



PSIP
Vulnérabilité des
zones littorales et
changement global

**International Workshop for a Multidisciplinary Research Programme
on the Vulnerability of the West African Coast – Final Report**

5-7 March 2019, Saint-Louis, Senegal

**PSIP -LITTORAL
March 2019**

5 March – 2:30 pm: Opening – Frédéric Ménard (Director of IRD OCEANS)

Thanks to the participants and their institutions:

Cheikh Anta Diop University (UCAD)
Gaston Berger University (UGB)
Nangui-Abrogoua University
University of Cape Coast
University of Douala
University of Abomey-Calavi
University of Thiès
Federal University of Technology
University of Ghana
National Centre for Scientific Research (CENAREST)
Ecological Monitoring Centre (EMC)
Institute of Fisheries and Oceanological Research of Benin (IRHOB)
Scientific Council of the Banc d'Arguin National Park
Ivorian Centre for Economic and Social Research (CIRES)
CNAP (Geoazur)
French Research Institute for the Exploitation of the Sea (IFREMER)
National Centre for Space Studies (CNES)
Mercator
Marine Hydrographic and Oceanographic Service (SHOM)
Geological and Mining Research Bureau (BRGM)
French Ministry of Foreign Affairs (French Embassy in Senegal)

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Objective of the workshop: build a project together that broadly involves stakeholders from the beginning as well as potential donors, while remaining open to new partners for integrations during the project's development. This workshop is a step with a deliverable to be produced, i.e. a project document. The writing of this document will be continued after the workshop through the engagement of task forces identified during the workshop.

General presentation of PSIP - LITTORAL - Rafaël Almar (PSIP-LITTORAL team)

Environmental hazards, anthropogenic pressure, developing generic methods.

PSIP-LITTORAL is a program that proposes to take into account and examine vulnerability and vulnerability factors concerning all processes and elements of the eco-socio-system, such as: physical phenomena such as erosion and retreat of the coastline, strong swells and submergence, subsidence, migratory flows, anthropogenic pressures, inappropriate coastal management, ecosystem degradation, dune fragility, uncontrolled urbanisation, overexploitation of living resources and aggregates, competition for land use, conflicting sociological aspects, protection policy difficulties, tensions between conservation and development (fisheries, agriculture and tourism).

The program will be implemented in areas where the stakes are high and where important IRD experiments already exist in relation to partner scientific communities. This is the case in West Africa and the Gulf of Guinea. The strategy is to mobilise existing scientists, experts, data and knowledge, while preparing to collect new data and increase knowledge where scientific barriers exist.

One approach could be to establish a regionally feasible multi-scale study model that incorporates all physical, ecological and social vulnerabilities. And one aim would be to use such model as basis for making recommendations in terms of governance. The necessary research actions include:

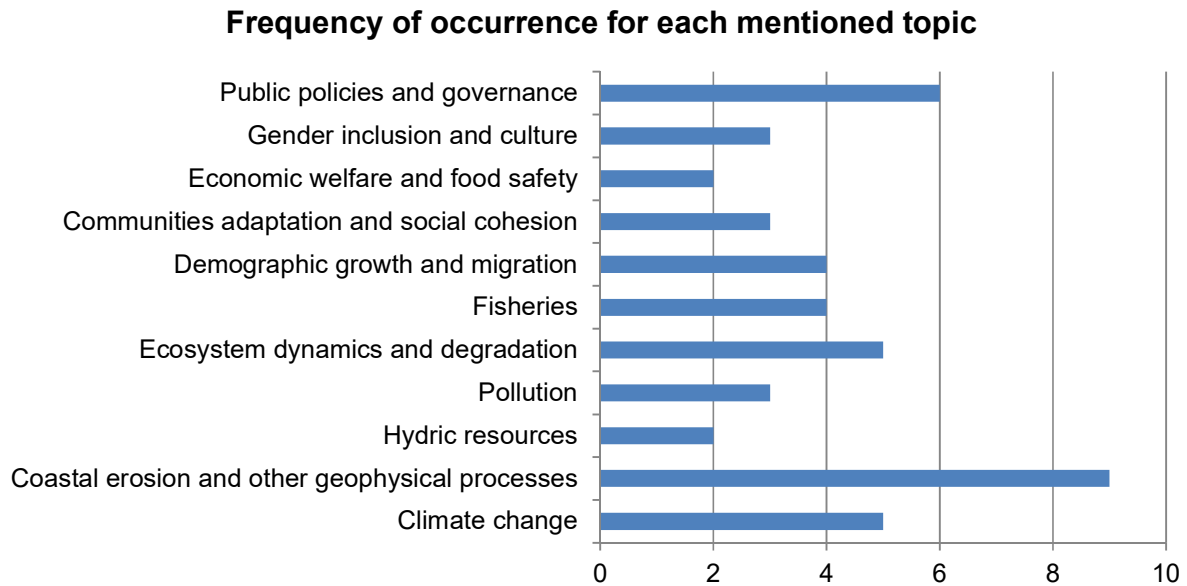
- Improving the quantification of geophysical hazards: spatial approach, numerical modelling, observation networks
- Ecosystem and social studies in pilot sites, with field data collection
- The integration of the data and knowledge in 1 and 2 into one or more models
- The use of data, knowledge and model results to strengthen the adaptive capacity of societies, including the security of populations, goods and activities.

Presentation of the results of the consultation - Bruna Alves (PSIP-LITTORAL team)

A consultation was held prior to the workshop with invited participants. This consultation aimed to identify the expectations of the scientific partners and their willingness to engage in this project. This included gathering ideas on research priorities for the West Africa and Gulf of Guinea coastal zones and on desired research strategies that were considered effective.

Out of 40 researchers contacted, 16 responses were obtained. Fourteen out of 16 researchers recognised the need of a scientific project combining a local and regional approach. Thirteen out of 16 researchers believed that it is relevant to develop an integrated model to achieve a global vision of coastal vulnerability. The most frequently

mentioned topics and themes, because they represent significant stressors or problems, are as follows:



Presentation of the workshop program and working groups - Pierre Morand (PSIP-LITTORAL team)

Wednesday morning session, March 6, was presented and explanation on the working groups was given.

1. Working Group 1: Geophysical Themes - Guillaume Dodet (IFREMER) and Donatus Angnuureng (University of Ghana)
2. Working Group 2: Biological and Chemical Themes - Philippe Cecchi (IRD OCEANS) and Jean-Daniel Mbega (CENAREST)
3. Working Group 3: Themes in Socio-Economics, Perception and Governance - Jeanne Riaux (IRD DISCO) and Boniface Komona (CIRES)
4. Working Group 4: Tools and Models for Integration and Remediation - Frédérique Seyler (IRD DISCO) and Zacharie Sohoun (IRHOB).

Composition of groups and terms of reference are shared in Appendix 2 and 3, respectively.

The terms of reference for each of the first 3 working groups required the following points to be addressed:

- A. Which phenomena and scientific issues should be addressed as a priority?
- B. What working methods and approaches should be adopted?
- C. Concerning A, highlight the links with the other working groups.
- D. Who are the volunteers leading the project proposal writing?

Working Group 4 (Tools and Models for Integration and Remediation) had specific terms of reference assigned.

5 march – 4 pm: Questions and Answers Session

Juliette Mignot (IRD OCEANS)

Question: What is the expected financing for this project?

