climate change and its impacts on fisheries, as well as strategies for adaptation and mitigation;
- Information and awareness of policy makers, planners and fisheries stakeholders for the mainstreaming of climate change issues into development policies, plans, programs and projects for the development of the fisheries sector.

However, mitigation strategies related to the reduction of greenhouse gas are very poor in West Africa which nevertheless has enormous potential carbon sinks in coastal areas. Reducing greenhouse gas emissions in the sub-sector of artisanal fishing remains a problem in terms of overcapacity whole it contains and unsustainable technologies used that contribute to both pollution and overfishing.

Development of fisheries and fisheries technologies during the past five decades has brought an end to a vision of the unlimited exploitation of marine resources. With over half the world's population now lives in the coastal zone (within 60 or 100 miles off the coast), this proportion could reach 75% by 2020 and thus increased population pressure on fishery resources, more than three-quarters of the stocks of fish caught are now considered fully exploited or overexploited. The speed and intensity of the operations globally leave little opportunity for sustainable fishing practices, resulting in the erosion of marine biodiversity.

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## 2. Mitigation strategies and reducing greenhouse gas emissions in fishing West Africa

According to the IPCC, mitigation strategies are interventions aimed at reducing anthropogenic net emissions of greenhouse gases, which would decrease the pressure of climate change on natural and human systems. Mitigation options are possible by:

- (1) Reducing emissions of greenhouse gases by reducing the use of fossil fuels,
- (2) Reducing emissions from land through the conservation of large river existing within ecosystems,
- (3) And the acceleration of carbon uptake by ecosystems.

In Africa, although it is true that emphasis is placed on adaptation strategies rather than mitigation, it is important to highlight the important ability to sequester carbon, due to the existence of forests and mangroves.

In the fisheries sector, the development of clean production processes of fresh and processed products and the recovery and conservation of stocks, but also in terms recovery of coastal habitats are good points of entry to mitigate the possible effects of climate change on the continent, including the livelihoods of artisanal fishing communities.

The Western African coastal areas have rich and diversified marine and coastal habitats to develop its potential in terms of carbon sequestration and reducing emissions of greenhouse gases (GHG) and the recovery of fish stocks, while limiting the actions that can contribute to the weakening of marine and coastal ecosystems, and even pollution.

Thus, in the fisheries sector, mitigation actions are envisaged by the REPAO in its area (16 western African countries) to help reduce greenhouse gas emissions and enable fisheries stakeholders have modes of production more sustainable and consistent with the emergence of a green economy in this sector.

### A. Developing technologies in harvest and post-harvest activities

Development of technology allows the use of mechanisms and / or clean energy in the production process of the fisheries sector. **Activity to consider is reducing the consumption of fossil fuels (diesel boat) by artisanal fisheries.** As part of the implementation of the program Adapting Fishing Policy to Climate Change (APPECCAO) initiated by the Network on Fisheries Policies in West Africa REPAO), fishing communities in Senegal (Joal-Fadiouth, St. Louis and Foundiougne) identified this action as a priority (REPAO, 2011, Identification and analysis of adaptation strategies to climate change fishing in Senegal). Indeed, in addition to air and noise pollution, the noise of outboard motors scares fish (thousands of motorized canoes go to sea each day). Thus, fishermen communities have proposed to promote either outboards silent and consume less energy, either sailing canoes improved (with some storage capacity and storage of catches at sea). In addition, they recommend that these strategies are combined with actions by a regeneration of the resource such as aquaculture restocking coastal areas, the immersion of artificial reefs (fishing protected areas) to replace the shelters (rocks) destroyed by monofilament nylon and trawling in the coastal zone, and secondly to diversify livelihoods of fishing communities. Such an approach is initiated in the Parc National du Banc d'Arguin (PNBA) in Mauritania and today only sailing canoes are authorized to go fishing (Resource Assessment and management of the fisheries of the Mauritanian EEZ; IMROP , 2006). In Senegal the consumption of fuel in artisanal fisheries costs more than 10 billion CFA (around 20 millions USD) per year to

the Government in terms of direct subsidies. That is not sustainable in a situation of overcapacity and overexploitation of fisheries resource.

In West Africa, artisanal processing of fishery products use a lot of timber cut from forests and mangroves for fish smoking. Successful experiments of **drying and smoking fish with the use of solar energy** and improved kilns were held in Senegal (e.g. small-scale processing site with the use of solar energy implemented in Nianing). These experiments can be extended to other processing sites of Senegal (Saint-Louis and Joal-Fadiouth) and other western African countries to reduce deforestation as Guinea (Bonfi and Kamar) and Guinea-Bissau (in Cacine, Bouba and Cacheu). Women processors in fishing communities are facing huge difficulties in accessing wood for smoking fish. They demand an improvement in the transformation process **by reducing the use of wood and / or by promoting renewable energy (solar, wind)**.

