Tentative Implementation of an Ecosystem Approach to Guinean Fisheries

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Abstract

A project is described which aims at establishing the means necessary to develop fisheries based on ecosystem respect in Guinea, a West African developing country. The general purpose of the project was not to provide the "solution" but rather to elaborate and make available the background necessary for Guinean stakeholders, at large, to jointly wish, define and conduct an Ecosystem Approach to Fisheries (EAF).

The Guinean context was such that implementation of the EAF had to be done from the very start. The first step consisted in elaborating a national skill in scientific monitoring and understanding of both the ecosystem (including a sustainable, i.e. at low cost, coastal monitoring) and the socio-economic context. Various tools (information system, monitoring system, simulation tools) have been developed to support and integrate knowledge and indicators. These tools should be able to transmit information to a diversified set of target groups, including illiterate stakeholders. In parallel, a bi-directional relationship has been constructed between research and stakeholders.

This process, involving meetings, exhibition, investigation, participative approach and consultation aimed at establishing a common information platform in which information could be exchanged, discussed and used as a basis for elaborating a "shared awareness" of the ecosystem role in definition of a sustainable fishery sector.

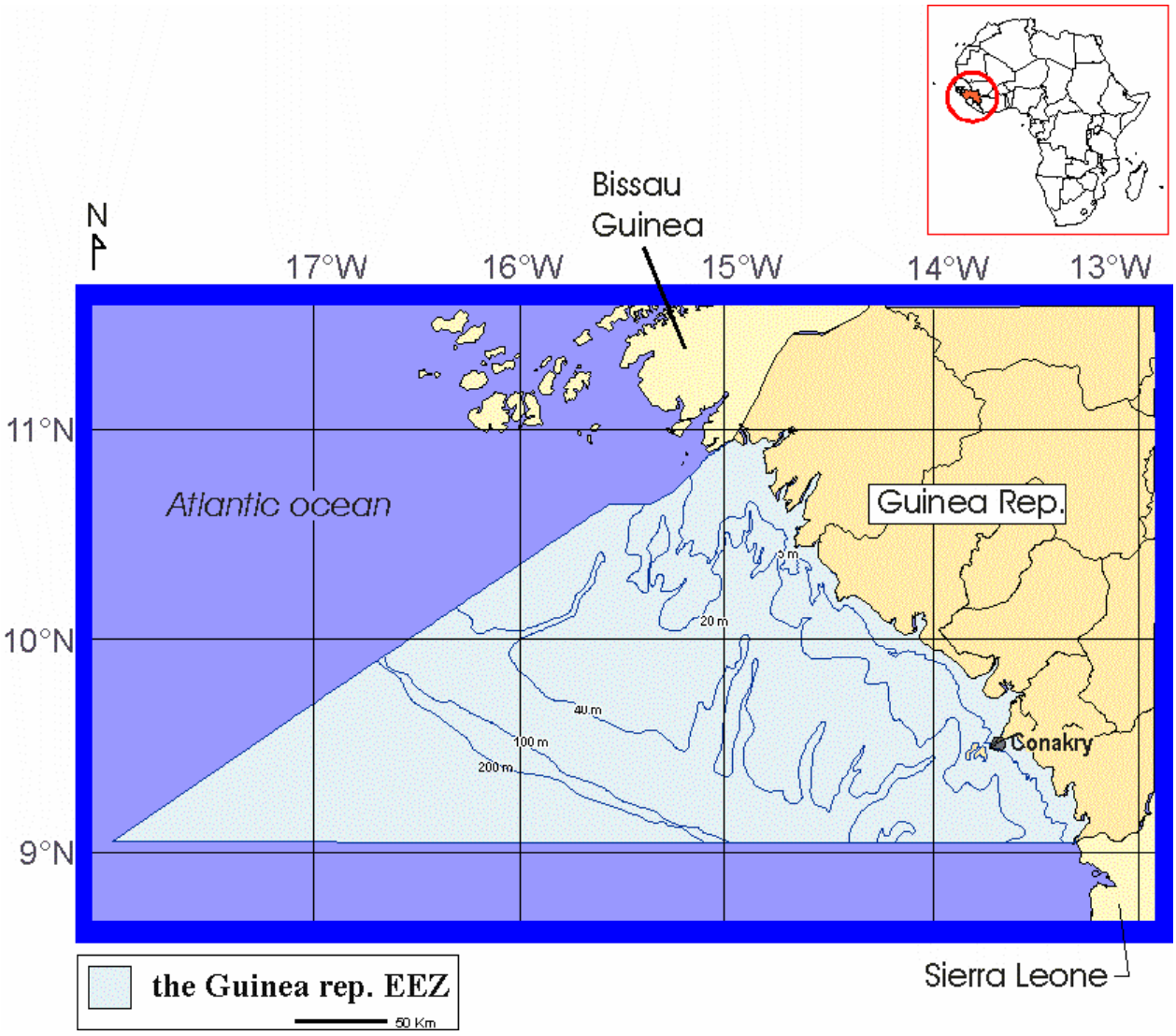
The whole project resulted in a diversified interactive set of research and engineering operations, all integrated and oriented toward the EAF development objective. Results and mid-term perspectives of the whole project are presented and discussed.