Answer: First of all, we must recall the World Bank's WACA (West-Africa Coastal Areas Management Program) initiative, where the tasks are well identified but a priori not very focused on research and improving knowledge. However, World Bank and AFD have been invited here as potential donors and our workshop should, among other aims, interest them and, if possible, convince them to engage in research support. This is not impossible if research activities are proposed on areas where there are currently scientific obstacles. The World Bank's attitude is rather interesting since it recently invited IRD to Rotterdam to participate in the definition of the first-year agenda of the WACA Knowledge Pillar. So, this workshop is expected by WACA. This is why we can be ambitious in starting the project.

Cyril Maman (French Embassy in Senegal)

Presentation of "One Planet Summit" that will bring together heads of state in Nairobi in March 2019 to discuss financing on environmental issues. Many investors will be present, WACA will be there, and we need to coordinate to get messages across.

Question: Challenge between fundamental science and operability of the project.

Answer: There is a double challenge: that of the modeler and that of the transfer to society and to solutions.

Question: There are national specificities, how can they be taken into account?

Answer: We will try to produce a model that aims to be regional, but we will not say that the research will regionalise it entirely during the project, i.e. deploy it with all the necessary data.

Session 1 – Round-Table: Ideas for the framing of the future project: Alioune Kane, Allassane Outtara, Olusegun Dada and Jean-Daniel Mbega

Question to Alioune Kane (Prof. UCAD)

What prompted a specialist in the physical geography of water and rivers like you to broaden his scientific approach and collaborations to include dimensions of social sciences and even cultural aspects? And what did you learn or retain from this effort to integrate your research into several other fields and disciplinary methods?

I was a professor in continental hydrology at the time of the great droughts in the great watersheds ("*fleuves malades d'Afrique*"). These rivers are characterised by 2 seasons (flood and low water), which at the mouth creates an alternation of freshwater and saltwater periods. The research focused on the flow of the river (how much water in the valley and estuaries?), on the rise of the salt wedge when there is no fresh water, on the balances between continental and marine areas. Our research then focused more on the coastal zone, because it must be said that the word littoral is a vague word in geography. Following Rio 1992, the coastline emerged as a theme, and "coastal complexity" emerged as a concept. In Senegal, 3 out of 4 humans are in the coastal zone, all the major cities of West Africa are there, there is a concentration of problems related to urbanisation, multiple activities, nature-society interactions intensified by development. Following this, we designed the Master's on Integrated Coastal Management in West Africa to train specialists capable of addressing the problems of the coastal zone, both those related to the concentration of human activities and the problems of the bio-physical environment. A UNESCO Chair in Ecohydrology has been established, taking into account all aspects of development. The importance of good coastal management, with issues of public policy, administration and coastal governance, has been increasingly emphasized. The need to take into account the human and social dimensions has thus become increasingly necessary, which has finally led to the recognition of the need for a multidisciplinary or interdisciplinary science.

Question to Alassane Ouattara (Prof. Nangui-Abrogoua University)

The estuarine and lagoon ecosystems of the West Africa coast generate income and protein that are of great importance to the human populations living in this region. If, in the coming years, environmental changes and stresses affect these environments, particularly due to climate variations, erosion of barrier beaches or perhaps even the construction of new coastal infrastructure, do scientists like you have the data, knowledge and models to predict how these natural resources will be affected? And are scientists able to recommend measures to mitigate the negative effects of these changes on the productivity of estuarine and lagoon ecosystems?

Estuarine and lagoon ecosystems in West Africa are indeed an important source of resources, but they are now impacted by the effects of dams and the disappearance of mangroves. Historically, a lot of data has been acquired by the IRD. Between 2006-2016, two major issues emerged.

- 1) Vulnerability: in order to be able to establish scenarios of the future of populations and resources in coastal areas under climate change. For example, concerning mangroves that are disappearing. To study this, 3 hotspots were monitored on the Ivorian coast: 2 sites on the Ebrié Lagoon and 1 on the Great Lahou Lagoon. This made it possible to characterise and quantify the population's adaptation strategies and perceptions, and to discover deviant fishing practices (use of plant protection products).
- 2) Adaptation: for 20 years, following the silting up of the Ebrié Lagoon channel: what is the new ecosystem created, how have fishermen adapted to these new conditions? What are the appropriate models to consider a future trajectory for lagoons?

Question to Olusegun Dada (Federal University of Technology).

What do you expect in your field of research from the creation of an international multidisciplinary project on coastal vulnerability? And what do you consider to be the main condition to put in place to meet this expectation?

Coastal processes are complex and the predominant factors are different in each region. For example, in mangrove areas vegetation is often removed, decreasing the protection against the wave action, causing sediment loss and consequently leading to coastal erosion. Another example is the Niger river delta, where, from 1968 to 1980, erosional processes were observed, linked to a drought and, consequently, the decrease in river discharge. Such examples show that coastal research requires approaches with a broad overview and different fields in science.

Question to Jean-Daniel Mbega (CENAREST)

What data collection and use strategy do you use to support your research in organic matter on the Gabonese coast, in the Atlantic and in major watersheds?

In Gabon coastal zone research deal with environmental changes linked to anthropogenic pressures, resulting in particular from population growth around Libreville. There have been policies to create natural parks around Libreville, but the parks are also under enormous demographic pressure. With international partners from Cameroon, Benin (Abomey-Calavi) and France (IRD LEMAR and MARBEC) we have developed an interdisciplinary project in Arc d'Émeraude that addresses coastal erosion and pollution problems, ecosystem services and the Ecosystem Approach to Fisheries

(EAF). Issues of living resources, mangrove contribution and hydro-sedimentary balances are also discussed.

Discussion:

Questions:

Rafaël Almar: What are the methods used to quantify the sediment load of rivers?

Eric Machu: Do bivalves play an important role in the ecosystems of the Ivorian lagoons and in the estuaries and coasts of Gabon?

Zacharie Sohou: Can we define criteria for the success of regional projects, based on the experiences just mentioned?

Answers:

Regarding the sediment load, there is the problem of high interannual variability of particulate and dissolved matters flows, with measurements varying from year to year by a factor of 3 to 4. Langue de Barbarie was destabilised by the breach, the sediment being found in the river channel where it is highly mobile, making navigation difficult and dangerous.

In Nigeria the main problem is the lack of data. The Niger Delta is poorly observed despite the possibilities offered by remote sensing.

In Arc d'Émeraude, tide gauges were deployed for 3 years, allowing measurements on flows, and we used the ADCP on the mouth (thesis in progress on hydrodynamic modelling). We have also developed a model of oil slick drift.

Concerning bivalves, sand exploitation is damaging their habitat, as is coastal erosion.

Question:

How to make the link between science and governance?

Answers:

By raising awareness of policies through communication.

The relationship between research/operational management and governance needs to be better managed: as researchers, we can only make proposals or recommendations. There is a certain void in front of scientists who do not know which department to contact. We must invite political actors/decision makers to our workshops to make them understand our results, for example by raising their awareness through appropriate materials (e.g. posters on missing fish)

Question: How to develop coastal database properly?

Sharing data within teams is already a problem, but at the regional level it is even more so. To share data, there is a need for the same scientific objective.

It is necessary to assess the needs per country, share expertise through the mobility of students/researchers to have the same methodology, facilitate the country focal points (seminars). It is important to have countries that are neighbouring.

