Original: English

Distr.: General

07 June 2019

Third Project Steering Committee Meeting for the WIOSAP Project and First Project Steering Committee meeting for the SAPPHIRE project

25-27 June 2019
Durban, South Africa

THIRD PSC MEETING FOR WIOSAP PROJECT: SESSION Vg - PROJECT PROPOSAL ON STRENGTHENING REGULATORY FRAMEWORK, NATIONAL CAPACITY FOR MONITORING EFFLUENT DISCHARGES, WATER, AND SEDIMENT QUALITY IN COASTAL AND MARINE AREAS OF MADAGASCAR .

UNITED NATIONS ENVIRONMENT PROGRAMME
NAIROBI CONVENTION

WIOSAP FULL PROPOSALS TEMPLATE

Call title: Implementation of the Strategic Action Programme for the protection of the Western Indian Ocean from land-based sources and activities (WIO-SAP)

Participating countries: Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, Somalia, South Africa, Tanzania [and France (not project beneficiary)]

Executing organization: Nairobi Convention Secretariat

Duration of demo projects: 2 years

Stage of the call: Full proposals

Submission dateline: 5th March 2019

INSTRUCTIONS

Organisation Name	**Centre National de Recherches sur l'Environnement (National Centre For Environmental Research, CNRE)**
Project Title	**Strengthening regulatory framework and national capacity for monitoring effluent discharges, water, and sediments quality in coastal and marine areas of Madagascar**
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Registration Details	Type of organisation: Public institution of research Country: Madagascar Registration Number: Decree No. 88 -183 of 3 May 1988 establishing and organizing the CNRE, amended by Decree No. 92-471 of 22 August 1992 and Decree No. 93-747 of 02 November 1993 Year: 1988

Executive Summary: Despite the existence of policy to manage and combat pollution, particularly marine pollution, non effective regulatory framework and effluent discharge standards is damaging marine and costal environment from land-based sources of pollution and activities. The weight of marine resources in the national economy challenge concerned stakeholders, such as CNRE, to contribute to solving the problem. As this latter has already been working on this pollution issues within the selected WIO-LAB hot spot and also the proposed site to implementing the present demonstration project, the estuary of the River Betsiboka, developing this project will support the Ministry of environment (MEEF) by designing a management system combining appropriate and effective regulatory framework and decision support tool for managing pollution issues while valorising accumulated results for tackling these issues. So, the project aims at creating better and sustainable conditions for pollution management effectively backed by efficient monitoring framework and strengthened national structure endowed with experience and basic scientific capacity.

I. BACKGROUND AND JUSTIFICATION

a. Context and the problem or critical issue which the proposal seeks to resolve

Madagascar, the 4th biggest island in the world, has one of the longest coastlines in the WIO region, which is estimated around 5,000 km long. Sensitive and vulnerable marine and coastal ecosystems comprise mangroves, seagrass beds and coral reef, which cover a surface area of 2,991 km^2 and 2,230 km^2 respectively (UNEP/NC/WIO-SAP, 2017). With about 55% of the population living within 100 km from the coast, it is obvious that one of the main sources of income for the country comes from the exploitation of the resources from the sea. All resources from this latter (tuna, shrimp, lobster, crab, fish, algae) represent the first source of foreign currency before agriculture products (vanilla, and coffee) and tourism. This is why protecting the marine and coastal environment represents primarily an economical but also a sanitary and environmental stake for Madagascar. However, as many WIO countries alike the reality is different when it comes to the state commitment to ensure its protection duty as it hardly set up the basic conditions to do that in term of appropriate regulation framework, structure to enforce regulation and to control its effectiveness. Consequently, the major source of wealth, the marine and coastal environment, which can drive the country's economy, is since many years ago highly threatened by land-based activities and the resources coming from are unconsciously depleted. This situation is occurring in one of the WIO-LAB hotspot and site implementation of the present project proposal, the estuary of the River Betsiboka adjacent to the city of Mahajanga, where ineffective and non enforced regulation framework is damaging the most rich in biodiversity and most sensitive coastal environment of the country despite the priority given by the government to implementing pollution management policy.

Mahajanga (latitude: $15^0$40 'and longitude: $46^0$21') located in the north-western side of Madagascar, is a coastal and port town with an area of approximately 53 km^2. Located on the right side of the mouth of the River Betsiboka, well known by its reddish-orange coloured waters due to highly loaded lateritic sediment (estimated at 82.1 million tons / year according to Chaperon & al, 1993) from the deforested catchment, the city is home to about 226,610 inhabitants (estimate in 2014). The river is the second biggest river of the country in term of flow. The mouth of the river shaped as a bay, called the Bombetoka Bay, is actually part of its estuary (see figure 1). The Betsiboka estuary, including the bay, with an area of 73000 ha, is the largest marine marsh in the island, including 46000 ha of mangrove formations. The mangroves are place to practice numerous kinds of activities for local populations: fishing, wood exploitation, charcoal production, fences

stakes production, artisanal fish growing (https://www.wioder.org/14/mangroves-and-remote-sensing). It is important to note that the Bombetoka Bay, where the port of Mahajanga is located, was one of the selected hotspots during the WIO-LaB Project. In this context, it was monitored for the quality of water, sediments and biota.