Introduction

Fisheries carry many hopes for development in Guinea republic, a West African developing country (figure 1). These hopes cover population needs for food, industry development, labour market or contribution of the sector to the gross product (Orstom-CNSHB, 1998). While production regularly increases, abundance indices for demersal fishes are a tenth of what they were in 1985, when the stock remained almost unexploited (Domain, 1999). Moreover, on the social side, harmful interactions occur between industrial and small-scale fisheries, industrial fishery is widely composed of foreign fleets, small-scale fishery is recognised as a poverty sector, etc.

Though developing, marine fishery thus does not fulfil the hope as Fontana (1999) estimated that the benefits retrieved from a more rational management of marine resources could be doubled. Reaching such an objective supposes a significant change in the way the sector behaves. In this sense, the Ecosystem Approach to Fisheries, or EAF (e.g., Garcia et al., 2003) appears an interesting, among a few, alternatives.

Figure 1: location of the study: the Guinea maritime region and the EEZ delimitation.



The present study is concerned with implementing such an approach in a developing country context. It aimed at establishing, as an exploratory first step, the more adequate environment for the EAF paradigm shift to occur. To do so, the study focused on the research sub-sector as an entry to develop the fishery sector. The study then aimed at the development of a scientific and technical environment producing information and knowledge. The information and knowledge thereby created were tentatively made available to various component stakeholders (management stage, processing stage, research) in the development of the fishery sector.

The methods and protocol used constitute the main part of the work presented. The results obtained with each method are presented and discussed. In the description, focus has been often put on the natural ecosystem thematic but the same effort has been realised on the socio-economic side.

Materials and Methods

Paradigm shift:

In this study, implementing an EAF has first been translated into the two following "paradigm shifts" or "predicates".

1. marine resource is no more a set composed of the commercial stocks that can be potentially harvested. The exploitable resource is rather the marine ecosystem per se, and its ability to produce harvestable stocks.

   Therefore, understanding, management and protection must focus on health or integrity of the ecosystem rather than on the ones of the various stocks.

2. From here, establish a shift from "sea harvesting", i.e., extracting what is needed, to "sea using", i.e., benefiting of what is provided/given. This second shift ought to reconsider the way fishing industry (small-scale included) could be allowed to realise its activity in Guinea.

These two "predicate" appeared sufficient in the context to encompass, under an understandable form, almost all of the topics concerned with understanding and management of fisheries through the ecosystem.

Field limits: trying to elaborate the means of a judicious use of the marine ecosystem supposes, and this constitute the first difficulty, to encompass a very wide domain, even when restricted to the Guinean situation.

Indeed, in the promoted approach, management based on respect of the ecosystems is, in the long term, devoted to the socio-economic development of the fishery sector in Guinea. An important issue of the approach therefore lies in the fact that the EAF perspective has to deal both with the ecosystem and its constitutive complexity but also with the particular society which, more or less directly, gets its livelihood from it (Arnasson, 2000, Jin et al.,2003) :

- The marine ecosystem has been considered as a coherent set of interacting elements whose development is conditioned by the efficiency of its trophic web, given the physical specificity of the Guinean marine, coastal and estuarine environments (namely a large continental shelf, a strong seasonal change in salinity due to a heavy rainy season, an important source of nutriment provided by the swamp which spread all over the coast (Domain et al., 1999, Colomb et al., 2004)).
- On the other side, the ecosystem productivity depends on the correct function of the society that uses it (the human and social component notably constitute the only possible lever to modify the relation between the productive environment and the socio-economy). The domain component are the various operators which intervene in the fish channel dynamics, from fishermen to consumers, and including administration, supervision, research, NGO, investors, etc.

Knowledge and advice on each of these components should be therefore available for sounded management.

Method: Research has been felt as the appropriate focal point for spreading and keeping the EAF going in an objective and documented way. In this study, Research should for this purpose fulfil five main objectives :

1. covering the whole field needed to account for EAF, this supposes designing an adapted, integrated and sustainable research system,

2. being able to realise field survey in the long term,
3. elaborating synthetic tools versatile enough for stakeholders to get and use the acquired knowledge in view of the sustainability objective,
4. gathering representative stakeholders around this common set of information, looking for ecosystemic viable scenarios,
5. construct a permanent bi-directional relationship between fishery science and the rest of the fishery sector for a mutual exchange of knowledge and advice.

To ensure information and advice on structure and dynamics of the fisheries, the Guinean government, through its fishery ministry, founded, at the beginning of the nineties, a research centre dedicated to survey of the fishery sector in this country: the "Centre National des Sciences Halieutiques de Boussoura" (CNSHB). This centre has been retained as the focal point for the implementation with an help coming from The "Centre d'Études et de Recherches Scientifiques de Conakry-Rogbané" (CERESCOR) a more generic public research centre with a department devoted to oceanic sciences.

Implementation and coordination has then been tentatively realised around the five main objectives.

Design of a sustainable research system adapted to deal with complexity.

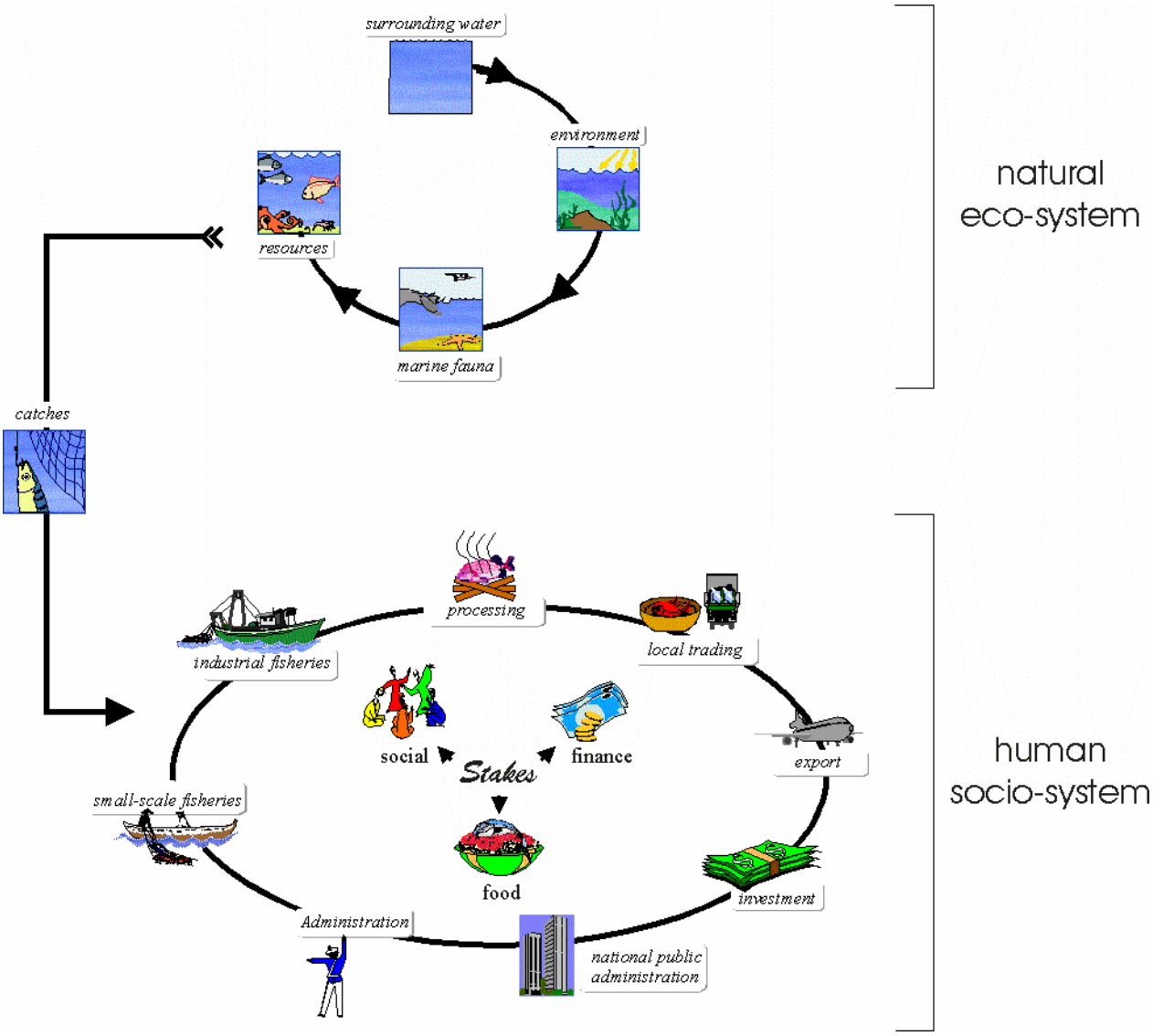
Accepting complexity of the field studied (Loehle, 2004) necessarily implies to account for diversity at any level (structural, functional, perceptual) and domains (natural, social), spatial heterogeneity and diversified dynamics (history, crises, phases, regimes, etc.), multiple and composite interactions, nested functional levels, etc.