In this context of scarcity of resources, it is necessary to direct interventions on the search for added value and improved value chain of fisheries products. Today, the sociological analysis of fishing communities shows that women have economically the role of head of household. They finance the education, health and physical needs of children. Thus, support for women working in the fishing returns to support a family. To enable women to have sustainable livelihoods while contributing to resource management and food security, we need to develop simple techniques of recovery and storage of products, and marketing and support the implementation of alternative activities (rice, livestock, trade, gardening, etc...) to diversify sources of income for women.

## **B. The protection of the mangrove**

In mitigation strategies identified it is envisaged that more rigorous protection of mangroves and promote reforestation of areas where it has suffered a sharp decline (e.g. in Senegal and Foundiougne Joal-Fadiouth, in Guinea Kamsar, Guinea Bissau to Cacheu). The acceleration of carbon uptake by mangroves in the area CCLME generally passes through three of the following actions:

- **Reforestation and sustainable management of mangrove ecosystems (carbon sink)**: this action has a double importance. It allows firstly preserving nursery areas for many fish species, secondly it plays an important role in carbon sequestration. Such an initiative is implemented throughout a program of biodiversity conservation (report on the implementation of the program on marine and coastal biodiversity countries of the region) and the activities of NGOs especially in Senegal and in Guinea-Bissau.

The study done by REPAO in 2009 on a contextual analysis of fishing and climate change shows the failures of reforestation areas due to the high salinity of the water and land in Foundiougne (Senegal). Thus, these communities require that the reforestation of these critical areas threatened by high salinity to be combined by the construction of dikes anti-salts (see report Identification and analysis of adaptation strategies to climate change fishing in Senegal REPAO, 2011).

- Consideration should also be **cross-border management of the mangrove ecosystem** in the case where it is shared between several countries (e.g. between Senegal and Guinea Bissau). In this case example, the shared management of mangroves between Senegal and Guinea-Bissau is

also a tool of conflict management, conservation of biodiversity, the fight against poverty and development strategies and adaptation mitigation of climate change.

- ***Renewal of the pirogue fleet with the introduction of fiberglass canoes*** in all countries is both a strategy of adaptation and mitigation of fisheries to climate change. Indeed, fiberglass canoes reduce the ability of canoes in terms of volume and duration of output (reduced fuel consumption). Thus, it will cause a reduction in fishing capacity. In addition, the promotion of fiberglass canoes contributes to the protection of forests. In the CCLME's area, there are at least thirty twenty thousand (30,000) artisanal fishing canoes, all made from wood from the forests.

Construction of canoes with the use of wood makes fragile the ecosystem in West Africa.

There is an experiment in Senegal fiberglass canoes, with use of recycled materials initiated by the Industrial Society and Naval Repair (ISNR). The renewal of the canoe fleet to replace the wood by fiberglass is an alternative that can be explored and considered as a strategy to mitigate the effects of climate change. Other mitigation strategies that can be functional in West Africa can be conducted in several phases from the recovery of fish stocks and marine habitats, reduction of fuel consumption by fishing vessels (canoes and boats included) with the use of renewable energies and the modernization of the production process of the products processed (by introducing improved stoves, clean equipment, etc.). These actions are proposed by the fishing communities in St. Louis, Foundiougne and Joal-Fadiouth in Senegal and other fishing sites involved in the program APPECCAO Guinea (Sao Pedro, Sal and Palmeira) and Cape Verde (Bonfi, Kamsar and Siguir).

***Actions to reduce greenhouse gas emissions and enhancing carbon sinks in West Africa can be capitalized and certified to be valued on the carbon market.*** Thus, we must to accurately assess the carbon sequestration capacity of mangroves in the area and the amount of carbon reduced through modernization of production processes (using fiberglass canoe, reducing the consumption of fossil fuels, renewable energy use in fish processing, ..) to formulate proposals for "sale" on the carbon market. Funds obtained can be used to finance actions mangrove conservation, fund the use of solar energy in small-scale processing of fish products, in the activities usually performed by women while strengthening the livelihoods of communities artisanal fishing nearby. For example, in the mangroves, the money collected in the carbon market could be used to finance the use of solar energy in small-scale processing of fish products, activities usually conducted by women. In addition, we can consider these following actions.