It is important that countries share the same objective, and it is important to organise mobility to train students and have the same methodology from one country to another. There is also a need to strengthen capacities and focal points in each country: in successful projects, we see that statisticians have come to each country to set up and share databases.

In the context of limited project life, the training of teams of young researchers and the establishment of teaching is a good criterion for success. It can be said that there are 2 criteria for the success of projects: the creation of a database at the heart of the project and the implementation of training through masters and doctorates that can produce new researchers.

An example is MOLOA, which made observations, produced data and a database that led to WACA. Amphora Project by IRD was also a successful sub-regional project.

Philippe Cecchi: to pursue a strategy of success, we can also mention the importance of defining common indicators for the definition of ecological status (biological, chemical and health). This requires the establishment of solid references with well-defined metrics, for instance, for chlorophyll measurement, for the taxonomy of benthic macroinvertebrates. Often these references are missing. For example, it must be ensured that the methods are the same (for chlorophyll measurement), that the names of molluscs are the same in Gabon and Ivory Coast.

Zacharie Sohou: To better manage the data problem, we also need the equipment made available at national level to be the same in the different countries (or at least inter-calibratable).

For example, in the Senegal River, where there is a yearly change in river flow, there is very little data on sediments, which nevertheless play a major role in the morphodynamic of the system. In Nigeria, no data on these sediments (river discharge, sediment discharge) are available either.

6 March – 8:30 am: Session 2 Starting the technical development of the project (Working Groups)

The following are the discussions in each working group:

Working Group 1 - Geophysical Themes

Fifteen participants contributed to the discussions (Appendix 2). The group identified three main risks in the coastal areas of West Africa and the Gulf of Guinea Bissau:

1. Sediment budget: this raises questions about the need to quantify the evolution of the coastline, the quantification of coastal drift at the level of sediment cells (including fluvial sediment load, disruption of littoral drift by human action and structures, etc.). Need for multi-scale and multi-tool estimations relying on remote sensing, which should be calibrated with fine *in-situ* measurements.
2. Salt intrusion: it is particularly prevalent in Cameroon. How to study this process? Remote sensing certainly is a key tool.
3. Flooding: the link between river flow and rainfall seems important, particularly for river mouths and deltas, in addition to oceanic contributions to sea level.

For these 3 axes, not only the lack of data, particularly at a regional level, is a limiting factor, but also, the need to develop expertise in new tools and technological barriers:

- Oceanic, wave and hydro-sedimentary modelling needs
- Needs for availability and expertise on quantitative multi-scale remote sensing methods (satellite and video, drone), because shoreline mapping is one thing but the topobathymetric determination is the state of the art today.
- Need for *in-situ* measures, more expensive than previous tools but fundamental.

In addition to the regional aspect, the identification of thematic hotspots came into the discussions, which contours are based on scientific and contextual rather than national considerations: e.g. Saint-Louis (river mouth and beach ridge), Bay of Benin (sedimentary cell including several countries), mangrove and estuarine areas in Cameroon and/or Sine-Saloum.

The need to create methodological workshops (i.e. modelling, spatial, video) and around the pilot sites was discussed, which promotes interdisciplinarity and exchanges with other working groups.

Working Group 2 - Biological and Chemical Themes

Eleven participants contributed to the discussions (Appendix 2). One of the main expected outcomes of this exercise was to clarify the different types of ecosystems studied by the group, bearing in mind that the future project will adopt a regional approach.

What are we doing now?

In Gabon, the estuarine areas located in the Arc d'Émeraude project are a major site of activity because of the importance in protected areas and mangroves (2% of the world's mangroves) and their influence on the adjacent ocean. Three groups of fish are particularly targeted, but the pollutant load associated with Libreville and the hydrodynamics of sediments are issues of concern. Other activities concern a complex of 4 coastal lagoons located in the southern part of the country that are relatively pristine (e.g. the Iguéla Lagoon), and which could be of great interest for future comparisons.

In Cameroon (Sanaga River/Assa Lake), Benin (Nokoué Lake) and Ghana (Keta Lagoon), a series of studies are being conducted to better characterise the hydro-ecological processes that control the functioning and metabolism of these coastal ecosystems. In particular, interactions between surface water bodies and groundwater are considered complex and poorly understood.

Coastal issues in Nigeria were briefly mentioned during the discussions, but relevant contributions were provided during other sessions of the meeting. Navigation linked to oil and petroleum traffic in the Niger estuary entails ecological risks that should not be overlooked. Many studies have focused on the ecological status of coastal lagoons, particularly on aquatic communities and contaminants. Original studies have reported potentially harmful invasive dinoflagellates.

In Ivory Coast, the urban basin of the Ébrié Lagoon (strongly impacted by anthropogenic pressures) is studied and compared to the Mondoukou Basin (considered as a potential reference site). The definition of indicators of the health status of local coastal lagoons is the link between the various projects currently being implemented. Plastic waste and its potential involvement in the survival and spread of human pathogens could emerge in the near future as a matter of concern and be the subject of further studies, in particular because of its ability to disperse over long distances. Dedicated experimental studies are currently being conducted at two sites (Abidjan and Mondoukou).

For Guinea, two major threats have been identified: overexploitation of coastal marine resources and disruption of river regimes linked to changes in watershed management and dam construction (not only in Guinea). This second aspect has a direct impact on coastal areas, in terms of reducing water flow and sediment load and controlling associated productivity. Estuarine salinity conditions can be dramatically affected, with impacts on mangroves and aquatic resources. Increased risks of local salinization of groundwater can also occur in the event of overexploitation of coastal aquifers for agricultural purposes and/or drinking water supply.

Taking these continuums into account (from upstream to downstream) requires the creation of multidisciplinary teams from the very beginning of the research process, (i) for the definition of the issues addressed, (ii) for the implementation of activities and (iii) for the dissemination of results.

In Senegal, in addition to the Senegal River and Estuary, a large number of multidisciplinary scientific activities are carried out in the Saloum Estuary, its protected areas and the adjacent marine system. A main task concerns the role of exchanges between the ocean and this semi-closed and confined ecosystem, followed by biogeochemical approaches. Shellfish communities are another important target for studies in this area, with both archaeological and ecological objectives. The lack of knowledge of physiographic characteristics (particularly concerning bathymetry) leads to serious methodological problems, shared by other teams in other places. The current development and implementation of low-cost field approaches (instrumentation and recorders) that could be easily shared throughout the area of interest can provide a unifying approach for the entire group.

How can we go further?

Three major areas of major interest have been identified, corresponding to three different ecosystems (hotspots). Indeed, these hotspots have in common: (i) the existence of a network of international partners, including local scientists who can serve as a reference point; (ii) a scientific activity already active and included in ongoing or very recent projects; (iii) a scientific history that may however require some data rescue efforts.

Two types of estuaries are concerned, the inverse estuary and the salt wedge estuary, respectively in Senegal and Gabon, while Nokoué Lake in Benin is a coastal lagoon quite typical of the entire Gulf of Guinea region.

The identification of these sites does not exclude the implementation of activities elsewhere, for example for comparison or knowledge transfer purposes. In addition, this selection was not entirely consensual within working group 2, some suggested that the

selection of an estuarine hot spot would be more relevant if a managed and managed river was considered. This important issue, if confirmed, will require the participation of all working groups.