This set of constraints leaded to definition of a research "system" composed of thematic operations covering science and engineering, surveys, analysis, tool development, etc. The research system has been designed so as to cover most aspects of the system's dynamics and structure, from fish production by the sea to fish food consumers needs (Figure 2). This strategy was retained as exploratory since no particular structure or component of the ecosystem was to be *a priori* privileged. For the ecosystem part for example, the initial structure was based on the biotic groups mainly gathered by similar trophic levels (e.g., plankton, top-predators).

The research system has been elaborated step by step, on the basis of an internal call for proposal, by adding new partners and research fields. Each new components added to the research provided new meaning to the whole system and new potential way to explore. On the other hand, an unfruitful operation could be removed without endangering the research system. As far as the project progressed, the composition of the research system evolved by exploring new aspects (e.g., pollution aspects, site specific studies) and conforming the system towards more coherence.

Figure 2: functional limits for the study.

The study is concerned with the development of the fishery sector. This implies studying the co-viability of both the social system and the natural system in a wide range of topics. The upper part represent the main natural components where knowledge is necessary for understanding productivity and supply for resources. The lower part represent the social system, composed of various stakeholders whose activity and global development is conditioned by several common global stakes such as richness, social peace, food supply. Both parts are characterised by a diversified set of components. Finally, one have to look closely to the interface between the two, mainly figured by the fishing activity.



Elaborating sustainable, low cost, surveys of the environment

In the same way a complete integrated field survey had to be made available. Considering the resource component, the previously existing approach consisted of scientific trawl surveys, using foreign vessels and, recently, a new ship provided by Japanese Agency for International Development. These "standard" oceanic surveys provide the species abundance indices all over the EEZ. This indicator is currently the only indicator used to evaluate the situation of the exploited stock. Despite its irreplaceable usefulness, this approach has some drawbacks which are mainly the high cost of the indicator, particularly for a developing country, uncertainty on the boat availability and the survey area restricted to the open sea (whereas the

coastal area is well known as the most productive one). Moreover, using the only abundance index could not be sufficient for a thorough assessment of the ecosystem state on the long term.

Monitoring the ecosystem health and integrity supposes the elaboration of a survey system which can be realised regularly and on the long term which, especially in the Guinea context, means at the lowest cost. For this purpose, two approaches have been developed to complement the existing ones.

The first approach was based on collecting the operators knowledge. Indeed, fishermen, through their daily practice, own a diversified and integrated (Johannes, 1980) knowledge on the ecosystem and the resources which live in it. Protocols have been tested with small-scale fishermen to obtain and validate knowledge on resource location, behaviour, spatio-temporal availability, feeding habits, etc.

The second approach consisted in fitting out a coastal speedboat, able to enter mangrove habitats, and equipped so as to realise various types of sampling. In each surveys, two boats of this type have been deployed. The whole has resulted in multi-disciplinary samplings of water, plankton, benthos, fishes in area of interest such as potential marine protected areas. The daily cost was lowered by factors of five to ten compared to the oceanographic ship use.