As part of the seafront of the city of Mahajanga, the bay is home to several activities, including many others, shipping (passengers and goods) and fishing (traditional and industrial). Because of its proximity to the city of Mahajanga, capital of the Boina Region, the estuary and its sensitive/vulnerable ecosystems are highly exposed and affected by the impacts of various land-based activities established locally but also upstream, of which mainly industry, tourism (hotels and restaurants), agricultural and fisheries factories, energy supply (thermal station), transportation activities (marine and land), and domestic and municipal activities (municipal discharges and solid waste dumping). As a result, the estuary and its ecosystems are under threat of land-based pollutions ranging from discharge of untreated industrial, shipping and municipal wastewater to dumped solid waste (litter including plastics) and sediment load from deforested catchment upstream. It is well established that pollution is affecting the sustainability of coastal and marine ecosystems thus limiting goods and services that can be derived from them without overlooking the threat on public health through the consumption of contaminated marine products as manifested by the occurrence of frequent case of poisoning. As many WIO countries alike, Madagascar has neither the appropriate regulation framework for land-based pollution and activities nor the capacity to control the sources of pollution affecting the marine and coastal environment including estuaries. Despite the existence of law to combat and regulate pollution from factories and standards for effluents discharge into the environment, their effective enforcement leaves a lot to be desired due to primarily lack of resources and means (human, technical, and financial) for conducting regular control besides the fact that there are no national marine and coastal Environmental Quality Guideline (EQG) for the protection of marine and coastal ecosystems. All these problems of ineffective and poor application of effluent discharges standards control or wastewater treatment regulation could be resolve by linking and the support of CNRE's team through its hot spot monitoring activities, which have been carried out since the implementation of the WIO-LAB project. To do so, CNRE's capacity (mainly equipment) needs to be enhanced in order to expand its technical capacity for the control of effluents discharge and monitoring the impacts on receiving waters and sediment. So, the project proposal is well justified by the need to frame appropriate regulatory framework in harmony with the regional requirement, that takes primarily into consideration the protection of sensitive marine and coastal ecosystems and related resources, and the strengthening of technical capacity (CNRE) to support their effective implementation and enforcement. It's noteworthy that even the best regulatory framework cannot be effective without appropriate technical capacity to control and assess their effectiveness.

Finally, it is important to note that this hotspot (the Bombetoka estuary) presents the synthesis of all the existing problems in the coastal and marine areas around all bigger Malagasy agglomerations in terms of impacts generated by land-based activities, without overlooking the potential and future threats coming from other emerging activities, mainly offshore oil and gas exploration. So the success of the demonstration project would permit its scaling up to other concerned agglomerations.

b. How the need for the project was determined

Selected as hot spot in the WIO-LaB Project during the second meeting of the Working Group on Water Quality, Sediment and Biota, held in Quatre Bornes-Mauritius in 2006, the Mahajanga Port located in the Bombetoka Bay has been, since the implementation of this project, monitored for the quality of water and sediments by a team from the National Centre for Environmental Research

(CNRE). These activities has enabled the CNRE to not only identify certain pollutants that affect the estuary, namely heavy metals and, to a certain extent, hydrocarbons, but also to study a phenomenon specific to this environment, namely the contamination and enrichment of sediments of the estuary with heavy metals, because of the heavy sediment load transported by municipal wastewater and the Betsiboka River (Ravelonandro, Rajoelisoa, Mong, Rajaonarivony, 2010). In terms of organic chemical pollutants, given the land-based activities that discharge significant amount of pollutants and contaminants into the Estuary and the Bombetoka Bay, the issue that should be addressed is their presence and the risk they pose to local population's health. In addition, in order to better understand the current ecological health status of the estuary relative to the impacts of land-based activities, the monitoring of the chemical quality of the estuary is currently coupled with the monitoring of a biological indicator, foraminifera (benthic or planktonic marine unicellular microorganisms), capable of highlighting ecological health status changes caused by climatic and environmental disturbances, and as proxies of pollution (Donnici & al., 2012). The results of the preliminary study of benthic foraminifera as potential bio indicator of the health status of marine and coastal ecosystems are very promising.

According to the results of the water, sediment and biota quality assessments carried out during the WIO-LAB Project (Ravelonandro, Rajoelisoa, Mong Yves *et al,* 2010), the most serious threats concern the massive presence of toxic heavy metals such as chromium, nickel, lead, copper, and cadmium both in water column and sediment, not to mention the other heavy metals (eg mercury, selenium and arsenic) for which the CNRE does not have adequate equipment for their dosage in laboratory. This pollution is explained by the discharges of wastewater from the city of Mahajanga directly into Bombetoka Bay without prior treatment and also by telluric inputs exacerbated by the intensification of deforestation, small scale gold mining, and bush fires along the catchment areas of the Betsiboka River. Intensive rice field cultivation is practiced around the delta zones of the river where fertilizers and pesticides are being used and surely are impacting on the estuary's health status. It should also be noted the presence of hydrocarbon residues near the sewage outlets discharging wastewater from the city of Mahajanga in the Bombetoka bay. In this context, the pollution of the Bombetoka estuary generated by land-based activities is a serious threat for all coastal and marine related activities within the city of Mahajanga areas.