A clear agreement was also quickly reached on the diversity and importance of the pressures that affect (and will continue to affect) the various ecosystems already studied. From a unifying perspective, the development of a classification of these pressures appeared necessary. Indeed, a series of main factors are universally recognized: climate change (temperature increase, saline intrusion, extreme hydrological phenomena - floods and droughts); sea-level rise and exceptional waves; population densification in the coastal zone; conflicts of interest concerning the exploitation - or simple use - of space and natural resources, etc. But the pressures generated by these global factors can vary locally depending on the (physical) configurations and (socio-ecological) context. The development of such classification should not be a task carried out by group 2 alone but should, by definition and in an integrative form, involve all working groups.

Watershed disturbances have emerged as one of the most significant threats to coastal ecosystems and associated ecological services: shoreline erosion, freshwater supply, pollutants. The qualification and quantification of flows (solid, liquid and dissolved) are both urgent, while the current lack of "coastal" or "littoral" hydrology has been unanimously denounced.

The issue of overexploitation of coastal aquatic resources has sparked a series of discussions on the place and role of aquaculture as a promising alternative. An informed debate will require (i) scientific and technical efforts to diversify the spectrum of potentially exploited species, (ii) convincing political and economic commitment to promote this still marginal activity, and (iii) the active and explicit participation of local communities.

Similarly, with regard to aquatic resources and their resilience, the need for a better understanding of connectivity between coastal areas (inland and marine) was highlighted. This is a complex issue because it requires analysis and integration of results at different spatial and temporal scales and an approach that combines expertise in physics (hydrodynamics) and biology. But such an original approach, implemented locally, could also be exported to the entire West African coastal zone, thus constituting a unifying roadmap.

Coastal land use planning should be an ultimate objective. This means that synoptic approaches must be implemented (including remote sensing), informed by local studies that will provide relevant and usable approximations of states and processes. With regard to ecosystem properties and associated provisions ("ecological services" or

"human benefits"), we collectively recognised that the notion of "habitat" could be the most relevant entry:

"What are the processes that determine habitat degradation/fragmentation?"

"What are the ecological and biogeochemical consequences of these disturbances?"

"What could be done to mitigate these disruptions?"

This last point should not be the task for group 2 alone and should involve all working groups in a theoretical and practical loop.

How do we do it?

- What are the pressures?
- What is the impact on habitats?
- What does it mean in terms of resources and pollutants?
- What methods should be used?

How to get started in the first place?

The group decided to organise a first "large-scale" study focusing on microplastics in sediments. A common methodology will soon be shared and details of this initiative will be provided. Another large-scale, single-passage study is also in preparation, focusing on contaminants using molluscs (*Crassostrea gasar*) as passive live samplers.

Who is the corresponding referent of group 2?

Philippe Cecchi agreed to be the corresponding member, i.e. for collective contributions (bottom-up strategy), contributing to the future task force and representing the group if necessary.

Working Group 3 - Themes in Socio-Economics, Perception and Governance

Preliminary remark: the group is not composed exclusively of researchers or lecturers in the social sciences, but of people from multiple disciplines (with an openness ranging from anthropology to physical oceanography, including economics, geography, hydrology) all with an interest in issues relating to societies in interaction with their physical and biotic environment.

Terms of Reference 1

A number of phenomena and processes have been identified as requiring research to increase their knowledge. We have identified:

1. Changes in the relationship that (African) societies have with the coastline and the sea.

These changes are occurring over the long term and particularly in recent decades. In some countries (e.g. Senegal, Mauritania, etc.), in less than a century, societies have turned their backs culturally and economically on the coast (cf. Pélissier, for Senegal in 1950) to a general tropism towards the sea and the coast, observable in all dimensions (demographic, economic, cultural). The issues that can be addressed are:

- a. What values does society associate with the coastline and the sea? Are there any changes in these values?
- b. What is local knowledge about the coast and the sea?
- c. What are society's perceptions of the environmental changes that have affected the coastline in recent decades?

2. The transformations of the human landscape on the coast.

- a. What are the past and current dynamics of the establishment and colonisation of coastal areas? Are these dynamics local or linked to large-scale mobility? Is there any mobility along the coast? Departures?
- b. Are there any local dynamics (e.g. changes in activities, new activities) that have changed the human occupation of the coastal area?

3. Human actions (or inactions) and their effects on the morphodynamics of coastal territories.

- a. What human activities exert pressure (intentional or unintentional) on the physical and biotic coastal environment? What are the effects of these pressures?
- b. What actions are deliberately implemented to modify, protect and develop the coastal environment? What is the dynamic (social, economic, institutional) of these actions? How do these actions evolve over the years?

4. The sensitivities and response capacities of different populations and professional actors to environmental changes or shocks.

- a. How are populations/actors (fishermen, farmers, tourism stakeholders, others) affected by progressive environmental changes (e.g. salinization)? How do they react?
- b. What are the reactions of populations/actors to sudden shocks (e. g. floods)?

- c. Beyond the reactions, do populations and actors show adaptive capacities? Are these adaptive capacities differentiated according to populations/actors?
 - d. Based on the answers to the previous questions, can we establish degrees of vulnerability characterizing coastal populations or actors?
5. The development of new exogenous/extraverted activities (zircon mines, oil/gas exploitation, fish meal plants).
- a. What type of new activities and how many sites are involved?
 - b. What are the impacts on coastal populations and stakeholders?
 - c. What are the positions and reactions of populations and actors, including institutional (NGO) and research actors?
6. The failure (or, more rarely, the effectiveness) of existing forms of governance over coastal areas and resources (whether traditional or modern, local or national).
- a. What is the role of public policies and governance in the phenomenon of coastal colonisation? What is preventing their ability to regulate the scale of the coastal phenomenon?
 - b. What are the specific challenges faced by integrated coastal zone management in the context of climate change (taking into account the possible displacement of areas affected by hazards)?
 - c. What particular difficulties does the coexistence on the coast of communities and actors of diverse origins (indigenous vs. migrant) and deploying various professions/activities create in relation to the desired establishment of successful governance?

Terms of Reference 2: Methods, products and dissemination.

Starting point (preliminary): lay the foundations, especially in terms of definition:

- What is the coast? The coast as a territory for social groups. What is the name of this space? (mangrove, etc...)
- Who are the actors of the coast?
- What activities on the coast are observed in the different countries?

Points of vigilance:

- Importance of the historical dimensions of processes to understand the dynamics of the social system, changes.

- A question of dialogue between disciplines, of information transmission. How to capitalise on what has already been done?
- Issues of knowledge aggregation between disciplines and groups of researchers.

Specificities of the situations in the different countries?

- Starting from a reflection and regional / broad questions.
- Understand local specificities.
- Compare the different situations.
- Identify common phenomena in different countries.

Research time and methods:

- Establish a reference framework:
 - Take an overview of interdisciplinary art / share references, definitions, concepts, based on previous literature and work
 - Retrospectively look back at past analyses and recommendations
- Work on major themes with "free" investigation (e.g. on public policies, etc.).
- Participatory approaches to bring up important issues (focus group). Participative mapping of coastal areas and resources.
- Mapping of networks of actors and institutions, at local and national level.
- Statistical surveys of actors or households for quantified indicators.

What are the mechanisms/strategies that bring together researchers from different groups around common issues or objects?