Developing tools to integrate knowledge and make it available to stakeholders

Two paths have been explored here: one oriented towards returning the most possible of the available information, the other aiming at a global understanding through integrating knowledge in a dynamic way.

The first tool, considered as a bottom-up approach for information, took the form of a versatile information system. It is based on (i) object oriented and internet (xml, java servlets) programming as well as (ii) modeling typology. The software makes it possible to store and return any kind of information whatever its content and whatever its medium (picture, graph, data, map, drawing, text, etc.). The "Centre d'Information" as it is called is based on meta-information (i.e., information descriptors) management. It allows the user to jump from one concept to the other by means of hypertext keywords associated with the information displayed. The information kept in this system have also been made available through manuscripts, posters, the web.

The second tool consisted in developing a modelling framework that could integrate knowledge coming from the various works realised in the "research system". The advantages searched for in simulations were the ability to formally put in dynamic interaction a diversified knowledge. The model, based on multi-agent programming, formalises the maritime region of Guinea and its EEZ (Figure 1), the physical aspects of the continental shelf, the biotic characteristics of the main group studied, fishermen and traders, etc (Colomb et al., 2002). Each element is spatialized in 3D for the oceanic part and put in interaction with the others. The model has been developed in order to integrate any new knowledge (on a given biological group for example) in the model database with the slightest modifications.

Establishing a mutual relationship with the actors and operators of the sector

In parallel to the development of research and tools, a structure was constituted as a possible link for consultation between research and the actors of the sector. The Monitoring and Orientation Committee (MOC) is composed of eight members representing : small-scale and industrial fisheries, processing, trading, export, administration, investment and research. The

MOC could share information on a given subject, guide research activity towards new trends, debates on particular subject of interest.

Return and communication about the activity which have been realised

To cope with knowledge on complex ecosystem, socio-system and their interactions, research and stakeholders have been put in relation through a diversified set of initiatives, namely,

- open days on fisheries research and activities where the most concrete result was that fishermen became aware of what survey was, which has been considered as a little but compulsory step,
- a web site with research contents. In the web page initiative, the public targeted was mainly the foreign investors and research teams.
- temporary mobile exposition at the small-scale fishery landing sites and the fishery administration: given a theme, a set of A3-size posters where extracted from the information system, protected from sea spray, and exposed. The main objective for these expositions was to touch illiterate stakeholders. During the exposition, actors were gathered and the posters were explained by a member of the scientific project.
- The last step at date was the organisation of a national colloquium, where most of the national, regional or international stakeholders of the Guinean fishery sector were represented. The reunion objective was to present what research could do and know about society, nature an their co-viability. The main question was however to ask stakeholders if research activity was worth going on given the results produced.

Results

Research system: At the end of the study, depending on the proposals and feasibility, a coherent set of thematic operations had been formalised, realised or terminated. For the example of the ecosystem part, the following aspects were covered :

- Knowledge and understanding of the ecosystem compartment at the basis of the productivity : hydrodynamics, phyto- and zooplankton, benthos, fish nurseries.
- Knowledge and understanding of top predators for purpose of exploitation and/or conservation such as sharks and rays, mammals, tortoises, seabirds, etc.
- relationships between fisheries and ecosystem traits such as spatial reaction of fish communities, evolution of the various targeted resources (demersals, pelagics, tunas, shrimps).
- human activities other than fisheries and their consequences on the marine ecosystem comprising urban pollution and parasitism of harvested fishes
- Conservation activities such as marine protected area identification, or endangered species monitoring.

It can be noticed here that this description do not account for operations concerning the socio-economic aspect of the fishery sector nor the other technical operations. The global approach, which included the natural and social research themes, gathered a set of fifty operations.

The growing operations' diversity conducted to a versatile research system which, by gathering appropriate operations, permitted to multiply the groups that could be constituted (e.g., productivity, fisheries, plankton, conservation, apex predators, etc.) and thereby explore

various themes. Moreover, reactivity of research towards stakeholders' needs proved efficient since various operations could be combined to account for new arising themes (e.g., MPA monitoring)

Ecosystem survey: The coastal boat survey permitted to establish reference points for three of the main estuaries of Guinea. Each estuary has been sampled at rainy and dry season, with samplings realized in the river, at the mouth, and off the coast. At each station, multi-disciplinary samplings were realised such as speed and direction of currents, phyto, zoo, ichtyo, -planktons, benthos and fish diets. The surveys and laboratory analysis were almost entirely realised by Guinean scientists.

