

# Climate Change Adaptation Strategy Technical Reports – Nigeria (CCA STR)

Infrastructure Sector  
Agriculture Sector  
Natural Resources Sector  
Health and Sanitation Sector  
Cross-Sectoral Issues

A Compendium of Studies Commissioned and  
Published by Building Nigeria's Response to Climate  
Change (BNRCC) Project

Coordinated by:  
Nigerian Environmental Study/Action Team (NEST)  
1 Oludkun Street, Off Awolowo Avenue, Bodija  
UI-PO Box 22025  
Ibadan, Oyo State, Nigeria



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Address: 1 Oluokun Street, off Awolowo Avenue, Bodija, UIPO Box 22025, Ibadan, Oyo State, Nigeria  
Telephone: 234-2-7517172

Internet: [www.nigeriaclimatechange.org](http://www.nigeriaclimatechange.org) and [www.nestinteractive.org](http://www.nestinteractive.org)

E-mail: [info@nigeriaclimatechange.org](mailto:info@nigeriaclimatechange.org) and [info@nestinteractive.org](mailto:info@nestinteractive.org)

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## Preface and Acknowledgements

The heightened impacts of climate change in Nigeria and other developing countries, which are likely to intensify in the coming years, have overwhelmed local and traditional knowledge and technologies, leaving many people with inadequate information and little means to deal with the challenges. In addition, there are too few government policies and strategies to address climate change impacts. To tackle these issues, the 'Building Nigeria's Response to Climate Change' (BNRCC) project, was implemented between 2007 and 2011, by the consortium of ICF Marbek and CUSO-VSO and by the Nigerian Environmental Study/Action Team (NEST), with financial support from the Canadian International Development Agency (CIDA).

The BNRCC project components included research and pilot projects, policy development, communication and outreach as well as youth and gender initiatives. The research projects involved community-level socio-economic and future climate scenario studies, while the pilot projects engaged partners and communities in all of Nigeria's ecological zones. Mainstreaming gender equality was integrated throughout all components, and communications activities built awareness at all levels, from the communities to government agencies. Lessons and knowledge generated from the project components fed into the development of the National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CCN), which was prepared in partnership with the Special Climate Change Unit (SCCU) of the Federal Ministry of Environment, and other partners.

Publications that have emerged from the BNRCC Project include: the *National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CCN)*; the *Climate Change Adaptation Strategy-Technical Report (CCASTR)*, which is a precursor to the NASPA-CCN; *Climate Change Scenarios for Nigeria: Understanding Biophysical Impacts for Adaptation Strategies*; *Gender and Climate Change Adaptation: Tools for Community-level Action in Nigeria*; and *Learning from Experience – Community-based Adaptation to Climate Change in Nigeria*, a practitioners' guide to climate change adaptation based on BNRCC's experience with pilot project in vulnerable communities. In addition, BNRCC produced two documentary films on climate change in Nigeria: *Water Runs Deep* and *In the Red Zone*. All publications and films are available on-line at [www.nigericlimatchange.org](http://www.nigericlimatchange.org) and [www.nestinteractive.org](http://www.nestinteractive.org).

The Climate Change Adaptation Strategy Technical Report (CCASTR) is a collaborative effort involving 22 researchers providing a broad perspective of recommendations on climate change hazards, impacts, vulnerability, adaptation options and policy for five sectors and 18 sub-sectors. CCASTR was supported by the BNRCC project. Document editing and collating was completed by Nigerian Environmental Study/Action Team (NEST) Chair, Professor David Okali and NEST staff Robert Ugochukwu Onyeneke, Ellen Woodley, Brent Tégler and Sarah O'Keefe. NEST and BNRCC would like to acknowledge the extraordinary effort made by all of the authors for their contributions to individual sectors and sub-sectors of the report. Also deeply appreciated are those people in the public and private sectors, including NGO representatives, who assisted in various capacities during the five years of the BNRCC project. All of these efforts – and sacrifices – and the resources expended will enhance Nigeria's capacity to adapt to climate change and we expect they will be of benefit to the service of humanity.

The Reports in this compendium, including the opinions and recommendations presented, are the sole responsibility of the named authors. The BNRCC project, its Canadian Executing Agency, ICF Marbek and CUSO-VSO, NEST and the Canadian International Development Agency which financially supports the BNRCC project, bear no responsibility for the content of the reports, including the opinions and recommendations expressed by the authors.

# Climate Change Adaptation Strategy Technical Report

## Natural Resources Sector

E. Nzegbule - Lead Author & Forestry & Biodiversity Resources  
 J. Ayoade - Water Resources  
 R. Folorunsho - Coastal Resources  
 O. Olukunle - Fishery Resources

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## Assessment of Current and Future Trends

### Sub-sector 4: Fishery Resources

There are abundant near-shore and inshore fish resources in Nigerian waters that include demersal, pelagic and shellfish resources. The total fishing area is estimated at 26,700 km<sup>2</sup> with a potential yield of 201,000 tonnes per year for the inshore waters. The major freshwater rivers and associated habitat are: Niger River, Benue River, and River Rima. The lakes and reservoirs include Lake Chad (Natural) in Borno State, Lake Kainji, Lake Asejire and Lake Eleiyele. In addition, artificial lakes created for electrical power generation, domestic water supply and irrigation have added to the potential fisheries production in Nigeria.

Fishing engages a significant proportion of the labour force in Nigeria, especially in the coastal and riverine areas. It is reported that small-scale (artisanal) marine and freshwater fishing contributes over 90% of the 800,000 tonnes of local fish production (NEST, 1992).

There has been a decline in fish catch in the country's water bodies over the years (from 756,728 tonnes in 1969 to 483,000 tons in 1988). This is attributable to:

- The escalating costs of outboard engines and spare parts;
- the reduction/removal of subsidy on these items by the government;
- the pollution of inland lakes and rivers as a result of oil exploration activities in the Niger delta areas; and
- over fishing as a result of increasing fishermen per unit area.

Variable water levels can also affect fish resources, both natural stocks and from fish farming. Climate fluctuation, such as the late onset of the rainy season (i.e. June instead of March) can lead to delayed fish breeding. As mentioned in the earlier section in this report on Water Resources, according to Ojo (2008), Nigeria's coastal ecosystem and the 3.68 million people which live in these areas, are at risk from a predicted 1.0 m rise in sea level. Also coastal erosion, which is already occurring along the shores of Cross River, Akwa Ibom and Ondo States has implications for the associated coastal mangrove/swamp vegetation and resources.

In addition, more severe water level fluctuations have been observed, including seasonal flooding and drying up of water ways (e.g. Lake Chad has been reduced to less than 50% of its former size). There has been a significant 10-11 metre draw down of water levels in Kainji Lake, resulting in a smaller volume of water for fish production as well as for the generation of hydro-electric power. These changes in the available water resources, which may be linked in part to climate change, have resulted in rising fish prices in Nigeria despite the support given to fish farming by public and private agencies.

Efforts have been made to introduce rural technologies that manage water resources using concrete tanks for fish culture such as the Lagos State experience in Homestead Pond and Cage culture (Ojeniyi *et al.*, 2001; Adekoya *et al.*, 2004; Olukunle, 2004). The supplementing of unreliable rain and surface water can be accomplished by sinking deep wells or boreholes, and more recently, through the use of rainwater harvesting techniques that collect water during the wet season for use during the dry season (Olukunle, 2004).

The problem of spoilage of harvested fresh fish has been addressed through the introduction of improved processing units such as smoking kilns and modified drum and mura kilns that do not depend on scarce and expensive sources of wood, kerosene, and coal, relying instead on electricity, gas and solar power in fishing communities around Kainji Lake, Lake Chad and in Sokoto State. These processing units were supplied by the Federal Fisheries Department to the Catfish Farmers Association of Nigeria (CAFAN, 2009) at a cost of N10,000 per unit. These improved kilns reduce infestation by destructive pests like the *Desmestes* beetle larvae, reduces the microbial load and improves physicochemical and organoleptic (i.e. taste, sight, smell, touch) characteristics of the dried fish products.

## Climate Change Impacts, Vulnerabilities and Adaptation Options

General observations on the vulnerability of freshwater fisheries and capture fisheries to climate change hazards and impacts include:

- Fisherfolk including men, women, youth and children are generally poor, their subsistence livelihoods rely directly on the quantity and quality of water resources and yet they are not engaged in decision making for natural resource management nor do they have ready access to alternative livelihoods;
- Climate change hazards are resulting in greater water level fluctuations from season to season; leading to flooding in the wet season and lowering of the water level or even drying up in the dry season;
- Adaptation options can include integrated fadama (floodplain) farming for growing rice and various vegetables as well as fish culture as has been shown in Kebbi State (FISON, 2007);
- Fisherfolk can migrate to floodplains and basins which provide potential suitable places for aquaculture and integrated fish farming during the dry season and be trained through the Unified Extension System (UES) to manage and control the small amount of water which is available (FISON, 2007);
- Fisherfolk can engage in alternative livelihood options, for example in Oyo State they have become farmers of crops, making mounds for yams for the following year and in the Chad basin they dig for potash which they market economically; and
- Recognition that in some areas overfishing is leading to low fish landings which in turn reduces the income of women involved in fish processing and marketing.

### Climate Change Impacts

Fluctuating water levels through drying and flooding destroy breeding sites of fish species, exposes the products (fry, fingerling) reducing and probably eliminating recruitment of future fish populations e.g. in Eleiyele and Asejire reservoirs there has been reduction in fish landed by fisherfolk. In addition, fluctuating water levels affect fisherfolks' livelihood, because there is less fish/landings for fishermen and for fisher women who process them. Further, the fluctuating water levels affect the economy of the fisherfolk, e.g. in River Numa in Kebbi State and Kainji Lake the fish landings have been declining.

The fluctuating water levels lead to less water for agricultural reservoirs. Flooding leads to the washing away of dikes of ponds associated with aquaculture, a problem that is particularly acute in the southwest of Nigeria. Also, unpredictable flooding periods lead to unpredictable water levels for crop and fish production e.g. *fadama* rice/fish production in Savannah and Sahel ecozones.

Fish physiology is adapted to certain temperature ranges, therefore increasing water temperatures will affect fish by altering physiological functions such as thermal tolerance, growth metabolism, food consumption, reproductive success and ability to maintain internal homeostasis in the face of a variable external environment (Fry, 1971) leading to a reduction of "sterothermal" (narrow thermal range) fish species and an increase in "eurythermal" (wide tolerance range) species. Additionally, increases in water temperature will also decrease water quality by enhancing eutrophic conditions and stimulating explosive growth of aquatic macrophytes. Kankaala *et al.* (2002) found a 2-3°C temperature increase caused a 300 to 500% increase in shoot biomass of the aquatic macrophyte, *Elodea canadensis*. As macrophytes take up the phosphorus in the sediment, the amount of phosphorus immediately available for other primary producers decline, subsequently, macrophytes die and decompose releasing nutrients such as nitrogen and phosphorus into the water column (Cooper, 1996; Kankaala *et al.*, 2002). This in turn leads to depressed levels of dissolved oxygen which can cause fish kills (Klapper, 1991). Floating of rafts of emergent, floating or subsurface also result in decreased wind mixing and increased periods of stratification, conditions that may be unfavourable to fish (Welcome, 1979)

Vegetation cover that favours fish production in wetlands may be reduced because of reduced groundwater levels. Lowered water levels lead to an overall reduction of fish habitat and fish resources and an increase in fisherfolk per unit of available fishing area further depleting resources and lowering fish catch.



## Climate Change Vulnerabilities and Adaptation Options

Presently, fisherfolk are deeply affected by climate change hazards that result in fluctuation of water levels of natural and artificial water resources. The primary areas of vulnerability include:

- The population of fisherfolk per unit area of water surface is generally too high and this increases due to climate change impacts;
- Poverty and low economic power puts fisherfolk at a disadvantage, and favours wealthy intermediate fish buyers who finance the purchase of fishing gears and buy fish landings cheaply to then sell fish at exorbitant prices to consumers who can afford them. Thus fresh fish, as a source of protein, is too expensive for the average Nigerian and a only small income is returned to fisherfolk;
- Government subsidies for the purchase of fishing gears has been discontinued;
- Fisherfolk's financial contributions to fish cooperatives are declining, as such the ability of fish cooperatives to assist them in buying fishing gears is also declining;
- The government undertakes fish restocking in some reservoirs (e.g. Asejire reservoir) but the control of fishing is not effective; and
- Some licensing of fisherfolk was undertaken in Oyo State, however they evaded taking a license and without adequate control the catch per unit effort dwindled as the number of fisherfolk per unit area was high, hence poverty became magnified.