- Define together the "eco-socio-systems" (in the broad sense) on which we will work.
- Discuss the meaning given to the notion of system. What components are taken into account? Importance of interactions rather than system elements or components? What interactions are we working on?
- Which spaces are considered? Which relationships with larger spaces?
- Strategy in relation to other groups spatial deployment/physical hotspot relationships/defining social hotspots.
- To build around an initial question that could be "How to live in these changing coasts?"

What is the mechanism for dialogue with society at large: restitution, dissemination?

What is the support? To whom?

- Feedback to the actors surveyed on the question of how to live differently on the coasts?
- Involvement of stakeholders throughout the process?
- Prospective study with scenarios to be entrusted to the actors

Terms of Reference 3: What are the interactions between the working groups?

For almost all issues considered by group 3, interactions with the work of the other working groups will be useful and desirable. But questions 1.c, 3.a, 3.b and 4.a will require the most intense exchanges of information with the work in physical sciences and geosciences (group 1) and environmental quality and bio-ecology (group 2).

People involved:

Luc Descroix (LMI PATEO), Jean-Yves Weigel, Boniface Komena (moderator), Jeanne Riaux (moderator), Alioune Kane, Sy Boubou, Juliette Mignot, Pape Malick Ndiaye, Pierre Morand, Germaine Ebong (review).

Working Group 4 - Tools and Models for Integration and Remediation

Eleven participants contributed to the discussions (Appendix 2).

The challenge of building a model comes from the ambition of the PSIP-LITTORAL project, which aims to integrate 3 areas:

- Marine and coastal resources, biodiversity, sustainable fisheries
- Environmental quality
- Social risks and safety (riverine, coastal and fishing communities)

There is no system capable of integrating all the knowledge and levels corresponding to these three areas. What exists are dedicated models such as:

- Early warning system for wave height (every two days)
- Chlorophyll content monitoring system (oriented towards high productivity areas)
- Monitoring of fishing vessels. Global Monitoring for Environment and Security (GMES) for the whole sub-region - alerts in all relevant GMES structures in countries that need to disseminate to populations (e.g. mobile phone messages to fishermen registered by the GMES system)
- IRHOB local early warning systems (all along the coast of Benin). It is accurate because it is linked to the tide. The forecast is sent to the Civil Protection Agency.

- There are similar systems to the previous one in Ghana and Senegal (managed by ANACIM - Agence Nationale de l'Aviation Civile and Agence Nationale de la Météorologie du Sénégal)
- These systems only concern the safety of fishermen
- Centralised national water quality system for Mauritania - water quality data exist in other regions but there is no centralized system.
- There are already some coastal video surveillance systems on some coastal areas in Benin, Ghana, Cameroon, Senegal (these are currently complex systems that could be set up inexpensively and therefore more widely, accepting lower accuracy).

The objective of the integrator system is to distribute products. It is therefore necessary to list the desired products:

1- At the regional level, the expected product:

- Harmonisation of data collection and processing methods for all or part of the existing methods (early warning system, water quality - physio-chemical parameters, chlorophyll, CO₂, erosion, water colour, etc.)
- A climate service: seasonal forecasts at the ocean-atmosphere interface

2- At the local level, we expect services from a pilot-study tool:

This pilot-study should have the capacity to integrate the 3 areas

- Marine and coastal resources, biodiversity (sustainable fishing)
- Environmental quality
- Risk and safety of populations (fishermen and local residents)

3- The operation and products of the pilot-study:

These products would target two temporal levels:

- The alert level (immediate)
- Long-term level (e.g. stock decline, biodiversity decline, environmental degradation - coastal erosion, all leading to predictive mapping of coastal hazards).

The pilot-study products will be web services but will be accompanied by a multi-level user interface, to help build small regional network in “coastal observatories”.

- The user interface for the long-term domain is at the national level (decision-makers and population).
- The interface of the short-term forecast domain (alert) is located at the level of local authorities

These coastal observatories could be enriched locally by observations/measurements carried out by populations (e.g. consequences of sea level warnings, quality observations, etc.). The system must therefore be chosen so that these capacities integrate and manage data of different levels of uncertainty and feedback (deep learning - depending on the calculation capacities - or not), assimilation. The observations thus collected will be in contexts where possible solutions are implemented, and they can therefore be used to evaluate the solutions.

Existing technical platforms on which the integration model(s) can be based:

Mercator (service for global ocean analysis and prediction); Theia (IDS V2) (French national inter-agency organisation to promote the use of images from spatial observation of land surfaces) - Dinamis Earth System. There is a server (real-time geodetic data) equivalent to Institut Géographique National, Senegal, that can be opened to other applications.

Will the model(s) developed be intended to be transferred to structures capable of implementing them or should we limit ourselves to the production of pilot-study?

The regional and local levels of the pilot-study will necessarily have to be implemented within the framework of functional sub regional programmes.

7 March - 8 am: Session 4 Sampling strategies, data collection and exchange, platforms and observatories

Veronique Landes, Babacar Ndao, Lemhaba Yarba, Frédéric Bonou, and Anne Liefermann

The round-table aims in particular to address the following aspects:

- Collection strategies (bearing in mind that the objective is to build an international multidisciplinary programme, for which not all data will be of the same nature but can be linked to each other)
- Considerations on how to store, share and use (technically and on data use agreement issues)
- Aspects of evaluation, dissemination and publication methods

Véronique Landes (Mercator)

Mercator (European company with 80 employees) provides data on forcing, boundary conditions of coastal oceanographic models, expertise on data collection, reanalysis and hindcast, service to the European Commission or other contractors, e.g. with the PIRATA programme, or the COPERNICUS marine project which is open to all and

includes a global model providing hourly forecasts of sea level, temperature etc. A total of 165 products can be supplied. For example, Mercator produces a document/report on COPERNICUS every year.

Babacar Ndao (from CSE, partially funded institution under supervision of the Ministry of the Environment)

What kind of collaboration exists between CSE and academic structures such as universities? CSE is a pivotal structure between universities and public authorities. It is a research and institutional structure, which plays a role of data provider, which has been coordinator of MOLOA, which accompanies States on coastal vulnerability management and follows the changes of MOLOA programme into an observatory. Initially, CSE was an association interested in desertification and remote sensing observation. CSE has produced a lot of data and has now positioned itself in all areas of the environment. It welcomes trainees from all over the world, and is organised into units, one of which concerns research and development (which produces publications in indexed journals). The CSE has the capacity to bring together several institutions (as it did in the MOLOA programme) and is able to maintain a dense network of partnerships. It ensures the reception of satellite data. NRT (Near Real Time). CSE also hosts international researchers, notably from CIRAD (landscape ecology, agricultural production modelling).

Lemhaba Ould Yarba (Scientific Council of the Banc d'Arguin National Park)

Created in 1976, with an area of 12,000 km², including 6,000 km² of marine areas, the BANP aims to conserve ecosystems and ensure the harmonious development of the indigenous population (traditional fishermen). Five groups of fish are exploited there. Monitoring data are produced (particularly on fisheries), and weather data are collected by Park agents. But the Park is also a laboratory for international research that focuses on all components of the ecosystem (meadows, benthos, birds, etc.). As the Park receives researchers from many institutes and countries (notably France and the Netherlands), it has implemented a sufficiently elaborate data policy to avoid losing the memory of the data collected by the various researchers and projects that come to work on the Park at one time or another. Before any fieldwork, the hosted researchers must therefore sign an agreement stipulating that the data they will collect and the results of their research must be copied to the Park, which can then store them in the long term and reuse them in the future.