Framing appropriate regulatory framework and legal basis for the protection of marine and coastal environment and making them effective could benefit from the CNRE's monitoring of the estuary because of accumulated results since WIO-LAB project but also through the use of bio indicators that are easy to use by those in charge of controlling the impacts of land-based activities (by building capacity of regional direction of ministry in charge of environment) on marine environment while giving all stakeholders the opportunity to develop better approach to managing land-based sources and activities. Furthermore, tackling the pollution issues affecting the Betsiboka estuary (including the Bombetoka Bay) could benefit the others large coastal agglomerations throughout Madagascar facing similar problem because of the lack of structure of control and effective legal basis for combating sources of pollution of land-based origin. The results and experiences accumulated from WIO-LAB and this demonstration project could be indeed replicated to other coastal and marine sites facing the same land-based sources of pollution and impacts.

c. How the proposed action relates to other relevant national development strategies and policies, WIOSAP priorities and relevant global commitments

As a member of the Contracting Parties of the Nairobi Convention and therefore of the participating countries having requested the implementation of the WIO-SAP Project, whose main objective is to reduce the impacts of land-based sources and activities and to sustainably manage

critical coastal and marine ecosystems, Madagascar is fully involved in this project because it recognizes the relevance of all the components addressed in this project in order to implement sustainable and effective management of coastal and marine areas in the face of countless threats generated by various land-based activities on the coastal and marine ecosystem. On the other hand, the implementation of ICZM national plan, whose strategies to be implemented include the management of marine and coastal pollution, is in need of effective regulation framework support and scientific-based information from the proposed demonstration project making this latter relevant to national development strategies. Last but not least is the Blue economy, which could benefit from and complement with the success of the demonstration project.
The results obtained during the WIO-LaB Project regarding the two hotspots (Mahajanga and Nosy Be) confirm that the pollution by discharges of municipal wastewater, without prior treatment, constitutes one of the main sources of pollution of the coastal and marine areas because it is a widespread practice in coastal agglomerations due to the lack of means and infrastructures for treating wastewater prior to discharge into the sea. This deficiency is largely caused by the weak institutional capacity to effectively enforce the existing legal framework.
As such, this project is an opportunity to strengthen Malagasy institutional capacity to (i) update and align with existing issues, (ii) improve means and mechanisms for the implementation, and (iii) make legal framework more effective in the management of coastal and marine areas.

The project will also provide the information and data needed to set up a decision support tool for local authorities so that they can take more site specific and targeted measures according to the severity of the impacts and the vulnerability of affected ecosystems.
The evaluation and monitoring of water and sediment quality at two hotspots, as part of the WIO-LaB Project, has collected valuable but likely insufficient scientific data on the nature of pollution affecting coastal and marine areas. This allowed the CNRE to set up the core of a marine pollution monitoring system whose strengthening through this project will contribute to the objectives of the WIO-SAP Project achievement, particularly the outcome B1.

Finally, since the monitoring by the CNRE of the quality of water, sediments, and from 2016, foraminifera, is unique in Madagascar in terms of assessment of pollution and degradation of the marine environment related to the impact of land-based activities, strengthening these activities through the WIO-SAP Project will enable Madagascar to have a competent and experienced structure for monitoring the impacts of land-based sources of pollution that is efficient, sustainable and ready to be harmonized and to be integrated into the regional structures. Consequently, the national regulatory framework for the monitoring and management of pollutants, effluents and the quality of receiving environments (coastal and marine) will be fully supported for effective implementation and enforcement.

The proposal will for sure contribute to related SDGs goals (Goal 14) achievement while supporting the implementation of the Blue economy strategy in Madagascar.

d. Whether there are other programmes and activities which will complement the proposal

Except the SAPPHIRE project, the ICZM national plan, the implementation of the Manila Protocol (waiting for funding), and the implementation of the Blue economy, no other programmes and activities are complementary to the project proposal as far as improved water quality and pollution areas are concerned. There is also reported information from the national focal point about the

implementation of the GPA funded demonstration project on the management of Marine litter that surely complement the present project.

II. PARTNERSHIPS

Existing partnerships with the Ministry in charge of environment, national research institutions and with foreign University departments will be strengthened during the implementation of the project in order to ensure the effective achievement of the objectives. Technicians from ministries concerned by pollution issues will be invited to participate in the working group for the regulatory framework and standards review.

a. The mandate and role of each partner

CNRE, as during the WIO-LAB project, will lead and coordinate the project due to its experiences and competence in carrying out such type of project. Its main role consists of co-leading the review of existing regulatory framework, standards, monitoring system in partnership with the department in charge of pollution management within the ministry of environment (MEEF). It supports and participates in the evaluation of national pollution monitoring capacity and training to be conducted by one regional expert.

The other national research institutions will participate in the national working group to review existing regulatory framework, and standards, evaluate national pollution monitoring capacity and deficiency. They will take part in the identification of improvement to be made for an effective implementation of harmonized regulatory framework and standards (capacity building, conditions for sustainability). They will be member of the monitoring network system to be developed later in order to cover the main hot spots.
Foreign university partners (University of Angers-France and Institute Polytechnic of Ancona-Italy will bring their expertise to help strengthen the existing pollution monitoring programme carried out in the estuary of the River Betsiboka (Port of Mahajanga and Bombetoka bay) with respect to foraminifera monitoring, and jointly build capacity of regional direction of the ministry of environment with respect to bio indicator use.

Partner Name	Mandate	Role in the project	Resources partner will provide
1. CNRE	Lead institution	Coordination & execution	In kind and human resources
2. MEEF	Project evaluation	Supervision	Human resources
3. Other institutions	Working group members	Evaluation of existing framework and capacity	Human resources
4. Foreign university	Partners	Local capacity building in project execution	Human resources and expertise

III. OBJECTIVES

A. Overall objective

The project overall objective is to improve the health status of land-based activities affected marine and coastal ecosystems in the River Betsiboka estuary (including the Bombetoka Bay) through

effective implementation and enforcement of an appropriate and regionally harmonized regulation framework.