Adaptation options that could address some of these vulnerabilities include:

- The government should provide climate change awareness raising and training in sustainable fishing techniques to fisherfolk through extension officers at the location of fishing activities (i.e. by the reservoir side);
- The government should reinstate programmes that provide partial subsidies in combination with closed fishing seasons to allow fish stocks to recover and this program should be rigorously monitored and enforced; and
- Government, private organizations and NGOs should support fisherfolk to become involved in fish-farming using cages, pen culture and the "adkaja" local method of fish culture on lakes; reservoir and deep reservoirs so that when water level goes down at the edges, the cages and adkaja can be moved to deeper water areas.

## Assessment of Economic Impacts

Developing countries are particularly vulnerable to the impacts of climate change because their economics are generally more dependent on natural resources that are directly affected by climate such as agriculture, forestry, fisheries and livestock. Fish production remains the main source of livelihood for riverside and coastal rural communities where a significant proportion engages in artisan fisheries. Nigeria, along with all countries of sub-Sahara Africa, are considered highly vulnerable to the impact of climate change according to the fourth assessment reports of the Intergovernmental Panel on Climate Change (IPCC) for the following reasons:

- Water resources are under serious threat which in turn will affect fish resources and energy supply, particularly the Kainji and Shiroro reservoirs;
- Changes in rainfall timing, drought and intensity will seriously impact two thirds of the Nigerian population who depend primarily on rain fed agriculture and fishing activities for their food and/or livelihoods;
- Nigeria's existing high population of 140 million people with one of the fastest growth rates in the world, depend on fish as an important local source of protein;
- Capture fisheries is still by far the largest source of fish in Nigeria. Statistics from the Federal Department of Fisheries shows that over 86% of fish production is from capture fisheries, with the other 14% from aquaculture. Most of the capture fisheries is done by artisanal fishermen who live along the coastline of Nigerian fishing within continental shelf areas and along the banks of major rivers in the country;
- People involved in artisanal fisheries are generally involved in small scale fishing operations holdings with some people involved in as fishermen, some as fish processors and fish sellers and others as part of the allied industry of gear and boat making and mending;
- Climate change will affect the livelihoods of those involved in various aspects of small scale fishing operations; and

## Assessment of Gender Considerations and Interactions

- Climate change may also impact species diversity of aquatic systems and terrestrial species that are dependent on the health of aquatic systems.

Climate change, with the attendant lowering of water levels in waterways, reservoirs and natural lakes and flooding that affects the major rivers, will reduce available fish stocks and fish catches thereby impacting the livelihood of persons related to fisheries. The impacts on both genders include:

- Both men and women fisherfolk will be able to provide less food and income for their families;
- Women fisherfolk will face additional challenges as they have less access to credit to purchase fishing gears and are less able to travel to deeper water to fish;
- Fish processors, who are most often women, will have less fish to process to earn income from; and
- children that rely on fish protein for nutrition and growth will have less fish available for consumption.

Table 10 provides a summary of the climate change hazards, impacts, vulnerabilities and adaptation options.