Frédéric K. Bonou (UAC)

Despite being a young researcher, Frédéric Bonou also works as a database manager at his university. The data includes recordings from a coastal surveillance camera system. These data make it possible to deal with the evolution of the coastline and wave dynamics (energy, period, height, etc.) as well as sediment transport. These are

important data for investors, particularly because they allow the dimensioning of structures and the quantification of the sand required for their construction. Through agreements, the UAC implements a data sharing policy that promotes collective valorisation. In addition, Bonou considers necessary to organise a system of mutual information exchange at the sub-regional level to ensure that everyone can have access to information on what other institutions are doing in their country or in neighbouring countries.

Anne Liefermann (CNES)

CNES is involved in the Space Climate Observatory initiative (SCO), which is an organisation for scientific foresight. For example, Rafaël Almar has placed a proposal on it for coastal spatial observation. CNES has created thematic centres including Theia (Continental Surfaces), Odatis (atmosphere and solid earth) and DYNAMIS (funded by 6 organisations), all accessible through a data portal. All this is overseen by the branch "earth system" which is a structure at the service of research. This structure is both a receptacle for your data and a support for innovations created by research.

SCO is a recent initiative following the USA withdrawal from the Paris Climate Agreement. This withdrawal has led to the MOPGA and One Planet Summit initiatives, with 25 representatives of States meeting soon in Nairobi. The decision to create SCO is part of a desire to accelerate the use of satellite data. This is an international programme, the aim of which is to promote an observatory approach, including in situ data collection and modelling capacity, to better measure the impact of climate change and provide decision support tools to promote adaptation. SCO also looks to decision-makers and public policies for the implementation of adaptation to change. A project is supporting the SCO for data management (a hub with outreach and learning, improving data access), for the design of innovative products and the development of pilot-studies capable of generating scenarios, for example. It should be noted that there was a theme on coastal vulnerability in Palavas, France. An operation on the vulnerability of the West African coastline would have its place in the SCO initiative.

Discussion following the "sampling strategies, data collection and exchange, platforms and observatories" round-table:

Frédérique Seyler: SCO is supported by IRD, so there is an opportunity to work with SCO on climate change scenario operations in the South (there are already 5 or 6 scenarios). We could propose a scenario on the evolution of the West African coastline. The questions, however, are: Who is funding? Who will launch the demand? Thanks to SCO, all products are free of charge except for the very high-resolution images. SCO therefore opens the way for many possibilities in data access.

Could CNES provide monitoring follow-up with Pleiades images on this scale?

Frédérique Seyler: We can propose a request to DYNAMIS in the form of a research project or a pilot-study because it cannot be part of a regular monitoring, it must necessarily be requested as an operation with a specific duration. In fact, all 6 organisations contributed to this data system. This system should also provide training to increase the capacity to use the data: capacity building (because there is no shortage of data but the lack of training means that they cannot be used properly).

CNES: Indeed, training is often lacking, and mechanisms must be found to provide and finance it.

7 March - 9 am: Continuation of Session 4 Capacity building, training, supervision of theses and dissertations

Alioune Kane, Precious Mattah, Donatus Angnuureng, Raphaël Onguéné and Juliette Mignot

- The speakers are requested to intervene on the following points:
- Issues of thematic orientation and organisation of masters and doctoral schools and their international relations
- Student supervision and following questions, with the role and activity of thesis committees, the composition of juries, student travel to other laboratories, etc.
- Mechanisms to support young researchers or teams after the theses, etc.

Donatus Angnuureng and Precious Mattah (University of Cape Coast and African Centre of Excellence in Coastal Resilience): ACECoR will have a dual objective of training and research. It will be open to all students from the sub-region (who will provide at least 30% of the staff) and they will benefit from the possibility of financing study visits (see the ACECoR website on which all the information is available). Everything will be organised in the best way to welcome students from all over the sub-region, both from English-speaking and French-speaking countries. There will be a need for international lecturers and also a need for international expertise to help supervise doctoral students. After the doctorate, there is currently no established post-doc program, there are needs in this area. There would also be a need for a programme to invite young researchers from neighbouring countries to come on scientific visits. Finally, there will be a need for professional expertise to fill the gap in connections between governments, companies (corporations) and organisations.

Raphaël Onguéné (University of Douala): The three-year *Réponse du Littoral Camerounais aux Forçages Océaniques Multi Echelles* (JEA RELIFOME) is a research team established between IRD and young Cameroonian researchers. Its objectives are

to strengthen capacities (thanks to the M2 OA master's degree) and to boost research. The support was provided by IRD and *Agence Universitaire de la Francophonie* via the *Institut Culturel*. It made possible to award scholarships to 15 doctoral students, who participated in the creation of a real research laboratory in which they held positions. An international master's degree has been developed in partnership with Gabon (2 universities in Cameroon and 2 in Gabon). The master's internship themes have been defined with companies to ensure that the training is well adapted to the labour market. A training and employment forum involving targeted employers (port, oil companies) brings together all companies to define internship themes, ensure employability and maintain links with companies. This adjusts the development of skills according to the demand for skills by companies. The outlines of the training are as follows: in M1 lawyers, geologists, physicists, etc. and then 4 specialities in M2. Thematic field schools are carried out for 2 or 3 weeks for M1 studies, while in M2 they are more of a case study. Seven students worked in master's degrees on the problems of the port and coastal local authorities of Douala, and some obtained a scholarship to continue their theses. The success of the training is based on the training partnership with the private sector (one of the 17 sustainable development goals of United Nations). This master's course is in favour of a regional coherence approach to training, playing on complementarities and avoiding duplication.

Juliette Mignot (IRD OCEANS, co-head of the Laboratoire Mixte International Eclairs2: LMI Eclairs2 founded by IRD and UCAD has focused on promoting the conditions for the development of physical oceanography in Senegal. LMI supports training courses to train oceanographers in physics from the master's level to the doctorate level. The master's degree in physical oceanography was found as already existing at UCAD, but two masters were created in Ziguinchor and Saint-Louis. For the doctorate, the idea is to support training through research and over time, with the presence of seniors in the laboratory. This approach can only succeed over a long period of time, the training of a new researcher is a process over all the years corresponding to the "master's degree>doctorate>postdoc>obtaining-a-position" stages, and it is difficult to provide permanent support over such a long period. At first, there was a shortage of researchers who could supervise students, but today we are able to co-supervise theses. We do not do double degree with French universities, but we do make sure that IRD has doctorate scholarships or French Embassy scholarships to allow students to stay in France (although this is not a permanent immersion). There is currently a desire to open up the LMI to coastal physical oceanography. Finally, there is a reflection to be carried out on the employability of the fraction of young doctorate and post-doctoral students who do not find a permanent position in the university. This could lead to the development of the professional dimension of training.

Alioune Kane (UCAD and UMI Résiliences): At the beginning of the 1990's, there was no training on coastal related topics. This is why UCAD's Department of Geography has designed the *Diplôme d'Études Approfondies* (now a master's degree) with 3 courses respectively in coastal environmental conservation, governance and coastal engineering. Since the beginning of the training, the target coverage scale has been sub-regional, in collaboration with the organisations that deal with the shoreline. This master's degree includes a course on mangroves supported by Wetlands International. This master's degree is also articulated with the doctorate program on Water, Water Quality and Water Use (about thirty theses defended since the beginning). For the future, a project for a Water and Coastal Institution would be created in Diamniadio, Senegal, a multidisciplinary training course for young people who could then return to more disciplinary laboratories, for example focused on governance. From 2020 onwards, there will be a reflection on the arrival of oil and gas exploitation in Senegal, the objective being to transform a curse into a blessing. A major ambition would be to propose an international research centre that would bring together all the scientific actors on the coast in West Africa.