B. Immediate/specific objectives

In accordance and consistent with the overall objective of the project, the specific objectives are:

- Objective 1. Improve the MEEF and its regional capacity to effectively manage and regulate land-based sources of pollution and activities: by setting up a working group that includes the department in charge of Pollution management at MEEF (Ministry of Environment, Ecology, and Forest), existing regulatory framework will be reframed and updated through the review of existing national standards for wastewater discharges and gaps completed by integrating EQG and EQO for coastal and marine receiving waters in accordance with the developed regional standards. Easy to implement mechanisms for effective enforcement will be devised, based on other WIO countries experiences having faced similar constraints of human, and financial origin and structure of control lacking. . Further, the regional direction of MEEF capacity building in the Boina region will be carried out through the design of and training on the use of a decision support tool based on environmental quality indicators (biological and chemical) and indices, which are a powerful tool for processing, analysing and conveying raw environmental information to decision makers, managers, technicians or the public (Caiero & al. (2005) citing Ramos & al., 2002).

- Objective 2. Increase existing national monitoring capacity to help implement and monitor effluent discharges and water and sediment quality in receiving coastal and marine environment: this will be achieved through the review and evaluation of the existing national capacity by one regional expert in order to identify the weakness and improvement to be made in terms of equipment and training needs and to ensure sustainable and effective support to the developed regulatory framework implementation and enforcement. Different environmental quality indicators (biological and chemical) and indices will be developed as input for the decision support tool.

In order to achieve the above specific objectives, the following activities should be carried out:
- Completing within 6 months the review and update of existing regulatory framework on pollution and wastewater management in order to improve their enforcement while overcoming existing constraints (human resources, financial, technical) that have made it ineffective. In this way, already used mechanisms in other WIO countries will be reviewed and adopted to improve the regulation enforcement capacity of the regional direction of MEEF in the Boina region on more than 50% of land-based sources of pollution and activities at the end of the project.
- Determination of, within 6 months, the conditions for improving monitoring framework taking into consideration the model developed during the WIO-LAB project and CNRE's accumulated results, in harmony with the regional monitoring framework, within the Betsiboka estuary.
- Developing and using, with the help of foreign universities partners, at the end of the first year of the project, a decision support tool to permit the regional direction of MEEF and related local based association for the protection of critical habitat to improve the management of the Betsiboka estuary through the implementation of site specific approach at least within the Bombetoka Bay;
- Achieving, within a year and half, the improvement brought to the programme of monitoring water, sediment and biota quality undertaken by the CNRE in the Betsiboka estuary in harmony with the framework developed at regional level by:
    - strengthening technical capacity in term of equipment and needed training;
    - designing cost-effective monitoring programme for the Betsiboka estuary using accumulated results since the WIO-LAB project, based on the regional monitoring framework;

- integrating and using relevant indicators (sentinel organism, foraminifera and chemical) and indices (contamination, background enrichment and ecological risk) having ability to reflect the hotspot's level of pollution and ecological health status in harmony with the regional indicators;
- completing the gaps in term of knowledge of the major pollutants/contaminants affecting the estuary and their dynamic, load capacity of ecotones in the estuary;
- mapping the types of threats on existing ecotones in the estuary to form the backbone of an information and decision support tool that can be replicated to at least 2 more marine and coastal areas facing similar land-based pressure (eg: Toliara and Toamasina).

It is important to note that developing modelling tool for studying sedimentation issues is beyond the scope of the present project proposal during the time frame. However, the team will seek help through WIOSAP in due time in order to further improve the capacity of the decision support tool.

IV. PROJECT IMPLEMENTATION AND MANAGEMENT PLAN

A. Expected project results and indicators (in accordance with outputs B 2.1 and B 2.2)

In accordance with the expectations of the WIO-SAP Project, the expected results are:

- Regarding national existing regulatory framework and standards related to water quality and effluent discharges, gaps and improvements to be made in order to get to the regional level are identified and completed while mechanisms for their effective implementation and enforcement are tested within the Betsiboka estuary;
- A decision support tool using indicators and indices are developed, tested and validated by the regional direction of MEEF in the Boina region along with the other stakeholders working on the protection of the Betsiboka estuary (eg: association for the protection of the mangroves within the Bombetoka Bay);
- Regional direction of MEEF capacity to managing land-based source of pollution and activities in Boina region is strengthened and the use of decision support tool adopted;
- Monitoring framework for water quality and receiving environment is developed and implemented within the estuary's catchment in harmony with the regional framework;
- Indicators and indices are tested and implemented in order to supply data and information to the decision support tool used by the MEEF regional direction and related marine and coastal environment protection stakeholders within the Betsiboka estuary.
- Existing monitoring program carried out by CNRE is strengthened and improved in term of human, technical and material capacities to fully support the enforcement of the improved regulatory framework and standards.

B. Project activities and work plan

The project activities and work plan, also summarised in the work plan table in Annex 1, will be carried out within the project time frame as follow:

- Specific Objective 1. Improve the MEEF and its regional capacity to effectively manage and regulate land-based sources of pollution and activities.

- Outcome 1.0: National regulatory framework for effluent discharges and standards for receiving water and sediment quality effectively implemented and enforced within the Betsiboka estuary catchment.

- Output 1.1: National regulatory framework for effluent discharge reframed and harmonized with the regional framework

Output descriptions: The primary aim of this output is to update and refresh the national regulatory framework for effluent discharges along with the development of receiving water and

sediment quality standards taking into consideration the regional developed framework, the developed EQG and EQO during WIO-LAB project and accumulated results from CNRE's monitoring activities. Receiving water and sediment quality standards will be used as a basis for monitoring the level of pollution and the land-based activities compliance to effluent discharge regulatory framework within the estuary's catchment.

- **Activities 1.1.1:** Review, update and improve and regionally harmonize the existing national regulatory framework for wastewater discharges.

All the process will be conducted within 6 months by working group composed of the representatives from MEEF (mainly the service in charge of pollution management), representatives from CNRE and other research institutions (National centre for oceanography research, Institute of fishery and marine science), and representatives from ministry having activities as potential sources of pollution, such as mining, industry, agriculture, tourism, fishery). Close collaboration with WIOSAP engaged regional expert/consultant will be set during the process time frame

- **Activities 1.1.2:** Developing receiving water and sediment quality standards.

The same working group in close collaboration with the regional expert will review the developed EQG and EQO developed by WIO-LAB project along with CNRE's monitoring data from the Betsiboka estuary, from Toliara, and Tamatave, this in parallel with the above activities and within the same timeframe. Then, the standards for receiving water and sediment will be developed based on these available information and data.

- **Outcome 2.0:** MEEF regional direction in Boina and concerned stakeholders for marine and coastal environment protection management capacity strengthened and improved.
- **Output 2.1:** Decision support tool developed and adopted by MEEF representatives (at national level from the ministry and at regional level from the Boina region).

Output description: The primary aim of this output is the development of simple and easy to use decision support tool using indicators (bio and chemical) and indices to convey information to managers and concerned stakeholders in order to give them a public awareness mean for potential polluters and later a tool for combating pollution through applying "polluter pay principle".

- **Activities 2.1.1:** Developing the decision support tool.

With the help of our partners from the Universities abroad (Angers/France and Ancona/Italy) this tool will be developed, up to the end of first year, by using biological indicators (foraminifera and sentinel organism) and different indices related to the developed standards for receiving water and sediment. Remote sensing technology will be brought onboard to support the use of indicators. In this way, CNRE has Remote sensing specialists to back the development of the decision tool.

- **Activities 2.1.2:** MEEF regional direction and concerned stakeholders capacity building for pollution management.

Immediately after the development of the tool, training of environment managers from the regional direction of MEEF and other stakeholders will be carried out locally for as much time as needed to allow them to use the tool at least from the beginning of the second year of the project implementation. Data from the CNRE's monitoring activities within the estuary will be provided in order to sustain and make effective the use of the tool for the management of the estuary's catchment and related land-based sources of pollution and activities.

- Specific Objective 2. Increase existing national monitoring capacity in order to help implement and monitor effluent discharges and water and sediment quality in receiving coastal and marine environment.

- **Outcome 3.0:** National monitoring framework regionally harmonized, and fully implemented at the estuary's catchment level

- **Output 3.1:** National monitoring framework developed, validated and adopted by working group.

Output description: Madagascar doesn't have any monitoring framework officially implemented at national level due to weak commitment from the ministry in charge and caused by lack of means (human resources qualified, financial and technical). CNRE's monitoring activities within the WIO-LAB selected hot spot, the estuary of the River Betsiboka including the Bombetoka Bay, was initiated as part of the implementation of water, sediment quality monitoring programme in Madagascar by WIO-LAB. Based on CNRE's team experience, this activity will be improved, harmonised, and expanded to be the core of the national monitoring framework with the support and contribution of the other research institutions so as to be able to cover the main coastal agglomerations of the country. The development of the monitoring framework will be carried out in close collaboration with the regional expert for harmonisation purpose.

- **Activities 3.1.1:** Developing national monitoring framework

Based on the monitoring activities carried out and expanded by CNRE within the River Betsiboka estuary, the national monitoring framework will be developed and regionally harmonised. In this way, integrating the use of indicators will be considered in order to improve the understanding of the extent of the pollution level and later the efficiency and effectiveness of the regulation framework and standards enforcement. This will be tested within the estuary's catchment within a year of the beginning of the project. It's noteworthy that using foraminifera as potential bioindicator of pollution in this site and in Toliara (Great reef zone and mangroves areas) is already carried out by CNRE and its partners from the university abroad (Angers and Ancona).

- **Activities 3.1.2:** Strengthening the capacity of the national monitoring structure

At least within a year and half, the capacity (material and training if needed) of the main structure, having already the basic capacity and experience to carry out the monitoring within the estuary's catchment, i.e. the CNRE, and later the possibility to expand (with the support of the other research institutions), is fully strengthened. The capacity strengthening will be carried out towards the supply of analysis material to cover the majors pollutants suspected to affect not only the present estuary but also most of the aquatic and marine environment of the country as caused by land-based activities such as mining (gold using mercury), untreated municipal wastewater.

- **Activities 3.1.3:** Supplying data and information to MEEF's regional direction decision support tool.

From the beginning of the second year, CNRE's team will be able with the help of its foreign partners (for foraminifera) to supply data and information to the MEEF's regional direction as far as the estuary is concerned. Activities which comprise mapping threat and completing knowledge on major pollutants affecting the estuary will be completed before supplying data.

- **Activities 3.1.4:** Validating the performance of the whole monitoring framework and structure.

Before the end of the end of project (by the end of the second year), CNRE's team along with institution partners will present and report the results of the project to the working group and the NIC, mainly the performance of the monitoring framework and structure in order to get their validation and officially recommend a mandate for the system to be implemented and replicated at national level.

C. Project Beneficiaries

As many WIO countries alike, poor governance of marine and coastal environment characterized by weak and ineffective policy, and legal and institutional framework leading to almost the absence of regulation enforcement and control, is the root cause of marine ecosystems health status degradation in Madagascar. The impacts of land-based sources of pollution exacerbated by the lack of treatment infrastructure facilities for municipal wastewater are effecting both aquatic and

marine environment. Faced with that problem the state with many other priorities (economic and social) to tackle remains powerless to bring solutions and leaves population under different threat, such as among other public health (frequent event of seafood consumption poisoning), reduction of the household sources of income. It is agreed and well known that loss caused by pollution problem affecting the environment may impact negatively on Gross National Product.

So by implementing the project, local population of Mahajanga are expected to be the main direct beneficiary in terms of health risk reduction and also protection of marine-based sources of income. Local women activities, as from many coastal areas alike, are mostly dependent of marine resources availability, such as selling seafood products, consumption for family food security in the household, handy craft production, so they will benefit a lot from the project output.
Secondly, the project will contribute to strengthening the Ministry of Environment, Ecology and Forest role in effectively implementing and enforcing adequate management framework of land-based sources and adequate tool for protecting marine ecosystems and resources through each provincial and regional related direction. The output of the project will surely help the Region of Boina (Mahajanga) enforce the "Polluter pay" principle and protect sensitive and vulnerable ecosystem health status along with all local associations and NGOs for the protection of these ecosystems and their valuable resources. Finally, national research institutions will also benefit from the project by upgrading their capacities so as to be capable of facing the challenges of monitoring land-based activities impacts and by supporting the country's development through the use of their activities results. It is important to note that about 40% of CNRE's lab scientists are females that will be involved in the project implementation.

D. Implementing agency management of project

Although the project implementation is split in 2 complementary phases according to the 2 overall objectives, the Ministry in Charge of environment ensure the Coordination of the project and CNRE will ensure the management and execution of the activities. However, as national regulatory framework, standards, and the MEEF's regional direction capacity is concerned during the first phase, the responsibility for managing the working group will be shared between CNRE and the representative of MEEF from the direction of Pollution management. Representatives of other institutions and concerned ministries will be members of the working group, whose opinions and reviews of many aspects related to failure to effectively implement the national regulatory framework, and the appropriate framework and standards for the country, will be of great importance for the next phase. This latter will be fully managed by CNRE with the participation of other research institutions and foreign partners at the ground execution level. One structure of coordination might be set up for planning and strengthening complementarities with any relevant and related programmes and activities.

V. PROJECT METHODOLOGY (See Logical framework in Annex 2)

Regarding the specific objective 1, **"Improve the MEEF and its regional capacity to effectively manage and regulate land-based sources of pollution and activities**", the methodology will be based on setting up a working group co-leaded by the MEEF representative and CNRE project coordinator. It will comprise of representatives from the research institutions, and from pollution concerned ministries (mining, energy, agriculture and fishery, industry, transport, health...). The working will work according to a term of reference including questionnaires related to the type of regulatory framework for (i) managing effluent discharges and receiving environment quality and (ii) monitoring regulation compliance. From these discussions will be expected to be reframed the national regulation taking into consideration the regional harmonization. Further, past failure

experiences and main constraint to effectively implement and enforce existing national framework will be fully tackled during these working group meeting in order to clearly define all conditions (human resources, technical, financial) required for effective implementation and enforcement.
Strengthening monitoring framework will be based on the WIO-LAB project experiences and CNRE's accumulated data, from which relevant indicators and parameters to be monitored will be selected taking into consideration available local capacity and scientific structure to undertake such a monitoring and the regional harmonization.
The decision support tool consists of mapping biological indicators and indices (contamination indice) having capacity to reflect receiving water quality, ecosystems health status within the estuary and therefore potential land-based sources of pollution compliance to effluents regulations. These indicators and indices (foraminifera, sentinel organism, chemical parameters) will be compared to Water and Sediment quality standards/guideline for the classification (eg: Good, Moderate, and Bad). Geolocalized sampling site will be colour spotted according to the value of indicators and indices.
EQG will be used for water and sediment quality comparison while 3 types of foraminifera indices will be used for monitoring the health status of marine and coastal ecosystems, namely Foram Stress Index (FSI, Dimiza et al., 2016), Foram–AMBI (Jorissen et al., 2018), and FORAM Index (FI, Hallock et al., 2003; Carnahan et. al., 2009). Example of decision support tool using foraminifera indices is presented in Figure 2.

To achieve the specific objective 2, **"Increase existing national monitoring capacity in order to help implement and monitor effluent discharges and water and sediment quality in receiving coastal and marine environment",** all the methodology will be based on already used by CNRE's team within the estuary hot spot. Regularly field sampling will be undertaken to collect water and sediments sample (geochemistry and foraminifera) from selected sampling site considering geomorphological aspect and potential sources of pollution localisation. 2 field campaigns per year, in rainy season (February) and dry season (September to October), will be conducted as considered to be representative of the whole year while giving enough time for analysing samples and supplying data to MEEF's decision support tool. Training for using illustrative map will be provided to MEEF's regional direction and concerned stakeholders in order for them to implement the monitoring framework. Least but not last is the strengthening CNRE's capacity in terms of equipment and identified and needed retraining.

VI. SUSTAINABILITY AND REPLICABILITY

The output of the project will be definitely sustainable because the tool (decision support tool) to be set up as support of the regulatory and monitoring framework implementation and enforcement will be handled over to the government regional representative (MEEF regional direction). Past experiences showed that without regular and sustain supply of information and effective field control, the output of the project, particularly from the objective 1 would not be maintained. However, CNRE's monitoring activities, with ongoing expansion to other coastal agglomerations, will ensure that regular data and information will be supplied to MEEF. Strengthening CNRE's capacity will be a guaranty for the tool to be useful and replicable while contributes to the enforcement of "Polluters pay" principle, being a potential source of funding for the MEEF. Use of foraminifera as indicators could be replicated in the WIO countries facing the same pollution issues. Finally, implementation of ICZM national strategy, SDG and Blue economy, would benefit but also contribute the project outputs being maintained and even expanded.

VII. PROJECT MONITORING AND EVALUATION

The mechanisms for monitoring of project operations will stand at two levels: (i) at the level of the WIO-SAP PMU and at the level of National Implementation Committee (NIC) leaded by the National Focal Point and (ii) at the level of the Ministry of Environment, Ecology and Forest (MEEF) and CNRE direction as beneficiaries. The procedures will be based on objectives achievement monitoring through activity and progress regular reports and physical control when necessary. The two levels of project monitoring will be informed on activities achievement and failure along with the reason for that failure. (See Project monitoring Plan in Annex 3)

VIII. BUDGET

The project budget is presented in the table below (See Budget and justification in Annex 4)

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Webography

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Figure 1: The Betsiboka estuary including the Bombetoka Bay

Foram-AMBI
≤ 1,2 very good
1,2 ≤ x ≤ 3,3 good
3,3 ≤ x ≤ 4,3 moderate
4,3 ≤ x ≤ 5,5 poor
5,5 ≤ x ≤ 6 bad

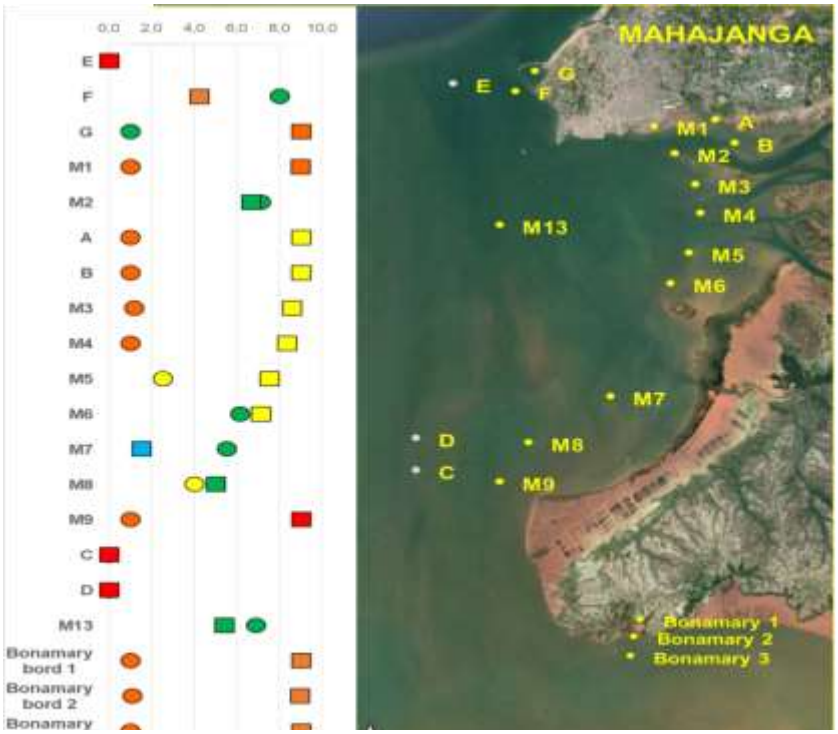

Figure 2: Example of Map supported decision support tool (in the River Betsiboka estuary including the Bombetoka Bay)

Annex1: Project workplan

Task	Responsible	Year 1												Year 2											
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Specific objective 1: Improve the MEEF and its regional capacity to effectively manage and regulate land-based sources of pollution and activities																									
Outcome 1.0	National regulatory framework and standards for effluent discharges and receiving water and sediment quality implemented and enforced within the Betsiboka estuary catchment																								
Output 1.1	MEEF and CNRE																								
Activity 1.1.1	MEEF and CNRE																								
Activity 1.1.2	MEEF and CNRE																								
Outcome 2.0	MEEF regional direction in Boina and concerned stakeholders for marine and coastal environment protection management capacity strengthened and improved																								
Output 2.1	CNRE & partners																								
Activities 2.1.1	CNRE & partners																								
Activities 2.1.2	CNRE & partners																								
Specific Objective 2: Increase existing national monitoring capacity in order to help implement and monitor effluent discharges and water and sediment quality in receiving coastal and marine environment																									
Outcome 3.0	National monitoring framework regionally harmonized, and fully implemented at the estuary's catchment level																								
Output 3.1	CNRE & partners																								
Activity 3.1.1	CNRE & partners																								
Activity 3.1.2	CNRE & partners																								
Activity 3.1.3	CNRE & partners																								
Activity 3.1.4	CNRE & partners																								

Annex 2: Logical Framework

Project title: Strengthening regulatory framework and national capacity for monitoring effluent discharges, water, and sediments quality in coastal and marine areas of Madagascar			
Project overall objective: to improve the health status of land-based activities affected marine and coastal ecosystems in the River Betsiboka estuary (including the Bombetoka Bay) through effective implementation and enforcement of an appropriate and regionally harmonized regulation framework.			
Project Results	**Outputs**	**Activities**	**Costs /output (US$)**
Outcome 1.0: National regulatory framework for effluent discharges and standards for receiving water and sediment quality effectively implemented and enforced within the Betsiboka estuary catchment	O.1.1: National regulatory framework for effluent discharge reframed and harmonized with the regional framework	A.1.1.1: Review, update and improve and regionally harmonize the existing national regulatory framework for wastewater discharges. A.1.1.2: Developing receiving water and sediment quality standards	**Sub - total** **11,000**
Outcome 2.0: MEEF regional direction in Boina and concerned stakeholders for marine and coastal environment protection management capacity strengthened and improved	O.2.1: Decision support tool developed and adopted by MEEF representatives (at national level from the ministry and at regional level from the Boina region	A 2.1.1: Developing the decision support tool. A 2.1.2 : MEEF regional direction and concerned stakeholders capacity building for pollution management	**22,500**
Outcome 3.0: National monitoring framework regionally harmonized, and fully implemented at the estuary's catchment level	O.3.1: National monitoring framework developed, validated and adopted by working group	A 3.1.1: Developing national monitoring framework A 3.1.2: Strengthening the capacity of the national monitoring structure A 3.1.3: Supplying data and information to MEEF's regional direction decision support tool. A 3.1.4: Validating the performance of the whole monitoring framework and structure	**248,500**

Annex 3: Project Monitoring Plan

Project Title: Strengthening regulatory framework and national capacity for monitoring effluent discharges, water, and sediments quality in coastal and marine areas of Madagascar			
Project overall objective: to improve the health status of land-based activities affected marine and coastal ecosystems in the River Betsiboka estuary (including the Bombetoka Bay) through effective implementation and enforcement of an appropriate and regionally harmonized regulation framework.			
Specific Objective 1. Improve the MEEF and its regional capacity to effectively manage and regulate land-based sources of pollution and activities			
Project Results	**Indicator**	**Target/baseline**	**Method**
Outcome 1.0: National regulatory framework for effluent discharges and standards for receiving water and sediment quality effectively implemented and enforced within the Betsiboka estuary catchment.	**IND.1.1** Reframe national regulatory framework developed	**Target**: Level of pollution within the estuary is significantly reduced over the project time frame **Baseline**: Existing regulatory framework is not effectively enforced and monitored by MEEF within the estuary catchment	Through working group discussion, consultation and validation based on term of reference including relevant questionnaires
Outcome 2.0: MEEF regional direction in Boina and concerned stakeholders for marine and coastal environment protection management capacity strengthened and improved.	**IND.2.1.** Decision support tool developed and used by MEEF in the Boina region	**Target:** National regulatory framework for effluent discharges and receiving water quality fully enforced and controlled within the estuary **Baseline:** Existing discharge regulation is not enforced and no	Development of decision tool based on indicators and indices mapping of the concerned site (estuary) and training for use

		EQG or standards applied to receiving waters	
Specific Objective 2. Increase existing national monitoring capacity in order to help implement and monitor effluent discharges and water and sediment quality in receiving coastal and marine environment			
Outcome 3.0: National monitoring framework regionally harmonized, and fully implemented at the estuary's catchment level	**IND.3.1.** National monitoring framework adopted and tested within the estuary and CNRE's capacity strengthened in terms of equipment and retraining	**Target:** Developed national monitoring framework is implemented within the estuary and MEEF's tool being supplied with relevant data and information from CNRE's monitoring activities **Baseline:** WIO-LAB developed framework is not implemented so there is no national monitoring framework	Harmonizing CNRE's current monitoring to comply with the regional requirement along with strengthening its capacity to fully be supportive of monitoring framework implementation

Annex 4 Budget table

Title of the Project : Strengthening regulatory framework and capacity for monitoring effluent discharges, water, and sediments quality in coastal and marine areas of Madagascar

Expected results	No Activity	Activity	Staff cost		Contractual services		Equipment and Training		Travel/Mission		Total cost (US$)
			Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	
***Output 1.1*: National regulatory framework for effluent discharge reframed and harmonized with the regional framework**											
	1.1.1	Review, update and improve and regionally harmonize the existing national regulatory framework for wastewater discharges.	2,500	2,500	2,500						7,500
	1.1.2	Developing receiving water and sediment quality standards			2,500						2,500
		Co-financing			1,000						1,000
		Subtotal for output 1.1	**2,500**	**2,500**	**6,000**						**11,000**
***Output 2.1:* Decision support tool developed and adopted by MEEF representatives (at national level from the ministry and at regional level from the Boina region).**											
	2.1.1	Developing the decision support tool			10,000				3,000		13,000
	2.1.2	MEEF regional direction and concerned stakeholders capacity building for pollution management			5,000				2,000		7,000
		Co-financing			1,500				1,000		2,500
		Subtotal for output 2.1			**16,500**				**6,000**		**22,500**
***Output 3.1*: National monitoring framework developed, validated and adopted by working group.**											
	3.1.1	Developing national monitoring framework		5,000	10,000					6,000	21,000

				3.1.2	Strengthening the capacity of the national monitoring structure				5,000	10,000	170,000	5,000	20,000	210,000
Co-financing							3,000			1,000	10,000	1,000	2,500	17,500
Subtotal for output 3.1							**8,000**	**10,000**	**5,000**	**11,000**	**180,000**	**6,000**	**28,500**	**248,500**
					Cost for the administration (5% of the total cost)									**14,100**
Total cost (US$)														**296,100**

Budget justification

	Category	Justification
1.	**Personnel**	Personnel will include coordination functioning and working members participation during the first phase, ie review and reframing regulation framework
2.	**Equipment**	CNRE's capacity strengthening requires water measuring equipment (in lab and for field test) for heavy metals and computer
3.	**Operating costs**	Communication will be used for getting in touch with PMU, National focal point and foreign partners. Telephone call will be used for getting in touch with working group member
4.	**Contract Services**	The project especially during the national monitoring capacity assessment will need external consultant from PMU in order to identify weakness to be improved and recommend better approach to make it supportive of regulation and standards enforcement
5.	**Travel**	Foreign partners, project staff, and consultant will travel nationally and internationally, likely retraining of project staff as well