- ***the organization of reforestation campaigns where mangroves suffered a sharp deterioration (examples of Joal-Fadiouth Foundiougne Senegal),***
- ***the construction of dikes and anti-salt protection (Foundiougne) to reduce the accelerating salinity of the mangrove degradation and disappearance of certain marine species are necessary initiatives to encourage more local actions (biological recovery, ban fishing of juveniles, reduction of fishing effort, ban trade or process of prohibited species, ...),***
- ***Restore the stocks threatened by climate change as shrimp Foundiougne and demersal species (grouper, pandora, etc.. alongside the establishment of reference centers for processing and recovery products fisheries that use renewable energy and improved production processes in Joal-Fadiouth and Foundiougne.***

### C. The use of algae and seagrass

Reconstitution of seagrass in the coastal zone CCLME can set up a huge carbon sink from Morocco to Guinea. Coastal wetlands such as mangroves, salt marshes and seagrasses are important carbon sinks and provide a number of ecosystem services including habitat for many species of fish, molluscs and crustaceans (UNFCCC, 2012). However, it is also one of the most endangered ecosystems on the planet. Globally, about 29% of seagrass beds have been destroyed so far, due to dredging and the degradation of the quality of coastal waters. And the attack continues, since 1.5% of seagrass beds disappear every year. The study estimated that the destruction of this ecosystem could generate the equivalent of 25% of carbon emissions from deforestation land (Geoscience 2012). Thus, it is urgent to take measures to protect carbon reservoirs largest and most vulnerable, and to restore and regain their ability to sequester carbon (UNESCO). Immediate action can be taken by coastal communities, managers, policy makers and scientists. Actions to protect and even recovery of seagrass are experienced and successful same in Canada. Actions seagrass recovery, such as "strict ban on all fishing below three (03) miles sailor," can be initiated on pilot sites in Senegal (Joal-Fadiouth) and Guinea-Bissau (Cacheu). These initiatives may capitalized and spread throughout the area CCLME.

Algae are organisms capable of photosynthesis and living mainly in aquatic (marine and freshwater). Many species of seaweed are edible for humans and animals. They also serve as fertilizer in coastal areas where they are collected on the beaches. It is clear that climate change is contributing to the proliferation of algae (QRE, IPCC, 2007). Several pilot projects are trying to exploit algae for biofuel production and promising results are obtained by a team of Chilean and American. More experimental pilot plant is under construction in Chile and should start to increase its activities in July 2013 by an American company that has four seaweed farms off the coast of Chile and the Chilean Agency for promotion of innovations. Coastal areas in Western Africa which are rich in algae (green, brown, red and blue) should also consider developing partnerships with specialized agencies for promoting innovations with research institutes working in the area of algae. The development of these partnerships is to allow marine aquaculture Seaweed and marketing of edible seaweed. A pilot experimentation and exploitation of algae could be put in place to Joal-Fadiouth (site rich in algae) in Senegal. ***This type of pilot project could have three component (1) seaweed aquaculture, (2) biofuel production, and (3) marketing of edible seaweed. It will help in the fight against the proliferation of algae which causes eutrophication of the seabed, the poverty of local communities and dependence on fossil fuels.***

The expansion of coastal cities, agriculture and horticulture and industrial development contribute to coastal pollution. For this purpose, you must press the directions of the environment on the one hand to ensure compliance with the code of the environment in the countries of the area CCLME and secondly to review the environmental codes based the context of climate change and to introduce the principle of polluter pays. Compared to invasive plants, it will work with basin organizations as OMVS and OMVG and research institutions to develop a strategy against the proliferation of invasive freshwater plants. To this end, a pilot project of fundamental research will determine the appropriate method of control depending on the species (biological, mechanical or chemical control).

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### **Webographie**

- Groupe d'Experts Intergouvernemental sur l'évolution du Climat (GIEC)
- Le GIEC ou IPCC (Intergovernmental Panel on Climate Change) a pour mission d'évaluer les informations d'ordre scientifique, technique et socio-économique nécessaires pour mieux comprendre les fondements scientifiques des risques liés aux changements climatiques ; cerner les conséquences possibles de ces changements et envisager d'éventuelles stratégies d'adaptation et d'atténuation. Il n'a pas pour mandat d'entreprendre des travaux de recherche ni de suivre l'évolution des variables climatologiques ou d'autres paramètres pertinents. Ses évaluations sont publiées sous forme des rapports de synthèse, dont le quatrième est le plus récent et le cinquième Rapport d'Evaluation (AR5) paraîtra en 2014 ; les rapports spéciaux, les rapports méthodologiques, les documents de base et les documents techniques.
- [http://www.ipcc.ch/home\\_languages\\_main\\_french.htm#1](http://www.ipcc.ch/home_languages_main_french.htm#1)
- United Nations Framework Convention on Climate Change (UNFCCC)
- UNFCCC ou Convention Cadre des Nations Unies sur les Changements Climatiques est la principale source d'informations sur la Convention, le Protocole de Kyoto et leur mise en application. Elle est destinée à mieux servir ceux qui sont impliqués dans le processus intergouvernemental des changements climatiques.
- <http://unfccc.int>
- Food and Agriculture Organization of the United Nations (FAO)
- La FAO met à la disposition du public des informations et des documents sur la Pêche à travers son Département des Pêche et de l'aquaculture, ainsi que sur les changements climatiques <http://www.fao.org/climatechange/fr/>
- Club du Sahel et de l'Afrique de l'Ouest (CSAO) Le CSAO a mis en place un Atlas sur l'intégration régionale en Afrique de l'Ouest, qui présente les effets des changements climatiques en Afrique en général et Afrique de l'Ouest en particulier <http://www.atlas-ouestafrique.org>
- African Marine Information System (AMIS)<http://amis.jrc.ec.europa.eu>
- Réseau international ChloroGIN<http://www.chlorogin.org>
- The NERC Earth Observation Data Acquisition and Analysis Service (NEODAAS) - Operational Ocean Observing <http://www.ncof.co.uk/Operational-Ocean-Observing.html>
- African Marine Atlas (AMA)<http://www.africanmarineatlas.net/>
- Climate Prediction Center - NCEP Global Ocean Data Assimilation System
- <http://www.cpc.noaa.gov/products/GODAS/>
- Institut de Recherche pour le Développement (IRD)<http://www.ird.fr>
- Organisation de Coopération et de Développement Economique (OCDE)<http://www.oecd.org/env/cc>
- Programme Aires Protégées d'Afrique du Centre et de l'Ouest (PAPACO) – UICN <http://www.papaco.org>
- Fondation Internationale de Banc d'Arguin (FIBA) <http://www.lafiba.org>
- United Nations Fund for Population Activities (UNFPA)<http://www.unfpa.org>

- Institut du Développement Durable et des Relations Internationales (IDDRI)<http://www.iddri.org>
- Institut de l'Énergie et de l'Environnement de la Francophonie (IEPF)<http://www.iepf.org>
- World Ocean Circulation Experiment - Global Data Resource (WOCE)<http://woce.nodc.noaa.gov/wdiu/>
- Global Climate Observing System (GCOS)<http://www.wmo.int/pages/prog/gcos/index.php>
- World Meteorological Organization (WMO)<http://www.wmo.int>
- Programme des Nations Unies pour le Développement (PNUD) <http://www.undp.org/french/>
- Communauté Economique Des Etats de l'Afrique de l'Ouest (CEDEAO)<http://www.ecowas.int>
- Union Economique et Monétaire Ouest Africaine (UEMOA) <http://www.uemoa.int/index.htm>
- Programme des Nations Unies pour l'Environnement (PNUE)<http://www.unep.org/french/>
- Convention on Biological Diversity (CBD)<http://www.cbd.int/>
- Adaptation to Climate Change in Coastal zones of west Africa (ACCC)<http://accf-africa.org/>
- Comparing and supporting endogenous development (COMPAS)<http://www.compasnet.org/index.html>
- Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) – Coopération technique allemande / Pêche <http://www.gtz.de/fisheries>
- Rural 21 - Journal international du développement rural publié par GTZ (Ancien Agriculture développement rural)<http://www.rural21.com>
- Programme Régional de Conservation de la zone Côtière et Marine en Afrique de l'Ouest (PRCM) <http://www.prcmarine.mr/>
- Commission Sous-Régionale des Pêches (CSRSP)<http://www.csrpsp.org/>
- Wetlands International<http://www.wetlands.org/>
- World Wide Fund (WWF)<http://www.panda.org/>
- Programme Adaptation aux changements climatiques en Afrique (ACCA) de CRDI[http://www.idrc.ca/fr/ev-94425-201-1-DO\\_TOPIC.html](http://www.idrc.ca/fr/ev-94425-201-1-DO_TOPIC.html)
- Centre de Suivi Ecologique (CSE) <http://www.cse.sn/>
- <http://www.scidev.net/fr/climate-change-and-energy/news/les-algues-marines-comme-biocarburants-une-id-e-qui-avance.html>.
- Enda communities – Connaissance locale <http://www.enda-communities.org/ik.htm>
- Edna Energie<http://energie.enda.sn>
- Enda Perspectives Dialogues Politiques (Enda Diapol)<http://www.endadiapol.org/>
- Réseau sur les Politiques de Pêche en Afrique de l'Ouest (REPAO)<http://www.repao.org/appeccao>