Discussion

According to Cyril Maman, there does not seem to be any training dedicated to the environment and climate planned as part of the Franco-Senegalese campus project within Diamniadio, Senegal, but it should be recalled that there are other initiatives. In addition, it is also necessary to start preparing for the World Water Forum to be held in Senegal in 2021

Raphaël Onguéné: Beware of the risk of duplication of master's degrees courses in West Africa, because the sector's ability to employ young graduates is limited. Above all, it is necessary to ensure that needs are well covered, in particular by setting up centres of competence to ensure that all the skills are available in a region but without duplication. This can be done by consolidating South-South regional cooperation and establishing a real network (example of the coordinated training offer between Benin, Cameroon and Gabon).

Frédéric Bonou: As ACECoR students will come from all over Africa for first-year schooling, can we know the date of the launch of the call for applications?

Precious Mattah: Applications' deadlines are posted on the ACECoR website. There will be US\$10,000 per student for the three years of study.

7 March - 11 am: Final Session Interventions by technical and financial research partners

Germaine Ebong (Agence Française de Développement - Senegal)

1- Project to support the policy of the Senegalese Marine Protected Areas (*Aires Marines Protégées du Sénégal*, AMP) through the conservation and sustainable development of the mangroves in Casamance and Sine-Saloum. Project budget €5M. This project has three components:

- Component 1 - Improve the management framework for AMP's and mangrove areas.
- Component 2 - Enhance, through sustainable activities, the value of natural capital preserved or accumulated.
- Component 3 - Project management.

2- Environmental Expertise and Capacity Building Fund (FERC Vert), with DEEC. Project budget: €0.5M.

- Feasibility study AMP Senegal carried out in 2016.
- Environmental risk mapping and feasibility study on the coastal observatory (coastal erosion mapping, coastal observatory feasibility study, industrial risk mapping).
- Support for the implementation of the national ICZM strategy in Senegal.

3- Project to control coastal erosion in Saint-Louis. Project budget €16M.

The project aims to find an urgent solution to the problem of coastal erosion affecting the properties and population of the city of Saint-Louis. It follows the request of the Mayor of Saint-Louis to the French President Emmanuel Macron at the One Planet Summit. The project represents €16M in aid managed by AFD. It should be noted that this is only an emergency solution for the local populations. The project aims to fix the coastline but will have no impact on marine flooding.

- Component 1 - Construction of a longitudinal structure (2.15 km) for emergency protection of the urban area of the Langue de Barbarie.
- Component 2 - Communication and awareness-raising of the population and scientific monitoring of the evolution and impacts of the project. The monitoring will be carried out by IRD, UGB and UCAD. It involves sedimentary monitoring, camera monitoring, PLEIADES data (satellite images).

- Component 3 - Project management and monitoring and evaluation. Study for the design and operationalization of an environmental monitoring and modelling system for the Saint-Louis coastal zone (Egis, France and Deltares, Netherlands). Objective: to reduce the effects linked to the very dynamic problem of the breach that sweeps away Langue de Barbarie and induces problems much broader than the floodplains in the Saint-Louis area.

Arame Tall (World Bank)

WACA project aims to help partner countries achieve coastal resilience in West Africa by increasing funding for knowledge, expertise and dialogue.

Created in 2015 following COP21, WACA addresses coastal erosion and management issues. This is an urgent issue, the determining factors of which are both natural and anthropogenic. Given the complexity and scope of this issue, it is necessary to develop a regional approach, which can only be properly addressed by a multi-sectoral, complex and high-level project with long-term (5 years) funding. WACA has thus been defined and is beginning to be deployed in 6 countries: Mauritania, São Tomé, Benin, Togo, Ivory Coast and Senegal following a regional approach. WACA is structured in 3 pillars:

1. The pillar on knowledge functions (identification of priority interventions, development of a set of solutions and/or project concepts)
2. The pillar of strengthening dialogue functions (technical cooperation, political dialogue, linking countries to financing options)
3. The resilience of investment financing

The WACA Knowledge Pillar was presented in Rotterdam in February 2019 and includes the following ideas:

- Knowledge Help Desk function: the strengthening of knowledge in countries and regions to meet needs.
- Knowledge Repository: knowledge management, knowledge conservation and learning (building a repository)
- Knowledge Partnerships: knowledge exchange
- Innovation: identification of areas of exploratory research (with calls)
- Capacity Building: development of a coherent strategy for capacity transfer (link with ACECoR in Ghana).

Recently, WACA has proposed the interdisciplinary themes of knowledge for the coming years, they are:

- Erosion and shoreline monitoring and management

- Pollution and environmental quality monitoring
- Conservation of coastal and marine biological resources
- Resilient coastal livelihoods
- Sustainable financing mechanisms
- Linking knowledge to action for Community action on coastal hazards
- Climate risk and disaster management and adaptation planning

There will be a need for expertise for governance bodies and to support the implementation of WACA. In the design phase, there will be another meeting in Rotterdam.

Resilience Investment Project (ResIP) component is already being implemented (with UEMOA, IUCN and CSE). The Regional Observatory has an envelope to set itself up, it must aim at the regional networking of researchers. There is a strong need to implement this regional observatory with a data sharing responsibility for the CSE, which must move quickly on this point.

A study was also launched with CEREMA on the historical study of the evolution of the coastline. A generic standard method for addressing vulnerability has yet to be agreed, and we need researchers for the success of the platform.

We must recognise a weak involvement of Central African countries to date because the 6 countries currently integrated are those originally involved but there is a real interest for regional deployment.

WACA's financial architecture is composed of grants, donations and credits (€220M including €80M from the World Bank and €20M from the Global Environment Facility), but there is a need to find additional funding for other countries outside the top 6.

Finally, it should be noted that there are still many sectors without data or knowledge.

Conclusion

IRD OCEANS department and the PSIP-LITTORAL team thanks the participants for their rich contributions. The workshop proceedings will be developed and shared as soon as possible.

The contributions should lay the foundations for a regional interdisciplinary research programme. Participants will be invited to collaborate on the drafting of this project,

which should be ready by June. This project will be submitted as a whole or "by component" to the technical and financial partners likely to finance it.