**Table 10** Hazard-Impact-Vulnerability-Adaptation Matrix for Natural Resources: **Fishery Resources Sub-sector**

| Climate Change Hazards  | Climate Change Impacts  | Determinants of Vulnerability  | Adaptation Options  |
|---|---|--|---|
| Ecozone: ALL  |   |  |   |
| <ul style="list-style-type: none"> <li>■ Increased aridity from temperature increase</li> </ul> | <ul style="list-style-type: none"> <li>■ drying up of waterways, drawing down of water levels in reservoirs and wetlands and ground water</li> <li>■ loss of biological diversity of fisheries resources due to habitat degradation (e.g. fish, clams, water snails, etc.)</li> <li>■ loss of sources of livelihood</li> <li>■ shortage of fuel wood for smoking fish</li> <li>■ lower water level in reservoirs</li> <li>■ water quality for fish declines because less water flow and less amount of water for dilution of nutrients</li> <li>■ lowered groundwater levels cause reduction in vegetation cover along margins of wetlands</li> <li>■ increase in aquatic vegetation (e.g. water hyacinth) along the edge of waterways</li> <li>■ pollution/eutrophication of fresh water through the decay of aquatic vegetation and animals trapped in areas of lower water levels</li> <li>■ reduced groundwater available for fish culture</li> </ul> | <ul style="list-style-type: none"> <li>■ high poverty levels</li> <li>■ prohibitive cost of protecting habitat and infrastructure: fishing gear is expensive</li> <li>■ lack of financial resources to use coal and smoking kilns</li> <li>■ not enough Fish Extension Officers employed by government</li> <li>■ people no longer manage fish resources effectively (e.g. closed season, type of gear used)</li> <li>■ lack of education and use of traditional knowledge to manage fish resources</li> <li>■ competition for groundwater for drinking, for agriculture and for fish farming</li> </ul> | <ul style="list-style-type: none"> <li>■ alternative livelihoods (e.g. farming of crops, aquaculture, trading etc.)</li> <li>■ where natural water bodies and fish resources declining switch to aquaculture</li> <li>■ refinement of early warning and monitoring systems (e.g. meteorological, water levels, fish catch) to improve fish resource management</li> <li>■ research into alternative fish processing strategies e.g. utilization of solar energy</li> <li>■ fish cooperatives should be encouraged</li> <li>■ physical harvesting and chemical destruction of macrophytes e.g. water hyacinth. Alternative utilization of weeds</li> <li>■ dredge silted water ways</li> </ul> |

## Review of Existing Governance, Policies and Programmes

### Role of Government at Federal, State and Local levels

The fisheries sub-sector is governed by a directorate at both the Federal and State levels headed by the Minister of Agriculture and Commissioner respectively. At the Local Government Agency level, fisheries are addressed under Agriculture.

At the federal level, there are field officers who supervise federal programmes on data collection associated with reservoirs, rivers, aquaculture and cooperatives. Fisheries policy addresses factors such as:

- Afforestation of wellands;
- Recycling of nutrients from aquacultural recirculation systems
- Prevention of soil erosion; and
- Integrated aquaculture of flooded rice and fish production, poultry and fish production etc.

Currently at the state level, the Departments of Fisheries are not educating fisherfolk on climate change, though when the Department of Fisheries was contacted in the course of the preparation of this report, they expressed a willingness to provide climate change information to them if they are provided relevant training. Institutions such as the University of Ibadan do encourage academic seminars and lectures to create climate change awareness.

### Role of other Stakeholders such as NGO's and Private Sector

Workshops, such as those organized by the BNRCC project, can be organized to collect information and to bring awareness to government regarding climate change including information from international sources. Private companies such as Ajanla Farms, Zartech and Durante are involved in the production of fish and can demonstrate how they have introduced water recirculation systems that economize water use while also producing a large quantity of fish in a small space.

### Role of Community Initiatives

The fisherfolk, fish processors, and fish marketers constitute the most direct stakeholder in the fisheries sector and community-based initiatives related to climate change adaptation need to be encouraged.

People engaged in the fisheries sector need to be taught scientific and technical innovations that will assist them in adapting to climate change hazards. Community-based adaptation options could include:

- Integrating and expanding local knowledge of adaptation techniques that can be integrated into development initiatives to help communities adapt to climate change hazards;
- Assisting local communities with the purchase of fishing gears because of their vulnerability. They could be given 'soft loans' and supported with subsidies;
- Local communities should be assisted to organize themselves into groups or cooperatives to better develop adaptation strategies for climate change; and
- Fishing communities could be made more aware of and assist in the development of early warning mechanisms to protect themselves from natural hazards (NEST, 2003).

## Recommended Climate Change Adaptation Actions

Recommended policies, programmes for adaptation are presented in Table 11. An evaluation of these is presented in Table 12.

**Table 11** Policies, programmes and adaptation options addressed and implementing agency:  
Fishery Resources Sub-sector

| Recommended/<br>Suggested CCA Policy<br>Actions           | Proposed CCA<br>Programmes  | Ecozone<br>Addressed by<br>Proposed Policies<br>and Programmes | CCA Options Addressed<br>by Proposed Policies and<br>Programmes  | Implementation<br>Agency (s)  |
|---|---|--|--|---|
| <b>Immediate Needs</b>                                    |   |  |  |   |
| 1. Climate Change Awareness Policy                        | <ul style="list-style-type: none"> <li>■ Educate and create awareness of the implications of CC to fisheries (e.g. water level changes in waterways and watershed)</li> <li>■ Communicate through workshops, radio, seminars of the effect of CC on water resources</li> <li>■ Assess vulnerability of communities to CC hazards</li> </ul>   | All Ecozones   | <ul style="list-style-type: none"> <li>■ CC awareness should make people consider what are the CCA options they may need to implement to address CC hazards</li> <li>■ Alternative livelihoods (e.g. farming of crops, aquaculture, trading etc.)</li> <li>■ Where natural water bodies and fish resources are declining, switch to aquaculture</li> <li>■ Fish cooperatives should be encouraged</li> </ul> | <ul style="list-style-type: none"> <li>■ Federal Government and Universities involved in training Field Officers</li> <li>■ State Government Fisheries Officers</li> <li>■ Stakeholders (e.g. CAFAN Catch Fishers Association of Nigeria)</li> <li>■ NGOs</li> <li>■ Private Sector, Individuals</li> </ul> |
| 2. Climate Change Monitoring Policy                       | <ul style="list-style-type: none"> <li>■ Waterways monitoring and data collection program for fisheries (e.g. water levels, water quality and fish landing quantity and quality, type of gears used etc.)</li> <li>■ Train field officers to collect reliable data</li> <li>■ Train agents or field officers to make reliable forecasts</li> <li>■ Train stakeholders in risk perception and decision-making</li> </ul> | All Ecozones   | <ul style="list-style-type: none"> <li>■ Refinement of early warning and monitoring systems (e.g. meteorological, water levels, fish catch) to improve fish resource management</li> <li>■ Physical harvesting and chemical destruction of macrophytes (e.g. water hyacinth).</li> <li>■ Alternative utilization of aquatic weeds</li> <li>■ Dredging of silted water ways</li> </ul>                        | All stakeholders  |
| 3. Watershed Management Policy                            | <ul style="list-style-type: none"> <li>■ Afforestation</li> <li>■ Waterways &amp; dam management</li> </ul>   | All Ecozones   | <ul style="list-style-type: none"> <li>■ Research &amp; alternative fish processing strategies (e.g. utilization of solar energy)</li> <li>■ Dredging of silted water ways</li> </ul>  | All levels of government & all stakeholders   |
| <b>Long term Needs</b>                                    |   |  |  |   |
| 1. CC Monitoring Policy<br>2. Watershed Management Policy | <ul style="list-style-type: none"> <li>■ Programmes noted above should be continuous long term programmes</li> </ul>  | All Ecozones   |  |   |

**Table 12** Evaluation of Proposed Policies: Fishery Resources Sub-sector

| CCA Options Addressed by Proposed Policies & Programs            | Criteria to Evaluate Effectiveness of Policy Implementation   | Implications if Policy IS Implemented (individuals, communities, private sector)   |                  | Implications if Policy NOT Implemented (individuals, communities, private sector) |  |
|--|---|--|------------------|---|--|
|  |   | Positive Impacts   | Negative Impacts | Positive Impacts  | Negative Impacts   |
| <b>Immediate Needs</b>   |   |  |                  |   |  |
| Climate Change Awareness Policy                                  | <ul style="list-style-type: none"> <li>■ Level of awareness in government circles, among stakeholders and the public</li> </ul> | <ul style="list-style-type: none"> <li>■ Individual communities and private sector have relevant information to handle CC hazards</li> </ul> | None             | None  | <ul style="list-style-type: none"> <li>■ The status quo is maintained or the situation gets worse</li> </ul> |
| Climate Change Monitoring Policy                                 | <ul style="list-style-type: none"> <li>■ Number of monitoring programmes in place</li> </ul>                                    | <ul style="list-style-type: none"> <li>■ Ability to predict CC hazards accurately</li> </ul>   | None             | None  | <ul style="list-style-type: none"> <li>■ Fisheries resources lost</li> </ul>                                 |
| Watershed Management Policy                                      | <ul style="list-style-type: none"> <li>■ Number of monitoring reports prepared</li> </ul>                                       | <ul style="list-style-type: none"> <li>■ Improvement of all resources including fisheries</li> </ul>   | None             | None  | <ul style="list-style-type: none"> <li>■ Watersheds destroyed</li> </ul>                                     |
| <b>Long Term Needs</b>   |   |  |                  |   |  |
| Programmes noted above should be continuous long term programmes |   |  |                  |   |  |

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