In parallel, traditional ecosystem knowledge of the fishermen permitted to elaborate precise maps of the reproduction areas for some local mangroves as well as obtaining detailed information on reproduction season or on the various types of mud and their associated fauna on the coast of Guinea. It was also possible to rebuild some part of the food webs following fishermen advices. Good agreement was obtained when results were compared with equivalent scientific studies.

Information tools: The information system was available on several mediums including internet. The computer version provides the ability to navigate between various concepts from one information to the other. Each time a new information is provided, the number of concepts is increased and put in relation with the others. On the mid-term, knowledge integration can become ever more effective.

The ecosystem-society simulator, still in progress, could not yet provide valuable insight on the combined dynamics. Nevertheless, this kind of tool should constitute a complementary mean to integrate diversified knowledge.

Relationships with stakeholders: The "Monitoring and Orientation Committee" quickly appeared as a source of mutual enrichment between research and stakeholders, and in a more general crossed manner between each other representative. Despite their occupation, most of the members attended to the committee sessions. At the same time, the structure appeared potentially powerful since it was solicited several times and by various decision stages. Despite a short experience, the potential of a common platform for information for elaborating consensus on management scenarios clearly emerged with the MOC. For example, during the validation process of the information system, various information was provided to the MOC. The committee found there a basis for discussion of some problems in the fishery sector.

Return and communication : From one year to the other, the number of stakeholders visiting or having any relationship with the projet and the research centre increased. Communication thereby slowly but regularly improved, the word "ecosystem" appeared more often in speeches but not enough to lead to any concrete measurable action.

During the national colloquium, attendants could have a broad view of the sector complexity, the diversity of problems to deal with (apart from their own) and the intermediate role research could play. Society problems exposed were more discussed, but decrease of resource abundance appeared a key problem to every one.

Discussion

In the literature, each separate aspect of the implementation described have been developed with great efficiency in other places. Indeed, various studies presenting high quality results

have already been conducted on ecosystem knowledge understanding (Cury et al., 2003), efficient links between research and fishermen (Wiber et al., 2003), research organisation (Parsons et al., 2003), or even on integrated implementation (Witherell et al., 2000). The situation in the present study was to encompass all the possible steps with the more possible aspects, even at the price of a lower quality in the results obtained, and beginning for the very start. Several objectives were pursued in doing so:

- develop and keep at the disposal of Guinean actors all the necessary skill, tools and methods for an EAF implementation, and this in the short period dedicated to the study.
- explore all possible aspect of the EAF implementation and in this way give the ability to choose which ones could work best and which could be abandoned, in the context and with the means available in Guinea.
- develop (or "scan"), a one unique scheme containing all the aspects needed in order to evaluate if EAF could be considered as a feasible approach in the context. From the results obtained, it sounds that not only EAF can be developed in Guinea but that immediately coping with an ecosystem approach to fisheries could speed up the development process compared to going on with a "traditional" fishery management which is now criticised in many aspects. The stakes for Guinea sector are important enough to consider this possibility.
- Develop the process furthest as possible to provide a general idea of the amount of work to do, the means necessary at each time step so as to determine the opportunity or not to enter such a process and how to enter.

Conclusion

The present study was concerned with gathering and making available the means necessary to establish a sustainable ecosystem approach to fisheries in Guinea. An integrated and diversified set of thematic operation lead to a coherent research system, with the ability to adapt to new theme or question. A low-cost multi-disciplinary sampling apparatus and protocol have been associated to this system. Information tools have been developed which facilitated the integration of knowledge in the perspective of their diffusion. A participative approach was also elaborated which took the form of a monitoring committee. This structure provided a mean for more efficiency in the research process and efficient consultations within the fishery sector. Finally, the broadest communication and diffusion permitted to enhance relationships between stakeholders of the sector. The effects observed confirmed the potential role of research as a focal point where integrated knowledge and information could be objectively shared and discussed.

Progress obtained in a few years' project can be only considered as the possible first step of a longer process. Nevertheless, on the mid-term, the research sub-sector appears as the adequate entry for a robust implementation and spread of a future Ecosystem Approach to Fisheries.

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