Appendix 1 – List of participants

Abdoulaye Ndour	Senegal	Université Cheikh-Anta-Diop
Alassane Ouattara	Ivory Coast	Université Nangui-Abrogoua
Alioune Kane	Senegal	Université Cheikh-Anta-Diop
Anne Lifermann	France	Centre National d'Études Spatiales
Arame Tall	Senegal	World Bank
Awa Niang-Fall	Senegal	Université Cheikh-Anta-Diop
Babacar Ndao	Senegal	Centre de Suivi Ecologique
Boniface Komena	Ivory Coast	Centre Ivoirien de Recherches Économiques et Sociales
Boubou Aldiouma Sy	Senegal	Université Gaston-Berger
Bruna Alves	France	IRD PSIP-LITTORAL
Cécile Giorgi-Mesquida	Senegal	IRD Dakar
Cyril Maman	Senegal	Ministère des Affaires Étrangères Français
Dah Dieng	Senegal	Université Gaston-Berger
Donatus Angnuureng	Ghana	University of Cape Coast
Eric Machu	Senegal	IRD OCEANS
Erwin Bergsma	France	IRD OCEANS
Franck Desmazes	France	Bureau de Recherches Géologiques et Minières
Frédéric K. Bonou	Benin	Université d'Abomey-Calavi
Frédéric Ménard	France	IRD OCEANS
Frédérique Seyler	France	IRD DISCO
Germaine Ebong	Senegal	Agence Française de Développement
Guillaume Dodet	France	IFREMER LOPS
Isabelle Henry	Senegal	IRD Dakar
Isabelle Manighetti	France	CNAP Géoazur
Issa Sakho	Senegal	Université de Thiès
Jean-Christophe Poussin	Senegal	IRD DISCO
Jean-Daniel Mbega	Gabon	Centre National de la Recherche Scientifique

Jean-Hervé Mvé-Beh	Gabon	Centre National de la Recherche Scientifique
Jeanne Riaux	France	IRD DISCO
Jean-Yves Weigel	France	IRD SOC
Juliette Mignot	France	IRD OCEANS
Kader Ba	Senegal	Université Cheikh-Anta-Diop
Lemhaba Ould Yarba	Mauritania	Scientific Council of the Banc d'Arguin National Park
Luc Descroix	France	IRD SOC
Magali Maurange	France	IRD OCEANS
Manuel Garcin	France	Bureau de Recherches Géologiques et Minières
Marina Levy	France	IRD OCEANS
Mouhamadou Diakhate	Senegal	Université Gaston-Berger
Nathalie Benarrosh	France	IRD OCEANS
Olusegun Dada	Nigeria	Federal University of Technology
Philip-Jayson Quashigah	Ghana	University of Ghana
Philippe Cecchi	Ivory Coast	IRD OCEANS
Philippe Charvis	France	IRD DISCO
Pierre Morand	France	IRD PSIP-LITTORAL
Precious A D Mattah	Ghana	University of Cape Coast
Rafaël Almar	France	IRD PSIP-LITTORAL
Raphaël Onguéné	Cameroon	Université de Douala
Thierry Garlan	France	Service Hydrographique et Océanographique de la Marine
Thomas Stieglitz	France	IRD DISCO
Veronique Landes	France	MERCATOR
Yoann Thomas	France	IRD OCEANS
Zacharie Sohou	Benin	Institut de Recherches Halieutiques et Océanologiques

Appendix 2 – Working groups and participants

Working Group 1: Geophysical Themes

Abdoulaye Ndour	Mamadou Sadio	
Anne Lieferman	Olusegun Dada	
Awa Niang-Fall	Philip-Jayson Quashigah	
Donatus Angnuureng (moderator)	Philippe Charvis	
Erwin Bergsma	Rafaël Almar	
Guillaume Dodet (moderator)	Raphael Ongéné	
Isabelle Manighetti	Thierry	Garlan
Kader Ba		

Working Group 2: Biological and Chemical Themes

Alassane Ouattara	Jean-Hervé Mvé-Beh	
Babacar Ndao	Philippe Cecchi (moderator)	
Eric Machu	Precious A D Mattah	
Frédéric Ménard	Thomas Stieglitz	
Jean-Christophe Poussin	Yoann	Thomas
Jean-Daniel Mbega (moderator)		

Working Group 3: Themes in Socio-Economics, Perception and Governance

Alioune Kane	Jeanne Riaux (moderator)	
Boniface Komena (moderator)	Juliette Mignot	
Boubou Sy	Pierre Morand	
Luc Descroix	Pape Malick Ndiaye	
Jean-Yves Weigel	Germaine	Ebong

Working Group 4: Tools and Models for Integration and Remediation

Bruna Alves		
Frank Desmazes		
Frédéric K. Bonou		
Frédérique Seyler (moderator)		
Issa Sakho		
Magali Maurange		
Manuel Garcin		
Marina Levy		
Lemhaba Ould Yarba		
Veronique Landes		
Zacharie	Sohou	(moderator)

Appendix 3 - Terms de Reference

Terms of Reference for Working Groups 1, 2 and 3

1) In the field of the WG (1, 2 or 3): identification of 2 to 6 key phenomena/processes deserving a research effort to deepen knowledge. For each phenomenon: identification of scientific questions that can be addressed.

Example: Regarding "WG1: physical and geomorphological sciences", what are the phenomena and processes that, although playing a key role in coastal evolution, are still insufficiently known or understood? For each of these phenomena or processes, what are the few key questions that can be used to frame the research effort?

Example:

Key phenomena/processes to be investigated	Scientific issues that can be addressed
Weakness/depletion of fresh groundwater resources in the coastal zone.	Relative weight of agricultural and domestic levies in the weakening of groundwater tables?
	Relative weight of the decrease in recharges by surface waters (river channeling, surface mineralisation) in the weakening of groundwater?
	Role of sea level rise pushing the salt bevel inland?
Shoreline retreat	Role played by sea level rise
	Role played by the increase in the frequency of extreme phenomena (storms)
	Role played by subsidence phenomena
	Role played by decreases in sediment inputs related to nearby (dikes) or remote (continental dams) infrastructure
	Role of energy reflection mechanisms on walls built too close to the shoreline

2) What approaches, in terms of tools, data and methods, would fill the knowledge gap on the phenomena/processes identified by answering the corresponding scientific questions:

Is all or part of the data to improve knowledge of the phenomena and to answer questions concerning them already available in administrative data (census, national directorates), in observatory data (MOLOA) or in LANDSAT or other remote sensing data? What approaches should be considered in terms of specific data collection actions (deployment, types of measurement instruments or collection methods, types of measures or variables) to fill in the necessary but missing information. What sampling strategies would be required? What is the point (or not) of harmonised collection at the regional level? Will the knowledge acquired on a given process be able to be integrated into a model? A model of what type? Is it possible that this model could have predictive capabilities?

3) Among the scientific issues you have identified, which ones cannot be fully addressed with the disciplines in your working group and will require data or knowledge produced by disciplines in the other disciplines/working groups (which ones)?

4) Among the participants, are there any people who could free up time in the next 3 months to participate in a Task Force focusing on writing the parts related to this area of research (1, 2, 3 or 4) in the project.

Names of participants:

Terms of Reference for Working Group 4

1) Identify existing systems that allow the integration of data and knowledge from different fields, and that have already been used in projects of comparable size (regional, interdisciplinary)

2) Specify the objectives of the integration model(s) to be built: reanalysis (hindcast) or forecast (forecast, early warning system). Based on the types of phenomena studied by working groups 1, 2 and 3, identify ways of joining the data, results and knowledge produced. In practice, identify the technical types of models best suited to achieve the objectives: deep learning (complex linear models), neural networks, Bayesian inference, data assimilation, artificial intelligence.

3) On which type(s) of technical platforms (calculation means, data connection) can we rely to realise this (these) integration model(s).

4) Will the model or models developed be intended to be transferred into structures capable of implementing them (MOLOA, Meteo Nationale...), or should we limit ourselves to the production of pilot-studies?

5) Among the participants, is there anyone interested in participating in the next 3 months on writing the parts related to this research?

Names of participants: