IOC-Smartfish project / GEF-Satoyama Project

THE BARACHOIS PROJECT

A collaborative management approach for the sustainable development of a local fishery in the barachois of Residences la ChauxMahébourg in the Republic of Mauritius.

An Integrated Coastal Zone Management (ICZM) Project

Feasibility study: developing community-based mariculture in the Barachois of Residences la Chaux/Mahebourg:

(Final Report)

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Executive summary

The feasibility study was conducted in the southeast of Mauritius over a period of 6 months, from February to August 2016, as part of the design and planning phase of The Barachois Project. The main goal of the study was to assess the adequacy and feasibility of developing community-based mariculture activities in the barachois adjacent to Residences La Chaux. Baseline biophysical and socioeconomic data were collected using various mechanisms to demonstrate the adequacy of community-based mariculture in the barachois, which will create additional and alternative income generating activities in the adjacent community. A strategic plan has been developed through consultation strategies including group interviews with fishermen, participatory mapping, observational walks, and boat trips. The first species considered for cultivation in the barachois as a pilot and demonstrative initiative is the mud crab (*Scylla serrata*). Two grow-out systems will be tested: a "net pen" and various "cages" of different materials in the mangrove area. Various tests and evaluations highlighted the feasibility and adequacy of crab culture as an experimental start to developing mariculture in the barachois. The positive outcomes of the first phase include: successful evaluation of overall water quality and presence of two mangrove species adequate for culture, positive local perception toward the project and willingness to participate by the fishermen, community awareness and support towards mariculture development, election and implementation of management structure, availability of crablets, low-cost availability of feed, high demand for seafood at local level, good transportation andproximity to potential customers, and partnerships with others stakeholders. The experimental study of crab culture shows that the barachois project is ready for implementation. The present project is currently financially sustainable with funding from GEF-Satoyama Project. Moreover, future contributions are pledged by Ladies Circle.

I INTRODUCTION

The Barachois project is a small scale community-based initiative that aims to contribute to the enhancement of the ecological integrity of the Grand Port lagoon by promoting sustainable management and use of a coastal and marine wetland with the support and participation of the traditional fishermen's community. This goal will be achieved through various objectives: (1) enhancing fisheries production locally through mariculture initiatives; (2) enhancing livelihoods at community level through income generating activities and a healthier environment; (3) capacity building through training, education, sensitization as well as participation in decision-making and management activities; (4) improving ecosystem health by conserving ecosystems and offsetting the community dependence on marine resources; (5) using a collaborative management approach in which all stakeholders, particularly the local community, are involved and consulted in all aspects from project design and planning to implementation to ensure project effectiveness and sustainability.

It is now widely recognised that emphasis should be placed on encouraging and providing the resources for local people, particularly fishermen, to seek alternative or additional livelihoods (Giasuddin & Alam, 1991; Kador, 1991; Campbell *et al.,* 2006).

Community-based mariculture is considered promising in East Africa for poverty alleviation, economic development and the promotion of environmental sustainability (Mirera & Samoilys, 2008). Small-scale aquaculture is seen worldwide to be crucial for the livelihood, well-being and food security of the poorest coastal communities (Brummett & Williams, 2000). However, mariculture development had previously gone through several setbacks due to lack of adequate technology, a high cost of labour (Christensen, 1995), lack of facilities, infrastructure and government policies in the Indian Ocean (Mirera & Ngugi, 2009).

In consideration of these deficiencies, the present study investigatesmariculture possibilities and assesses the adequacy and feasibility of developing community-based mariculture activities in the barachois of Mahebourg / Residences La Chaux as part of the planning and design phase of The Barachois Project.

II OBJECTIVES

The objectives of this study are:

- Examine the adequacy of bio-physical characteristics of the study area, including water quality, for mariculture activities.
- Investigate possibilities for integrated mariculture initiative in the coastal community of Residences la Chaux.
- Develop pilot mariculture strategiesin collaboration with local fishermen, government agencies and other stakeholders.
- Evaluate fishermen's perceptions toward mariculture activity as an additional or alternative income generating activities.
- Determine fishermen and local residents willingness to participate and collaborate in mariculture activities.
- Identify the availability of local mariculture expertise.
- Identify socioeconomic conditions and livelihood of the coastal community and level of resource uses in the area to assess the adequacy of mariculture and guide project design and planning.
- Effectively design and plan management activities including a crab culture strategic plan using local and regional expertise and traditional knowledge.
- Prepare for the implementation phase.

III METHODOLOGY

3.1 Location

The study area is located in the district of Grand Port, in the south-east of Mauritius Island (fig.1). The study area comprises the barachois of Mahebourg / Residences la chaux including its adjacent mangrove forest, covering a surface of approximately 28 ha. Residences la Chaux is the local community adjacent to the study area with GPS position: 20025'03.35''S ; 57042'47.35''E.

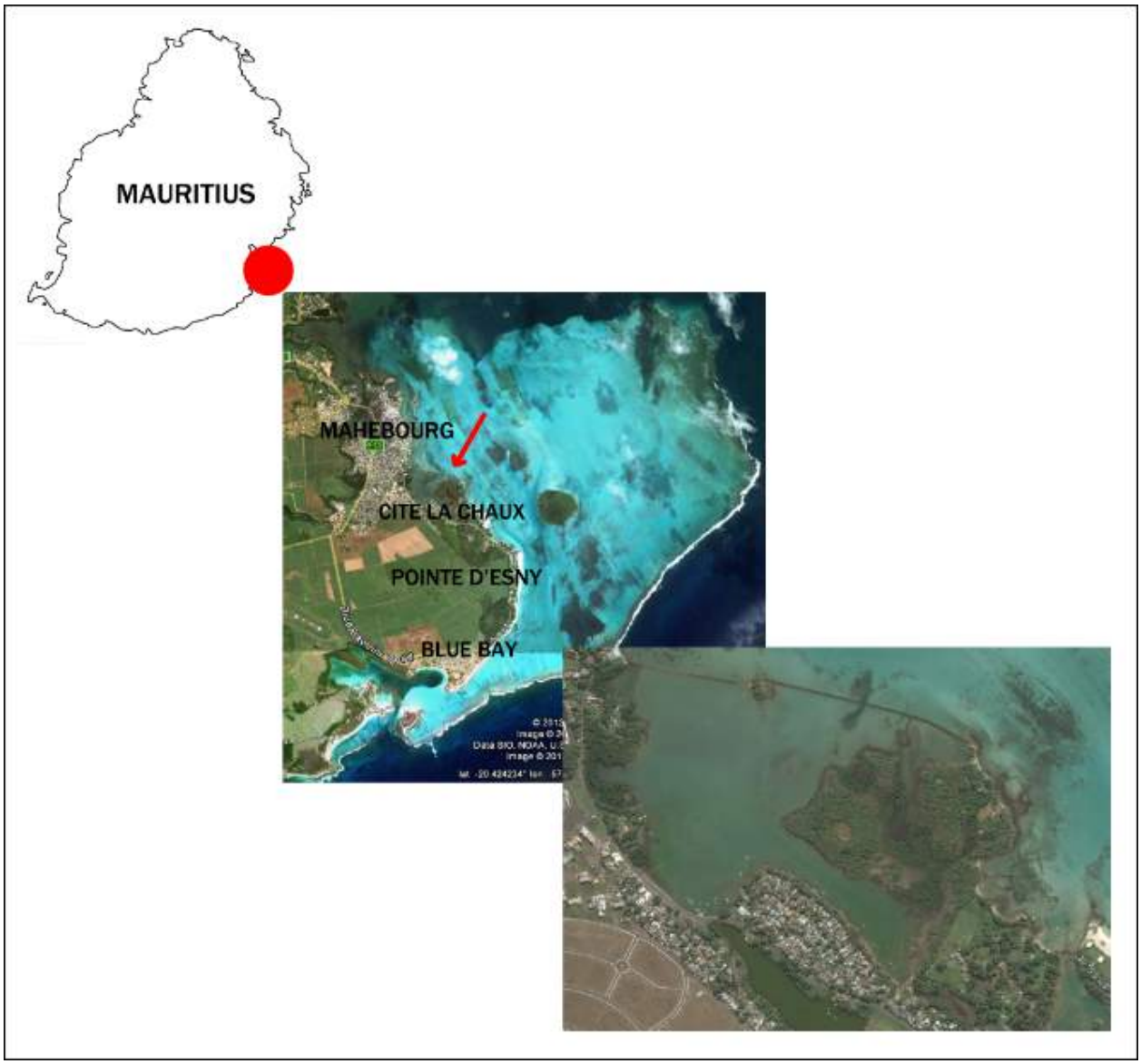


Figure 1:*Compilation of maps displaying the area of operations at different scales.*

3.2 Timeframe

The project officially started on the 15th February, 2016.

Component / Activity	Feb-16				Mar-16				Apr-16				May-16				Jun-16				Jul-16				Aug-16			
	w1	w2	w3	w4	w1	w2	w3	w4	w1	w2	w3	w4	w1	w2	w3	w4	w1	w2	w3	w4	w1	w2	w3	w4	w1	w2	w3	w4
Phase 1 (15th February - 15th August)																												
Barachois restoration design & planning																												
Regular Meetings (consultation strategy) with local fishermen		■	■		■					■			■	■	■		■	■				■		■	■	■		
Compilation of local knowledge on resources uses within the CMA		■	■	■	■	■	■	■	■	■	■	■																
Design of a questionnaire for individual interview survey with local fishermen				■																								
Conduction of questionnaire-based interview survey with local fishermen					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■						
Undertake baseline bio-physical study with the University of Mauritius																		■	■	■	■	■						
Design of the baseline socio-economic study for local residents (household survey)													■															
Undertake baseline socio-economic survey with local residents (household survey)													■	■	■		■	■	■	■	■	■	■	■	■	■		
Selection of local community representatives (community/fishermen/women)																			■	■	■	■	■	■				
Consultation strategies with local, national and international experts & government agencies		■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Development of a strategic plan for mariculture																							■	■	■	■		
Identification of and consultation with potential buyers of future barachois products																							■	■	■	■		
Identification and selection of representatives for the CMA Committee							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Awareness-Sensitization																												
Consultation strategies (face-to-face discussions, individual and grouped interviews)					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Design of awareness raising materials (map, information and warnings panels)					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Development of the logo									■																			
Development of a Facebook page										■																		
Creation and production of business cards																									■	■		
Development of a report to funders and government agencies													■													■		
Development of a volunteer program									■	■	■	■	■	■	■	■												
Development of an Internship program															■	■	■	■	■	■	■	■						
Press release								■																				
Mangrove areas restoration and clean-up																												
One day community-based mangrove areas clean-up event (zone 1)											■																	
Clean-up of mangrove areas by selected local fishermen (zone 1 & 2)																			■	■								
Financial Management																												
Funding application with CSR companies		■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Funding application with international donors		■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Budget management and development of a financial report		■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		

Table 1:*Timeframe of year 1 of the Barachois Project (months 1 to 6).*

3.3 Barachois restoration design and planning

3.3.1 Regular meetings with fishermen

3.3.1.1 Overview

Eighteen meetings were conducted with the targeted local fishermenat different locations in Mahebourg and Residences La Chaux (see table 2). Locally registered and non-registered fishermen of Residence La Chaux and selected fishermen of Mahebourg, as well as the project manager (PM) and project assistant (PA) debated and brainstormedproject design and planning.

MEETING	DATE	TIME	ATTENDANCE	LOCATION
Meeting 1	15-Feb-16	(Meeting postponed)	2	Residences La Chaux Social Welfare Centre
Meeting 2	29-Feb-16	4 pm - 5 pm	14	Residences La Chaux Social Welfare Centre
Meeting 3	14-Mar-16	(Meeting postponed)	1	Residences La Chaux Social Welfare Centre
Meeting 4	17-Apr-16	5 pm - 7 pm	9	Residences La Chaux Social Welfare Centre
Meeting 5	2-May-16	5 pm - 6 pm	6	Remi Ollier building - Mahebourg
Meeting 6	9-May-16	5 pm - 5:30 pm	6	Residences la Chaux - close to barachois
Meeting 7	15-May-16	10 am - 12 pm	35	Residences La Chaux Social Welfare Centre
Meeting 8	18-May-16	5 pm - 6 pm	6	Remi Ollier building - Mahebourg
Meeting 9	21-May-16	2 pm - 4 pm	14	Residences La Chaux Social Welfare Centre
Meeting 10	3-Jun-16	3 pm - 4:50 pm	23	Residences La Chaux Social Welfare Centre
Meeting 11	8-Jun-16	3 pm - 4:15 pm	17	Remi Ollier building - Mahebourg
Meeting 12	10-Jun-16	3 pm - 4:15 pm	32	Residences La Chaux Social Welfare Centre
Meeting 13	8-Jul-16	3 pm - 5 pm	25	Residences La Chaux Social Welfare Centre
Meeting 14	29-Jul-16	6 pm - 8 pm	12	Residences La Chaux Social Welfare Centre
Meeting 15	2-Aug-16	4 pm - 6:15 pm	26	Residences La Chaux Social Welfare Centre
Meeting 16	3-Aug-16	7:30 am - 11 am	2 (selected)	Observational walk (zone 1)
Meeting 17	9-Aug-16	4 pm - 7:15 pm	19	Observational walk (zone 1)
Meeting 18	11-Aug-16	10 am - 3:30 pm	4 (selected)	Port Louis

Table 2: *The list of meetingsincluding respective location, attendance and schedule.*

3.3.1.2 Objectives

Main objectives of meetings with fishermen:

- Involve the local fishermen in the decision making processes of the planning and design phase of the barachois project.
- Include the fishermen's wants, needs and opinions in project planning and design.

- Regularly inform fishermen ofthe activities of the management team to providethem the opportunity to participate.
- Evaluate fishermen's attitudes and perceptions towards the project.
- Identify and predict potential conflicts that may arise over project implementation and management, and mitigate these conflicts in advance.
- Ensure ownership of the project by key stakeholders.

3.3.1.3 Minutes of proceedings

Meeting 1 (Postponed due to lack of participants)

Meeting 2(Majority fishermen of Residences La Chaux)

The project manager introduced the Barachois Project, as well as the activities potentially associated with the project after its successful implementation. The fishermen were strongly encouraged to attend meetings in order to contribute to the project, as their participation is critical to ensure its sustainability and ongoing maintenance. The fishermen raised concerns as to meeting times that would allow all stakeholders to attend and encourage participation from fishermen who had not previously been involved in community engagement.

Originally, the project was planned to be implemented with the support of the NGO “Mouvement Solidarite de Mahebourg," but a vetting process revealed the lack of project expertise and background of the NGO, and a partnership was formed with EPCO (Environmental Protection and Conservation Organisation) in 2015. To confirm agreement and support with EPCO's involvement, the Fisheries Director requested a petition be taken by the fishermen in the community, as well as the "Association des Pecheurs Professionels de Mahebourg.”

A draft map of resource use patterns was developed and presented to guide the first phase of the project, focusing on designing a strategic plan for mariculture activities. The fishermen confirmed that their commercial activities do not currently take place within the CMA zone. They also expressed concern with a lack of surveillance in the barachois, and requested community awareness and a focus on a specific site within the barachois, which would allow for monitoring and prevention of illegal poaching of crabs and fish from the barachois.

The meeting concluded with a brainstorming session regarding commercially viable species within the barachois, with the fishermen voicing input for "carlet" crabs.

Meeting 3(Postponed due to lack of participants)

Meeting 4 (Majority fishermen of Residences La Chaux)

The project manager introduced the scope, activities, benefits, participating organizations and sources of funding to the meeting participants. The conversation continued to address the resource map, with the fishermen's main concern being surveillance to counter illegal crab fishing at night. Possible suggestions included boat and foot patrol, warning panels, closed circuit television monitoring, and ensuring that the entire community was aware of the project. The project manager confirmed a meeting open to the entire community to raise awareness.

A cleaning of the barachois area to conduct a biophysical study was arranged, taking into account the fishermen's schedules; fishermen were reassured that their boats would not be removed and their access to the lagoon would not be restricted by the cleaning or project. It was stressed that the project requires the ongoing support of the fishermen to decide usage patterns within the CMA, and there would be no interference with their commercial activities without their explicit consent.

Meeting 5 (Only fishermen of Mahebourg)

This meeting addressed the fishermen of the "Assocation des Pecheurs Professionels de Mahebourg" who had not attended the previous meetings. The fishermen voiced concerns that the fishermen of Residences La Chaux were not interested in their help or participation as the barachois is adjacent to the Residences La Chaux community.

The project manager requested a list of fishermen interested in the project, as well as a list of activities and materials that could be implemented in the barachois, which would be addressed with the fishermen of Residences La Chaux, in order to proceed with the project and resolve issues between the communities.

Meeting 6(Majority fishermen of Residences La Chaux)

The project manager informed the fishermen that she contacted the President of Residences La Chaux, Christian Aristide, to discuss the project. The President requested a list of fishermen involved in the project, a project proposal and acceptance letters from the government. The President organized a meeting with the non-profit organization, "Mouvement Bien Etre de Cite La Chaux" to mobilize the fishermen and encourage their attendance at future meetings. Convocation letters were sent by the President to fishermen within Residences La Chaux to increase attendance at the meetings.

Meeting 7 (Fishermen of Residences La Chaux)

The President of Residences La Chaux attended the meeting and gave a speech reiterating his support and the approval of the "Mouvement Bien Etre de la Cite La Chaux," and cited the benefits to the community. The President addressed concerns that EPCO may assimilate control of the barachois, and spoke honestly about the need to restore and maintain the barachois to keep the property within the community. He encouraged fishermen to attend meetings and be a part of the process to allay their fears, as previous attempts to develop the barachois had been met with a lack of expertise and financial capital, but the current project addressed those problems and would bring a net positive effect to Cite La Chaux.

The project manager introduced the project again and her role in bridging the divide between the community and the government, as well as experts and institutions who can finance the project. Several fishermen were not convinced that they would maintain access to their boats and fishing grounds, and requested a letter from EPCO certifying that the boat passage would not be blocked. The project manager reassured the fishermen that their input was required in the decision making, and because the barachois is government property, the NGO cannot restrict usage in the lagoon. Further fears were addressed that a hotel would be constructed within the mangrove system.

The discussion shifted to the fishermen's preferred area for mariculture, which was agreed upon, allaying concerns that the area would be too large, and therefore attract illegal and exploitative use of the barachois.

The project manager responded to questions of the benefits to the community-at-large of the project, noting the restoration of the environment, the establishment of the barachois, and the implementation of activities within the lagoon that will benefit the fishermen and the community. The inclusion of 19 fishermen from the "Assocation des Pecheurs Professionels de Mahebourg" was addressed, and the fishermen of Residences La Chaux expressed concerns over their ownership of the barachois. The project manager described the role of the fishermen from Mahebourg in rehabilitating the barachois in 2001, and their assistance in advocating for the project with the government. The fishermen responded positively, and suggested that a representative of the fishermen be elected to encourage meeting attendance.

The project manager detailed the creation of a CMA committee to include representatives from the fishermen's community, the government, NGOs, and experts from the University of Mauritius who would meet every four months to discuss, plan and solve issues concerning the project.

Meeting 8 (Only fishermen of Mahebourg)

The fishermen confirmed the participation of 18 fishermen, and the dissolution of the "Assocation des pecheurs professionels de Mahebourg." The lack of participation by the fishermen and lack of attendance had prevented a strategic plan from being drafted, leading the project manager to agree that fishermen who did not attend the next meeting would be removed from the project. The project manager also confirmed that the fishermen of Residences La Chaux were willing to cooperate in the development of the plan, and after one last meeting exclusive to the fishermen of Mahebourg, all future meetings would involve fishermen from both communities.

Meeting 9 (Majority fishermen of Residences La Chaux)

A surveillance plan was put forth by the fishermen involving a two-man patrol boat at night, and monitoring by the Coast Guard and fishermen by day, as well as closed circuit cameras on areas where illegal fishing activities generally occur.

Suggestions for mariculture were put forth, including the crab 'carlet' and 'sevrette de mer,' but the lack of expertise of the fishermen requires the consultation of an expert on mariculture practices. A resident of Ville Noire had been contacted and was willing to sell crabs for the barachois, and another private barachois owner in Bambou Virieux would allow the participants to collect crabs. A fishermen informed the group that fingerlings could be obtained from the Albion Fisheries Research Centre.

To address absenteeism, a fishermen suggested that three representatives should be elected to represent and speak for the decisions of the community, share relevant information to the fishermen and be responsible for the convocation of fishermen to meetings.

The disagreement concerning the involvement of the fishermen from Mahebourg was voiced again, and participation in the forthcoming beach clean-up event was discussed.

Meeting 10 (Majority fishermen of Residences La Chaux)

Eightfishermen were chosen for the clean-up event (8 from Residences La Chaux and 2 from Mahebourg), three fishermen's representatives of Residences La Chaux to interface between the fishermen and the project manager were chosen, but official nomination was postponed due to absenteeism. The fishermen were informed that the clean-up would occur during the week of June 13th to 18th, 2016, and they would be paid 500 MUR per half day. The fishermen were reminded that experts from the University of Mauritius would be coming to conduct a biophysical baseline study, and fishermen were encouraged to observe and cooperate with the study.

The fishermen expressed frustration over the consistent absenteeism and a lack of progress, and concerns that the representatives be transparent and able to interact with all members of the community to ensure the involvement of all fishermen. The issue of involvement of fishermen from Mahebourg was addressed again, and the project manager stressed that the number of fishermen from Mahebourg would always be smaller than the number of participants from Residences La Chaux.

Meeting 11 (Only fishermen of Mahebourg)

The fishermen asked for the scope and activities of the barachois project to be explained again, and the project manager gave an overarching explanation, the representative of Mahebourg fishermen was elected and two participants were chosen for the clean-up project after the salary and schedule were explained.

The permanent schedule of meetings on Fridays at 3:00 PM with the fishermen of both communities was established, and the project manager encouraged the participation of the fishermen. She took down their names and signatures to begin an approval process for interviews.

The fishermen suggested 'sevrette de mer' as a potential mariculture, and fears of restricted boat access were addressed. A fisherman discussed digging the barachois, as it is currently too shallow to support mariculture activities.

The project manager emphasized the length of the project and the delay in benefits to the community as the project was established, and informed the fishermen that the next meeting would include fishermen from Residences La Chaux.

Meeting 12 (Fishermen from Mahebourg and Residences La Chaux)

The final list of sixteen fishermen from Mahebourg was confirmed, as well as their elected representative, while absenteeism prevented the representatives of Residences La Chaux from being selected. The fishermen from Residences La Chaux informed the project manager of a private meeting they had held, and decided they would elect their representatives themselves.

The fishermen communicated a list of crabs caught for commercial activities, and the project manager announced the visit of a crab expert who would help to establish the mariculture with approximately 100 crabs. The mariculture activity was planned to begin in 3 months, and a meeting with the women and fishermen of Residences La Chaux, as well as the Ministry of Housing and Lands would be organized. The fishermen were informed access to the mangrove forest "Cot Nicole" would be granted if the activities were successfully implemented, requiring adequate surveillance of the barachois and compliance and involvement of the community.

The inclusion of both communities of fishermen was discussed, and the fishermen agreed that both communities participating was necessary to avoid conflict over the benefits of the project. The project manager informed the fishermen that meetings would now be held every other week, and representatives would directly inform the fishermen as to the time of meetings and activities.

Meeting 13 (Fishermen from both Mahebourg and Residences La Chaux)

The project manager distributed the Household Survey and briefly described the questionnaire, as well as its significance.

The previous election of representatives by the fishermen of Residences La Chaux was reflected on, and the project manager announced the election of representatives through individual interview that allowed for input by quieter members of the community. The fishermen were given the opportunity to suggest two representatives, and there was general agreement about the selection. One final representative from 'Cite Tole' in Residences La Chaux had not been elected, and the project manager asked for suggestions to elect this member.

The project manager distributed a letter certifying the passage of boats through the barachois would not be affected to the representatives and stated that the letter was a request from the fishermen of Residences La Chaux. The fishermen expressed concern over the validity of the letter, and the legality of the letter if the project manager resigned. The project manager assured them that the letter would be updated.

Ladies Circle 1 agreed to provide financial support through a cupcake fundraising event, and the fishermen suggested a meeting with the Ministry of the Environment to garner government support for the project, as well as meetings with the community-at-large.

The project manager explained that the objective behind the CMA committee would be to include more community members in a workshop. The distribution of petition sheets was justified as being crucial to show the support of the population for the project and receive approval by the government. The project manager also detailed the Memorandum of Understanding (MOU) by the Ministry of Environment to ensure the security of the project and promote the effective implementation of the project, thus encouraging the fishermen to be confident in the future management of the project.

The project manager and a fishermen present at the meeting detailed the potential crab cage made of Strawberry Guava stems. The fishermen were concerned that cannibalistic behavior would occur in the mangrove area and dispersal of crabs would be difficult to catch. As a result crab will have to be stocked in net pen in the mangrove area to facilitate monitoring and crab collection and also in individual cages. All fishermen agreed that boats should be kept off the crab culture zones. The project manager confirmed that the initial experimental culture would be grown in an enclosed basin, but that the fishermen should note their ideas for crab cage design, and enquire about the permits required for mariculture activities. Fishermen suggested PVC piping to construct cages as it is very resistant under water. The project manager noted the high cost of such material and required fishermen to draw potential designs of cages including the list of required materials.

Meeting 14 (Fishermen from Mahebourg and Residences La Chaux)

The project manager provided a Powerpoint presentation on mariculture with case studies on crabs worldwide , and a general biological overview of culturing crabs and their preferred habitat. Fishermen reiterated their preference for PVC as well as the idea of floating cages. Absenteeism required a second date for the presentation.

Meeting 15 (Fishermen from both Mahebourg and Residences La Chaux)

The project manager informed the community that the Ministry of Housing and Lands would tour the site during the next week to approve the fencing and usage of Zone 1. The fishermen expressed their interest in working on the masonry of the fencing, as nine have experience in fencing and can contract other laborers from within Residences La Chaux. The specifications of

the fencing were discussed, including concrete, galvanization, stud spacing and diameter, and other required materials. The project manager further encouraged volunteer clean-up days to continue to work on Zone 1.

The project manager ran through the powerpoint presentation again and the fishermen talked through the presentation with suggestions for the revitalization of the mangrove area, experimentation with caging materials, and creation of polyculture with plastic, guavas and PVC piping. An observational walk was planned for the 9th of August, 2016, so all fishermen could determine the mariculture zone.

Meeting 16 (2 selected fishermen from Residences La Chaux)

Measurements of the depth of the barachois were taken at various locations and the two fishermen expressed their interest in creating a polyculture, but the depth of the lagoon was determined to be too shallow to support fish or floating cages. The site required intense cleaning and the removal of a temple.

Meeting 17 (Fishermen from Mahebourg and Residences La Chaux)

An observational walk through Zone 1 responded to fishermen's concerns that the barachois would not immediately employ people, but depending on the progress of activities within the barachois and sustained effort, the project could develop to benefit more people in the community, both directly and indirectly. The need for volunteers to contribute to the project, and to continue planning, were elaborated on.

Meeting 18 (4 selected fishermen from Residences La Chaux)

The project manager and the 4 selected fishermen went tocompanies in the region of Port Louis with the CEO of EPCO to check the size, price and availability of materials at Resiglas Co., Ltd in Calebasses, Plastic Industry of Mauritius (PIM) ltd, and Chantier Ramtoola ltd in Calebasses.

3.3.2 Questionnaire-based interview survey to local fishermen

3.3.2.1 Overview

The goal of the survey was to provide baseline data on the socio-economic conditions and livelihood of the local fishermen, who are the main stakeholders in the project. This data will serve as a benchmark to monitor the results of the planned project's activities and guide the project manager during the project design and planning phase. Based on the list of fishermen in the region requested from the Ministry of Ocean Economy, Marine Resources, Fisheries, Shipping and Outer Islands, 45 registered fishermen of Residences La Chaux have been targeted according to three selection criteria: (1) Resident of Residences La Chaux, (2) Resident of Pointe d'Esny Fishing Landing Station or (3) Resident of Residences la Chaux and Pointe d'Esny Fishing Landing Station (refer to App. 1). The 16 fishermen from Mahebourg are the second group of stakeholders to whom the survey was administered.

3.3.2.2 Objectives

The main objectives of the survey are:

- Establish socio-economic baseline data regarding local fishermen whereby the selected indicators can be effectively tracked to measure project effectiveness and determine the fishery and socio-economic effects of the project on the local fishing community.
- Accumulate knowledge on the commercial livelihood of the fishermen, and correlate this knowledge to the design, planning and implementation of mariculture activities.
- Understand how fishermen interact with their environment and use their marine and coastal natural resources.
- Identify treats and pressures on natural resources.
- Create a baseline to assist in economic valuations of the project.
- Increase interaction between EPCO staff and local fishermen.
- Assist in determining and measuring changes in the motivations and willingness of fishermen to contribute to the project.
- Provide information for sustainable management of marine resources.
- Evaluate fishermen's perceptions and attitudes toward the project.

3.3.2.3 Methodology

The interview survey was conducted using a questionnaire by two selected local women, who were selected and trained to conduct interviews, the project assistant and the project manager. The survey principally targeted fishermen who lived closest to the barachois area which was the village of Residences La Chaux, as it was assumed that this was the community the most likely to be positively impacted by the project. Each interviewer walked from house to house and interviewed any fisherman who were at home and was willing to be interviewed. Each interview was conducted either in French or in the local dialect "Creole" depending of the interviewer. The questionnaire included both closed and open-ended questions that were grouped into 8 different sections (see App. 3): (1) A series of personal and demographic questions about the fishermen;(2) Income from fishing; (3) Additional income; (4) Location of fishing zone; (5) Type of gear used; (6) Catch characteristics; (7) Stakeholders interaction and;(8) Project Perception.

Before beginning the interview, participants were informed that their participation in the survey was completely voluntary, and the answers provided would be totally confidential. All participants were given a number (1-X) in order to better ensure confidentiality. It was requested that each respondent answered each of the questions as accurately and honestly as possible. At the end of each interview, all respondents were given the opportunity to make additional comments, after which they were thanked for their participation.

3.3.2.4 Data analysis

To gauge whether there had been a temporal change in fishing activities, catch composition, income or gear, the village questionnaire was divided into two periods: the past (at least 10 years ago) and present time (limited to 2016). Qualitative and quantitative data gathered from interviews was pooled and analyzed using descriptive statistics and graphics and presented in narratives, tables and graphsusing Microsoft Excel.

The results of the survey are subject to limitations and bias, as well as organizational constraints. The answers to open-ended questions have been grouped into broad category statements to simplify data analysis.

3.3.3 Household survey to the local community

3.3.3.1 Overview

The main goal of the household survey is to assess the resources and capacity of the local community through a questionnaire-based survey with a target of reaching all 2500 houses within Residences La Chaux to create a socioeconomic baseline to gauge the effect of the project on the community and establish stronger connections and contacts within the village to facilitate future implementation of the project.

3.3.3.1 Objectives

The primary objectives for the household survey included:

- Facilitate engagement and interaction with the local community
- Understanding of the demographics of the community to longitudinally assess changes within households over time.
- Increased interaction between EPCO staff and local residents.
- Understand the skills represented in community and cultivate a list of contact for the future contribution to the project.
- Development of community-driven metrics to gauge the success of the project.
- Understanding of priorities, needs and wants of the local residents in order to design and implement management activities.
- To track changes in local people's knowledge, attitude, perception and use of coastal and marine biodiversity.

3.3.3.2 Methodology

The field assistant was entrusted with collecting timely responses. The survey started on the 29th June 2016 and will be conducted until the target number of households is reached. The questionnaire used is provided in appendix 5.

3.3.4 Baseline biophysical study of the barachois area

The baseline bio-physical study was conducted by the ocean study department of the University Of Mauritius (UOM) over a period of one month (refer to app. 5).

3.3.5 Consultation strategies with government agencies and local and national experts

On June 28, 2016 the project manager, project assistant and a fisherman from Residences La Chaux met with mariculture experts Khemrai Persand and Droovnath Seetaloo to better understand the logistics of creating a mariculture installation within the barachois and the requisite fencing and testing that will be required within Zone 1 before implementation of the project. The cages, water depth, market size requirements, tying of crabs and market opportunities were discussed to ensure that the planning phase takes from the project from its inception in the barachois to commercial viability in local markets and hotels.

On July 30th, 2016, the project manager met Nadeem Nazurally at the University Of Mauritius to discuss the project. The project manager gave a brief overview of the baseline biophysical study, which found that while the water and sediment are adequate for mariculture activities, the debris and garbage in the barachois, particularly the tires, are exceedingly toxic and must be immediately removed. Discussions of mariculture focused on feeding crabs, but artemia, a type of zooplankton that feed on rotiferes, a phytoplankton, were found to be exceedingly expensive to feed the crabs at 500MUR for a small pot. A clean-up must be coordinated to facilitate the removal of the tires, and begin to plant mangroves, which will further improve the water quality. Juvenile sea cucumbers were found in the lagoon, which must be preserved and protected. An integrated waste management strategy within the local community must be planned, and can be coordinated with the Waste Water Management authority to divert sewage into pre-existing pipelines in Mahebourg. Additional waste is deposited in the lagoon near the Hindu temple, including fruit and vegetable matter, as well as statues and ceramics; the project manager will need to speak with the Hindu community to rehabilitate the area.

On July 13, 2016, the project manager, project assistant, two representatives of the fishermen's communities, and two women's representatives met with the Deputy of Mahebourg, to discuss issues of pollution and fencing within Zone 1. The Deputy was responsive and took responsibility for installing cameras in the area to discourage dumping. He detailed the challenging logistics of securing a permit for Zone 2, but enlisted contacts within the Ministry of the Environment to assist with future directions of the project.

On September 2, 2016 an additional meeting was conducted between the project manager and Droovnath Seetaloo, a local fishermen, during which the logistics of the barachois project were outlined in detail, including the local market price and demand as well as size and collection and

distribution of crabs, ensuring the project manager had the requisite knowledge to begin formulating the strategic plan for the introduction of mariculture.

On September 9, 2016 the project manager met with Mr. Marcel Rault, the section manager of Omnicane, LLC, at a private Barachois in Bouchon, to discuss the commercial aspects of crab mariculture and future directions of the project. He detailed the cost of crabs (3,500 purchased annually) for the barachois (400 MUR/kg) and the retail price (500 MUR/kg). Mr. Rault expressed frustration with the commercial viability of the project, stating a loss of 45% of the crab biomass due to illegal crabbing and a lack of cages, resulting in excessive cannibalism. He also confirmed the high demand of crabs at local level. He provided the project manager with contacts for the cultivation of oysters, and local fishermen who may be able to source crabs for the mariculture project.

The project manager spoke with the Albion Fisheries Research Centre to find an expert within Mauritius who could assist in the cultivation of crabs ‘carlet’. The Centre said they currently do not have any experts in the area, and an outside consultant will have to be brought in to satisfy the demands of the project.

The project manager secured a permit from the Ministry of Agro-industry (Forestry Department) to collect Strawberry Guava stems, a pest species in Mauritius, within a designated area in "le Petrin" for the creation of sustainable cages for the mariculture project, as well as warning panels detailing the project in an attempt to mitigate loss due to illegal crabbing.

3.3.6 Identification of CMA committee members

Thirty members have been identified to be part of the CMA Committee.

Group	Representative Name	Designation
Local Community	ARISTIDE Christian	President of Residences La Chaux
	MARTIN Alberto	President Residence La Chaux Social Welfare Centre
	APPOLON Mario	President of Mahebourg
	MONROSE Sandy	Representative of Residences La Chaux women
	KEISLER Joanna	Representative of Residences La Chaux women
Fishermen	ETIENNE Jean Robert	Representative Fishermen of Mahebourg
	ARCANTE Jacques Andre	Representative Fishermen Residences la Chaux
	CHAMROO Gyaneshwar	Representative Fishermen Residences la Chaux
	SAINT MAR Joseph	President Fishermen Federation of Mahebourg
NGOs and Associations	WOOZAGER Pawan	Mouvement Bien-Etre Cite La Chaux
	MAGON Guy	Association Troisieme age Residences La Chaux
	MANETTE Corinne	Association femme Residences La Chaux
	GODER Natacha	Nu zenfant Cite
	PURBHOO Parwayze	La Voie de Mahebourg
	BALBOLIA Dilshaad	Mauritian Wildlife Foundation
	NAGGEA Josheena	Eco-Sud (Lagon Bleu Project)
	MAGRAJA Vishal	I love Mahebourg
	DESMARAIS Diane	Kolektif Ecoguard
Experts and Scientists	NAZURALLY Nadeem	University of Mauritius (mariculture)
	MANGAR Vijay	AFRC
	MARIE Daniel	MOI
	PERSAND Khemraj	Local experts
	DROOVNATH Seetaloo	Local experts
Government agencies	N/A	Ministry of Fisheries
	N/A	Ministry of Agro-industry
	N/A	Ministry of Environment
	N/A	Ministry of Housing and Lands
Funding contributors	NATORI Yoji	GEF Satoyama Project
	YVERGNIAUX Yann	COI Smartfish Project

Table 3:*Initial list of CMA committee members.*

3.4 Awareness raising and sensitization

3.4.1 Focus group interview with local women

3.4.1.1 Overview

Three meetings have been conducted with women of Residences La Chaux. A convocation letter (Fig. 2), designed by the President of Residences La Chaux was given to women to increase attendance.

MEETING	DATE	TIME	ATTENDANCE	LOCATION
Meeting 1	29-Jun-16	2:15 pm - 3:15 pm	20	Residences La Chaux Social Welfare Centre
Meeting 2	12-Jul-16	2:15 pm - 3:15 pm	21	Residences La Chaux Social Welfare Centre
Meeting 3	26-Jul-16	2:15 pm - 3:15 pm	12	Residences La Chaux Social Welfare Centre

Table 4:*List of focus group interviews with women in Residences La Chaux*

MOUVEMENT BIEN ETRES DE LA CITE LA CHAUX
REG 6405 (CSR 1326)

Madame 15 Juin 2016

Vous êtes priée d'assister a une réunion concernant la mise en place d'un Barachois par l'ONG EPCO a Cite la Chaux
Date: Mercredi 29 Juin 2016 a 14.00 heures
Venue: La Cour de Village Hall Cite la Chaux
Agenda:
(1) Session d'explication by Mademoiselle Estelle DEJA
(2) Question et réponse
(3) Réflexions sur le projet et les activités a mettre en place en fonction des besoins de la communauté.

Votre présence est importante

Veillez agréer Madame, l'expression de mes sentiments distingues
Louis Christian Aristide
(Président)

Figure 2:*Invitation letter sent by the president of Residences la Chaux.*

3.4.1.2 Objectives

The main objectives of the consultation with women are:

- Increase interaction between EPCO staff and local women.
- Provide information for sustainable management of marine and coastal resources.
- Involve local women in management activities.

- Design, plan and implement appropriate awareness raising and sensitization activities.

3.4.1.3 Minutes of proceedings

Meeting 1

The project manager inquired if the women in attendance were aware of the barachois project and gave a broad overview of the project, referencing the CMA zone map. The project manager explained the activities that had been undertaken so far, including the questionnaire and initial clean-up event, and outlined activities in which women would be able to participate. The project manager called for community mobilization. The role of women in the project is projected to focus on the restoration and rehabilitation of the area including "Cot Nicole", and therefore their participation is critical during all phases of the project.

The project manager further explained the household surveys and introduced a major event in November to attract community interest and awareness, which the women were requested to take an active role in. An attendance list was taken and interest in assisting with the event was noted, and the project manager explained that two representatives of the women of Residences La Chaux would be elected to facilitate communication between the project manager and community.

Meeting 2

Household surveys were distributed and explained to the women attending the meeting for the first time, and a detailed introduction was given to the project, both for newcomers and previous attendees. A petition showing community support toward the project was also distributed.

Two women were elected unanimously as representatives to attend CMA committee meetings and act as facilitators between the project manager and population. Their attendance was requested at a meeting the following day with the fishermen's representatives, project manager and project assistant to discuss the pollution in the lagoon and request government assistance to install fencing around the mangrove area in Zone 1.

The women contributed ideas for the community-based awareness event on Sunday, November 6th, including organizing a 'tombola,' having music and local food, as well as activities and a collaborative art project for children. Meetings were scheduled weekly until the event to ensure its successful implementation.

Meeting 3

A brainstorming session was held regarding the community event, and feedback was generated from the women.

3.4.2 Development of the one day community-based event

3.4.2.1 Overview

The fishermen's group voiced a need to first create awareness in both communities, Mahebourg and Residences La Chaux about the project, and explain the relevance for increased local livelihood through a community-based event. The event has to be conducted before the implementation phase to avoid potential conflicts.It will be a useful communication and information tool to provide the scope, actions and benefits of planned mariculture initiative.

3.4.2.2 Objectives

- Increase awareness and understanding of local residents toward planned mariculture
- Give residents the opportunity to be involved in management activities.
- Increase willingness to participate in coastal watch (surveillance strategy) to avoid illegal fishing activities.
- Debate and brainstorm regarding the project design and plan
- Increase local community support toward mariculture
- Identify potential conflicts that may arise and seek solutions in advance
- Increase satisfaction of local community

3.4.2.3 Methodology

The day-long community event will be conducted on November 6, 2016 from 7 AM to 10 PM with collaboration of the women in the community and Residences La Chaux associations, as well as various other key members of the Residences La Chaux community. During a PowerPoint presentation will be conducted by various key informants form the community providing information regarding the scope, benefits and proposed activities and conservation actions of the project.

Figure 3:*Poster of the one-day community-based event.*

3.5 Mangrove areas restoration and clean-up by selected local fishermen

3.5.1 Overview

The Barachois clean-up was an effort of community mobilization that displayed the willingness of the fishermen in both communities to participate and contribute to the welfare of their society, and brought attention to the polluted environment.

3.5.2 Objectives

The main objectives of the activity are:

- Inform the local population about the project's existence, role and objectives.
- Educate participants on ecological impacts and biodiversity.
- Increase interaction between EPCO staff and the local community.
- Involve the local communities in management activities.
- Test the development and implementation of working activities with local residents, particularly fishermen.
- Take action to implement the needs and expectations voiced by the local community.

3.5.3 Methodology

The clean-up began on the 14th of June 2016 and continued for 10 weekdays. Ten fishermen were selected in a voting process during a fishermen's meeting, with 8 fishermen from Residences La Chaux and 2 from Mahebourg. The clean-up was carried out in the first zone (left on the map) the first 7 days and in the second zone (right) the last 3 days (refer to the map below). The clean-up was conducted by foot and boat. A pirogue in wood was landed by one of the fishermen who participated to this activity. All participants worked from 12 PM to 5 PM and were compensated 5,000 MUR for 10 working days.

The activity was conducted in collaboration with Belle Verte for equipment rental and organization, as well as with Attics for the collection of waste. One woman from Residences La Chaux was designated by the Project Manager and trained to supervise the activity. The woman was paid 5,000 MUR by Belle Verte to uphold gender equality during the project. Waste was sorted into categories established by Belle Verte (recyclable wastes, non-recyclable wastes, big items and e-waste).

3.5.4 Location

Figure 4:*Map providing clean-up locations.*

IV RESULTS

4.1 Barachois restoration design and planning

4.1.1 Outputs of the regular meetings with fishermen

The main outputs of the 18 meetings were:

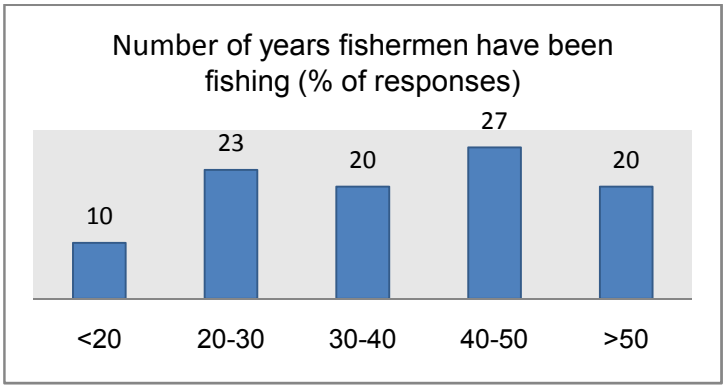
- Fishermen from the communities of Residences La Chaux and Mahebourg attend meetings at a location agreed upon by all participants.
- Ten participants of the clean-up event elected fairly with group consensus.
- Three representatives of the fishermen were elected; two representing the fishermen of Residences La Chaux and 1 representing the fishermen of Mahebourg.
- Role and responsibilities of the representatives clearly communicated.
- The benefits of the project to the entire community, including women and children, were understood, and the need for unity and collaboration were highlighted.
- Conflicts were resolved.
- The development of mariculture within the barachois was prioritized as the first activity to be implemented by the project.
- The timeline and gradual nature of the project was explained.
- The role of the meetings as productive platforms for discussion and information sharing by all involved shareholders was outlined.
- The frequency of the meetings (once weekly) was established.
- A map on resources use patterns (App. 7) as well as the final strategic plan for mariculture (App. 8) have been created based on traditional knowledge voiced by fishermen.

4.1.2 Result of the Questionnaire-based interview surveys to local fishermen

Personal and demographic

Characteristics of participants	Number of respondents	Percentage %
Age		
30-40	3	6
40-50	8	16
50-60	19	39
60<>70	16	33
>70	3	6
TOTAL	**49**	**100**
Marital status		
Married or partnered	38	78
Divorced	5	10
Widower	3	6
Single	3	6
TOTAL	**49**	**100**
Education Level		
None	4	8
Standard 1	1	2
Standard 2	1	2
Standard 3	4	8
Standard 4	6	13
Standard 5	4	6
CPE	27	55
Form 1	1	2
Form 5 (SC)	1	2
TOTAL	**49**	**100**
Number of people in Household		
Alone	7	14
2 or 3	16	33
4 or 5	14	29
6 or 7	8	16
8 or 9	2	4
> or = 10	2	4
TOTAL	**49**	**100**

Table 5:*Sample characteristics of survey respondents.*



Graph 1: *Experience in fishing activity.*

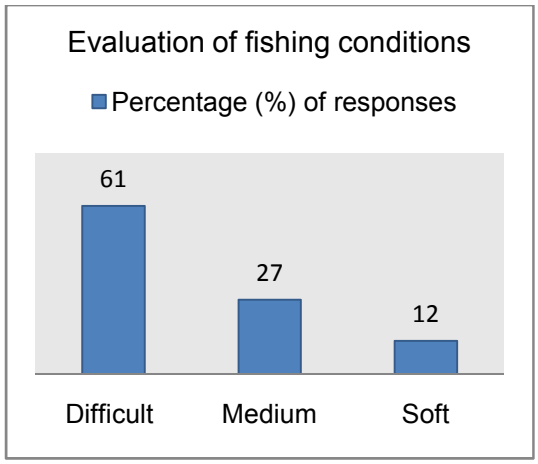
The survey was conducted between the 10th of March and the 23rd of July, 2016, on weekdays between 11 am to 6 pm for an average of 49 min.

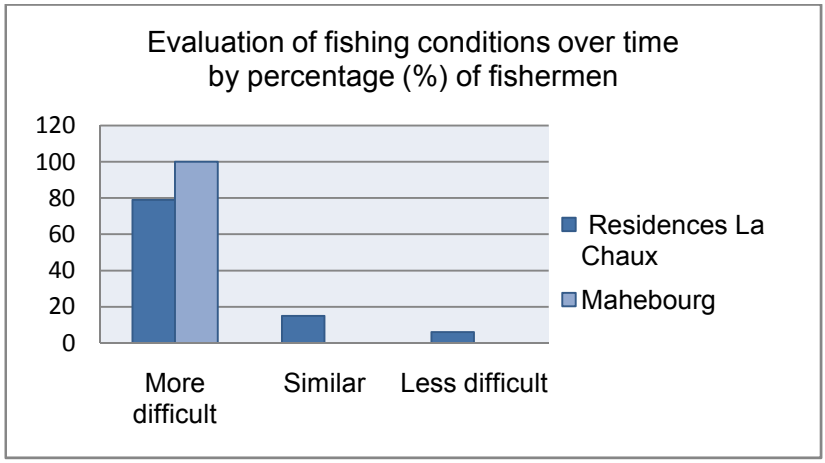
A total of 34 fishermen, heads from Residences La Chaux (76% of all registered fishermen)and 15 fishermen from Mahebourg (94% of all selected registered from Mahebourg) constituted the sample.

Various other information, not provided in this report, was recorded by the project manager. Such information included respondents' address, contact details, fishing card number and fishing landing station.

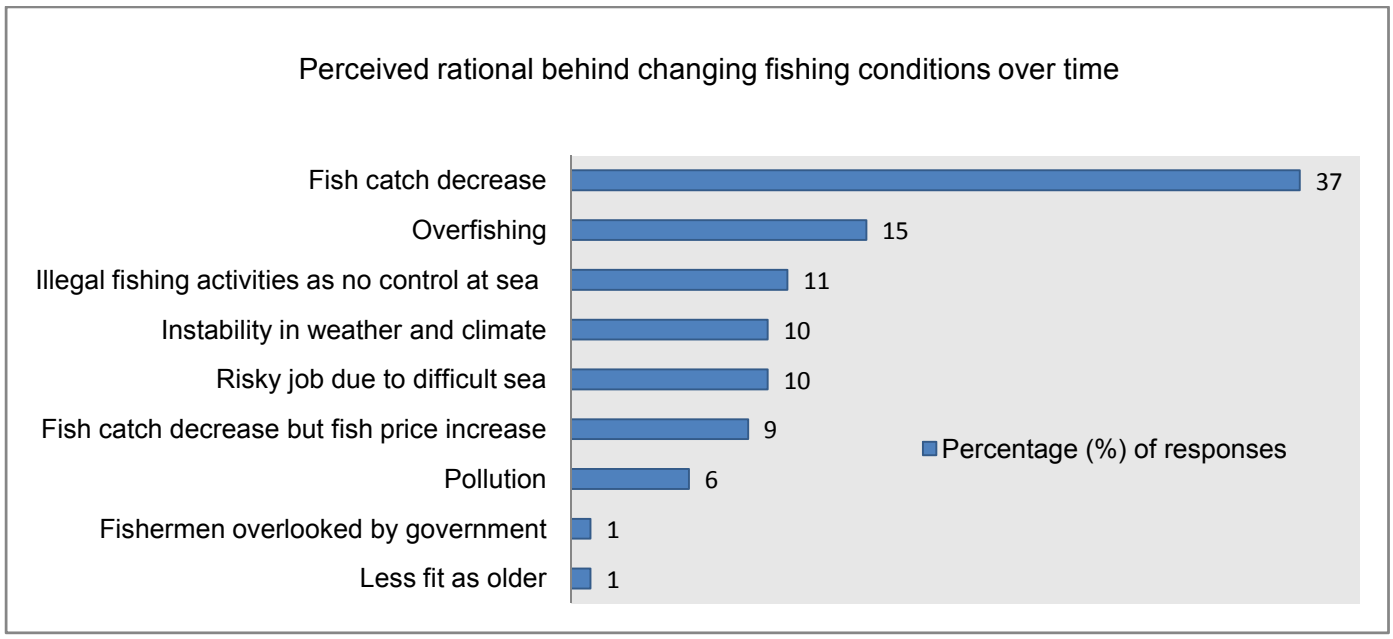
The fishermen ranged in age from 36 to 79 years old, with an average age of 56. Eighty eight percent of fishermen had basic education up to primary school level, while 4% had secondary school level education and 8% never went to school. Sixty one percent of fishermen live with 1 to 5 family members in their house, while 14% live alone and 24% live with more than 5 family members.

All the fishermen reported being satisfied with their profession. The fishermen from both communities are experienced, career fishermen whose livelihoods depend on fishing as a commercial activity. The oldest fisherman interviewed had 50 years of experience, while the most inexperienced fishermen began fishing less than 15 years prior to the survey.

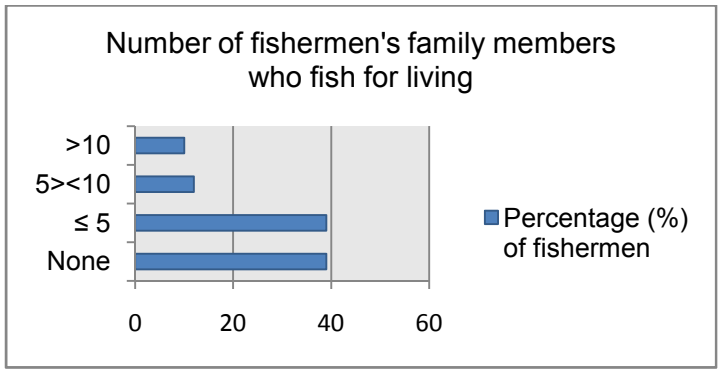




Graph 2:*Evaluation of fishing conditions***Graph 3:***Fishing conditions over time by % of fishermen*

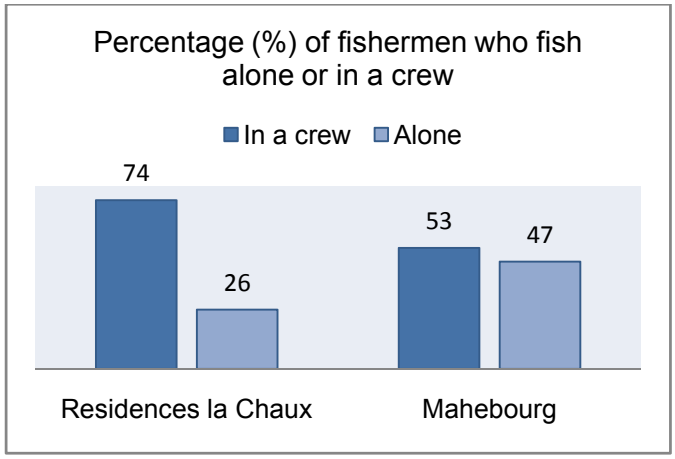


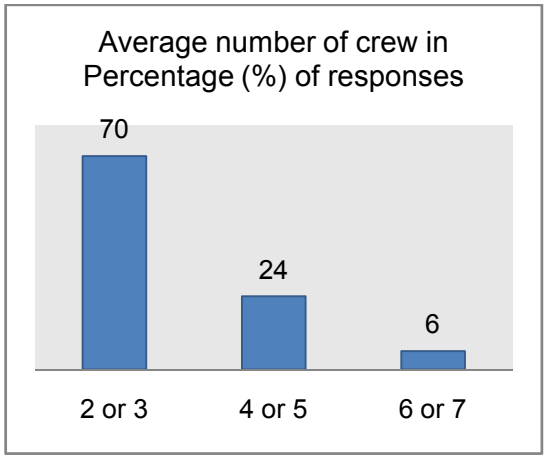
Graph 4:*Reasons for change in difficulty.*



Graph 5:*Statistics fishermen's family members who fish.*

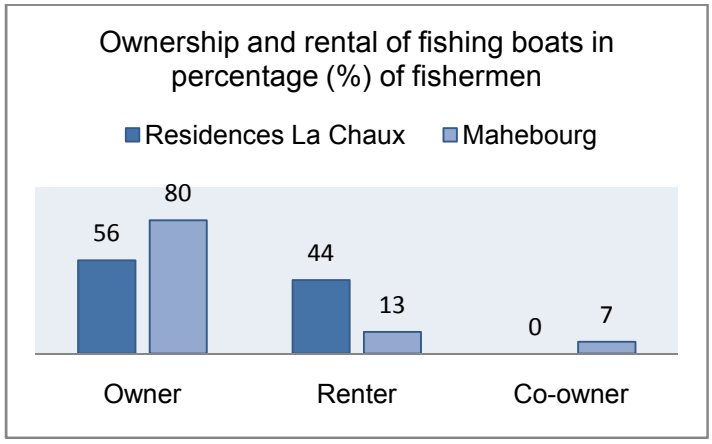
61 % of fishermen have family members who also fish for a living. 46 % fish with one or more family members.

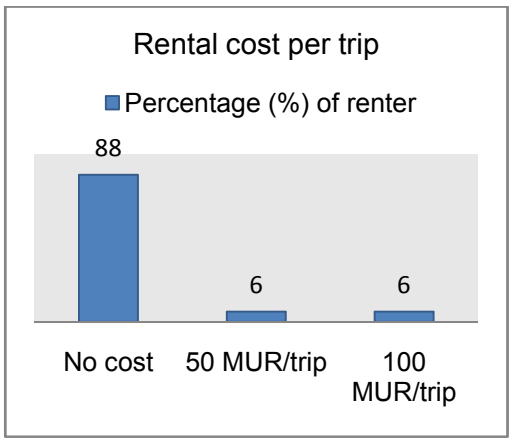




Graph 6:*Percentage of fishermen who fish alone or in a crew.* **Graph 7:***Crew characteristics*

The respondents are mainly small-scale fishermen who fish individually or in small groups. However, the majority of fishermen currently fish in a crew in both communities represented.





Graph 8: *Ownership and rental of fishing boats* **Graph 9:** *Cost per trip*

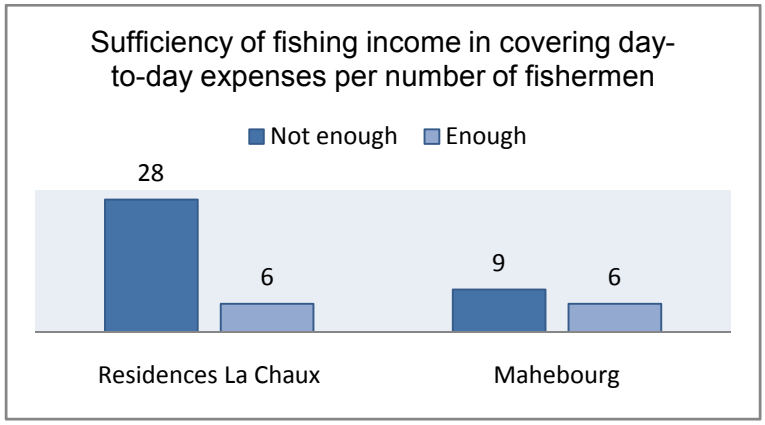
The majority of fishermen from Mahebourg and Residences La Chaux own their own fishing boats (80% and 56% respectively); the remaining respondents lease a fishing boat from a relative or friend. All boats are pirogue and made of wood (83%) or fiberglass (17%), varying in length from 13 to 23 feet with an average length of 21 feet. 40% of boats were constructed before 2000, the oldest being built in 1974 and the newest in 2015. The vast majority of fishermen interviewed own only 1 pirogue (92%). The boats primarily use Yamaha and Tohatsu engines, with horsepower ranging from 8 to 16 HP.

Income from fishing

Monthly income from fishing	Percentage (%) of fishermen			
	Residences la Chaux		Mahebourg	
	Current	Before	Current	Before
<6000	53	Lower 0 Similar 28 Higher 72	40	Lower 0 Similar 0 Higher 100
6000-15000	38	Lower 8 Similar 46 Higher 46	40	Lower 16 Similar 50 Higher 34
>15000	9	Lower 66 Similar 44 Higher 0	20	Lower 66% Similar 44% Higher 0%

Table 6: *Fishermen monthly income (MUR) for selling fish.*

The monthly income from the sale of fish shows a temporal decline. However, the remaining notice either an increase or no difference in their net income. The main reasoning for this decline was: " We catch less but the fish price of fish has increasedin recent years" and " I am too old now to go fishing every day so I fish less". Most fishermen (76%) voiced that their monthly income is not sufficient to cover their daily expenses. Therefore, the market demand for fish is high as 100% from Mahebourg and 70% Residences La Chaux respectively manage to sell all their catch.

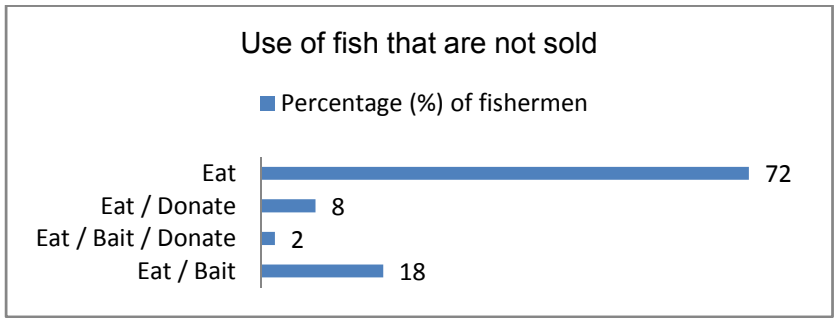


Graph 10: *Sufficiency of income in covering monthly expenses*

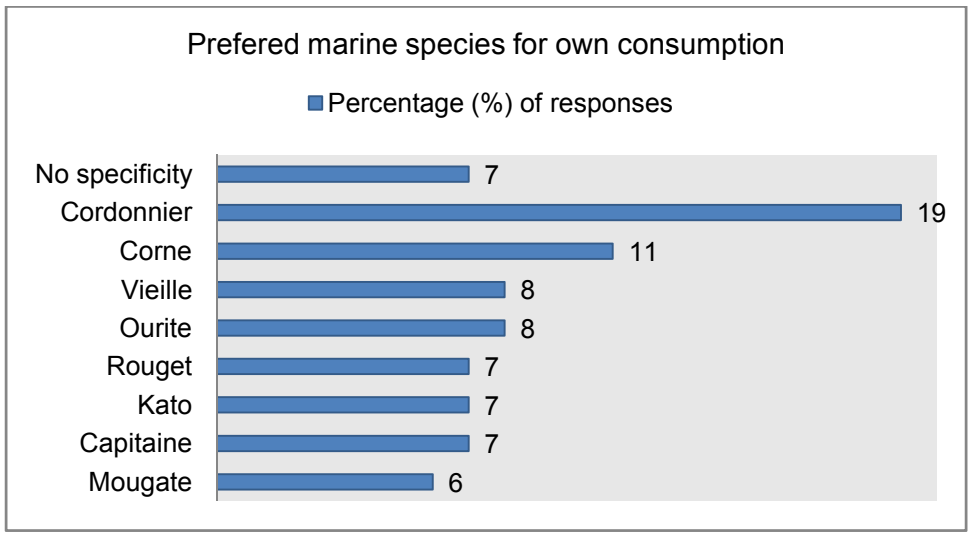
One hundred percent of fishermen manage to sell of their catch when their direct customers are middlemen.

Answers	Percentage (%) of fishermen
Middleman	65
Individual and middleman	19
Individual	10
Owner of the boat sell fish himself	2 (one respondent)
Individual/ Middleman/ restaurant	2 (one respondent)
Individual/ restaurant/ market	2 (one respondent)
TOTAL	**100**

Table 7:*Direct customers of respondents*



Graph 10:*Fishermen use's type of fish not sold.*



Graph 11:*List of most common marine species that are kept by fishermen for their own consumption.*

Twenty-eight percent of fishermen do not have favorite fish species for their own consumption.

Weight (kg)	Percentage (%) of fishermen
1-2 kg	84
2-3 kg	8
>3 kg	8

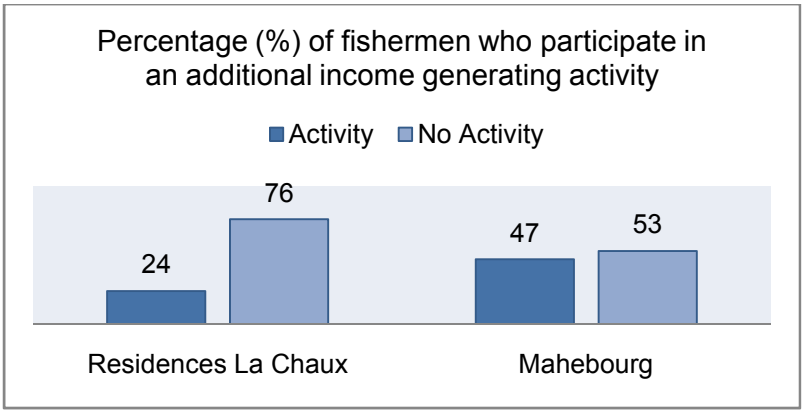
Table 8:*Weight (kg) of fish fishermen keep for own consumption.*

Fishermen from Mahebourg and Residences la Chaux spend respectivelyMUR 275 and MUR 270 of petrol in average per fishing trip. The cost of petrol varies depending on fishing location and crew number. Most of fishermen caught bait themselves while 12 % of fishermen buy on average, MUR 113 of bait per fishing trip. Only 2 respondents use a skipper for fishing trip with an average cost of MUR 500 per trip.

Percentage (%) of fishermen	Mahebourg	Residences La Chaux
Money equally distributed among crew	75%	52%
No sharing, individual catch among crew	25%	48%

Table 9:*Share system in place among the crew.*

Additional income



Graph 12:*Respondents statistics regarding additional income generating activity.*

Type of Activity per number of fishermen	Residences La Chaux	Mahebourg
Skipper of a boat tour company	3	2
Gardening	3	0
Building and selling of mesh	1	2
Masonry	1	1
Cleaning an Hindu temple	0	1
Poultry, rabbit and goose breeding	0	1
TOTAL	8	7

Table 10:*Type of additional income generating activities.*

Monthly Salary	Percent (%) of fishermen	Reason for having an activity	Percent (%) of fishermen	Time dedicated to the activity	Percent (%) of fishermen
MUR <4000	33	Required	60	0-20 %	14
MUR 4000-8000	47	Savings	20	20-40 %	59
MUR >8000	20	More comfortable lifestyle	7	40-50 %	7
		Hobby	13	≥ 50 %	20
TOTAL	**100**	***TOTAL***	**100**	***TOTAL***	**100**

Table 11:*Statistical table (in %) providing income, the reasons and the time related to additional activity.*

Finally, 27 % and 42 % of fishermen from Mahebourg and Residences La Chaux respectively have a retired pension. MUR 5000 and 6000 was the two amount of retired pension voiced by fishermen. The fishing pension range from MUR 300 to 5000 depending on climatic conditions.

Location of fishing zone

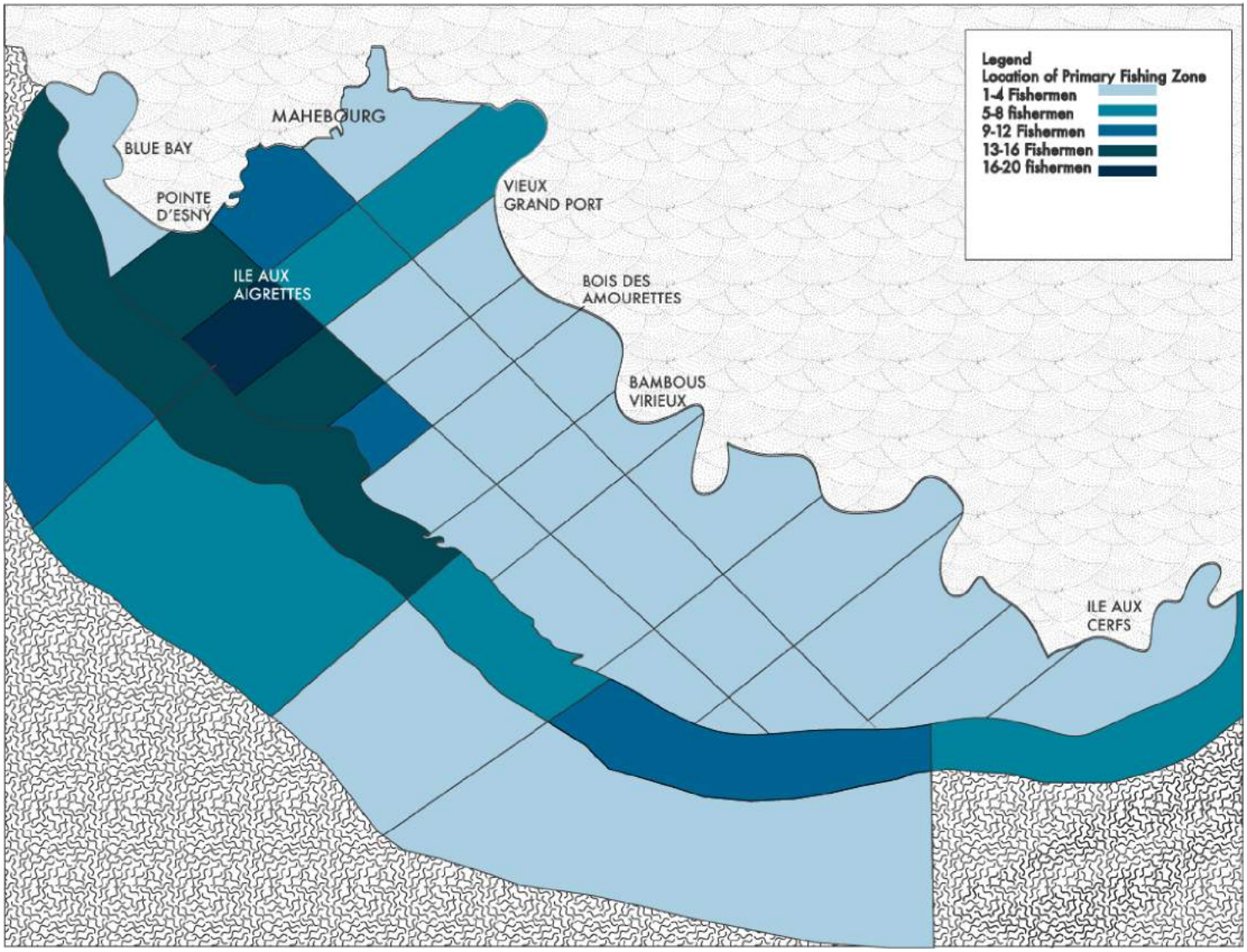
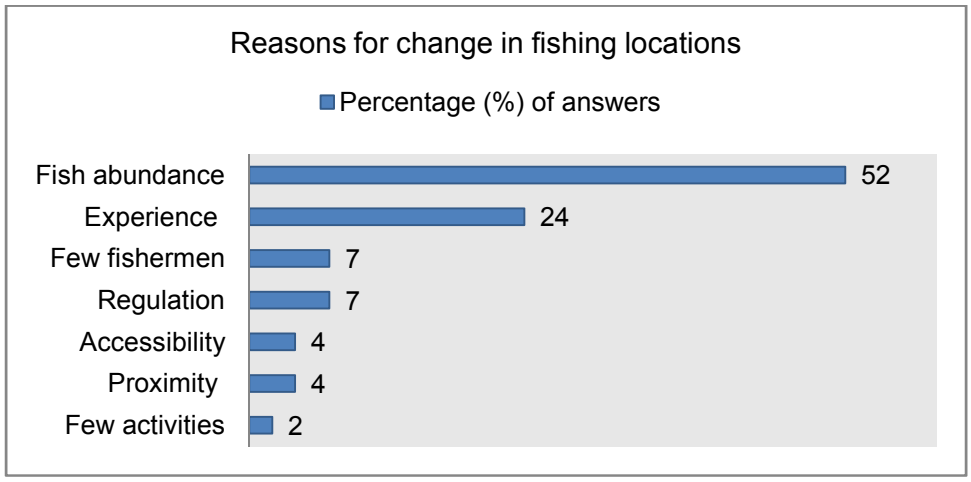


Figure 5:*Most frequently used locations for fishing activities.*

About 53% and 76% of fishermen from Mahebourg and Residences La Chaux respectively noted that they have change in fishing locations over time. The main reasons for this are listed in the graph below:



Graph 13:*Reasons for change of fishing grounds.*

Fishermen from both communities commonly fish Emperor (Capitaine, Dame berri, Battadet, Caya), Parrotfish (Cateau species), Spinefoot (Cordonnier), Wrasse (Madame tombee, Colombine and Lalo), Goatfish (Rouget species), Grouper (vieille rouge, grise and voleur), Unicornfish (Corne species) and Trevally (Carangue). The most frequently fished species are displayed below.

Fish family	Number of times the species was cited	**Percentage (%) of responses**
Emperor	56	**16**
Parrotfish	26	**7**
Wrasse	21	**6**
Goatfish	26	**7**
Trevally	19	**5**
Unicornfish	17	**5**
Spinefoot	27	**8**
Grouper	47	**14**

Table 12:*List the most common fish families that are caught by fishermen.*

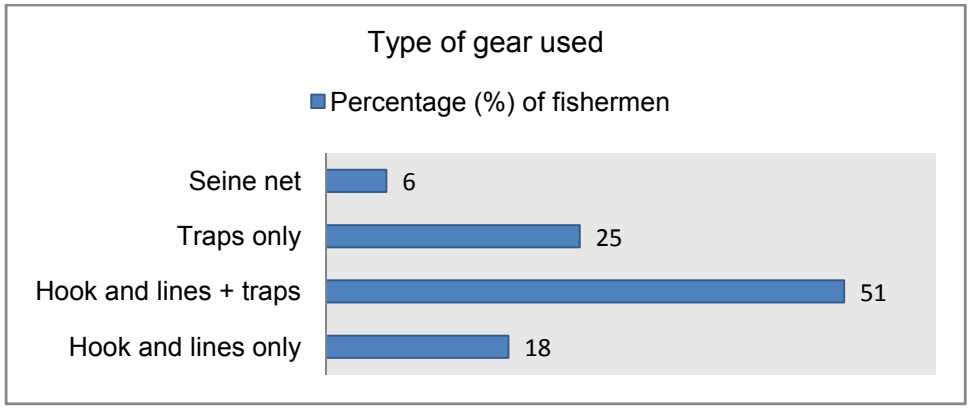
Local Name of fish	Price in MUR/kg			Number of times species was cited
	Minimum	Maximum	Average	
Anguille	140	140	**140**	1
Battardet	200	200	**200**	2
Bordemar	120	200	**140**	3
Bourse	100	200	**150**	2
Bretton	160	160	**160**	1
Cabot	150	150	**150**	1
Capitaine	160	250	**212**	30
Carandine	80	140	**97**	6
Carangue	120	200	**151**	19
Carpe	80	140	**104**	10
Cateau	100	200	**122**	26
Caya	120	180	**140**	5
Colombine	80	100	**93**	4
Corne	120	160	**145**	17
Cordonnier	100	190	**127**	27
Dame Berri	125	250	**200**	19
Dorade	120	120	**120**	1
Gueule pavé	200	250	**222**	9
Giblot	120	120	**120**	2
Homard	500	800	**707**	7
Lalo	80	80	**80**	1
Langouste	600	900	**700**	7
Lorsan	120	200	**150**	3
Madame tombée	80	160	**113**	16
Mougate	160	300	**241**	14
Mulet	120	120	**120**	1
Ourite	100	200	**190**	18
Raie	50	100	**75**	2
Requin recif	50	100	**83**	3
Rouget	120	150	**120**	26
Sacre chien	160	200	**187**	4
Sap Sap	80	80	**80**	1
Tazar	100	150	**130**	4
Thon	100	150	**125**	2
Vieille grise	60	120	**99**	24
Vieille rouge	150	300	**234**	23

Table 13:*Local minimum, average and maximum prices by species cited.*

Average duration for reaching fishing ground (in minutes)	Inside Lagoon	Outside lagoon
Fishermen from Mahebourg	59 min	127 min
Fishermen Residences La Chaux	48 min	102 min

Table 14:*Average trip duration for reaching fishing location.*

Type of gear

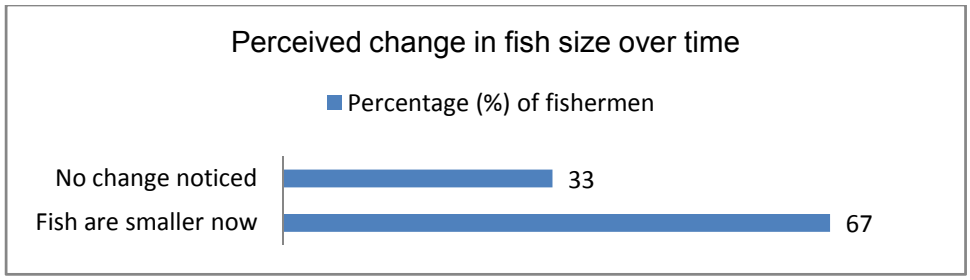


Graph 14:*Type of gear used by fishermen.*

Most of the interviewed fishermen can be categorized as small-scale fishermen. Fishermen from both communities use traditional fishing gear, with the two main gears being hook and line and traps. Only three respondents have the permit to use net seine. Fifty one percent use two types of gear (hook and line with traps) while the remaining fishermen use only one type. The number of trapsused by fishermen varies from 3 to 60 with an average of 16 traps per fishermen. Traps locally cost between MUR 1000 to 3000depending on the size. Casting nets is not common and is used, as supplementary gear, by only one respondent.

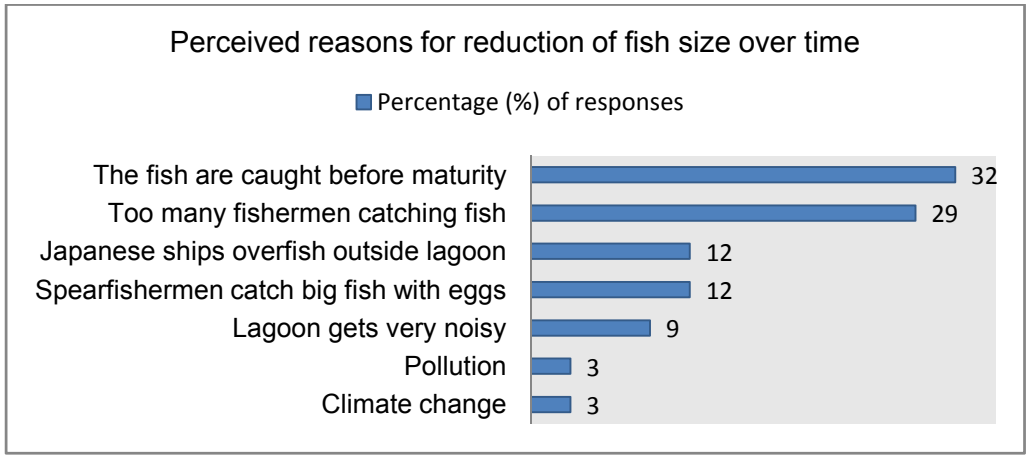
Catch characteristics

There are no specific targeted fish species by the fishermen considered the wide diversity of species cited. About 67% of fishermen from both communitieshave noticed a decrease in fish size compared to more than 10 years ago.



Graph 15:*Perceived temporal change in fish over time.*

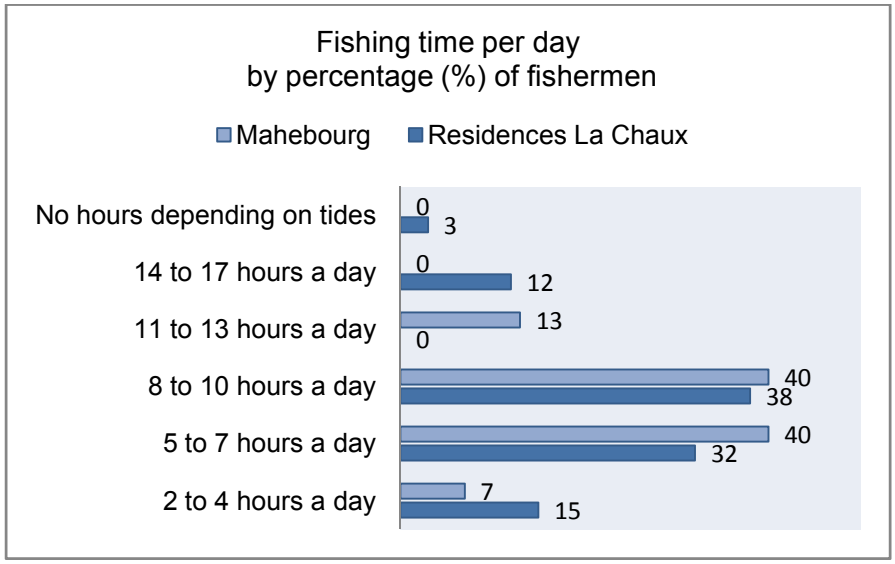
The most frequently cited reasons for the decrease of fish size are provided in the graph below.



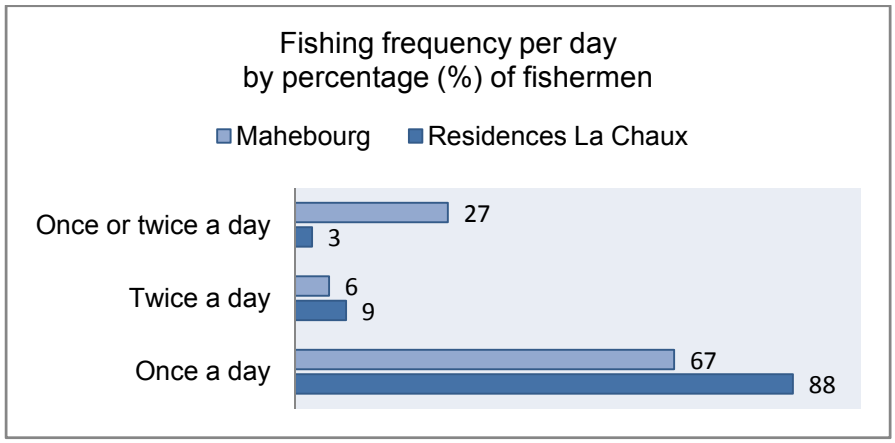
Graph 16:*Perceived reasons for reduced fish size over time.*

While 64% of fishermen stated that all species are still present, they noted the size of species caught has decreased, and some of the fishermen (36%) said species that they used to catch are no longer in the fishing zones; the species the most cited among the few respondents that answered positively included Madrass, Vieille rouge, Vieille ananas, Vieille voleur, Vieille farand, Bourse, Giblot and Bordemar.

Catch per unit efforts (CPUE)



Graph 17:*Average fishing time per day.*

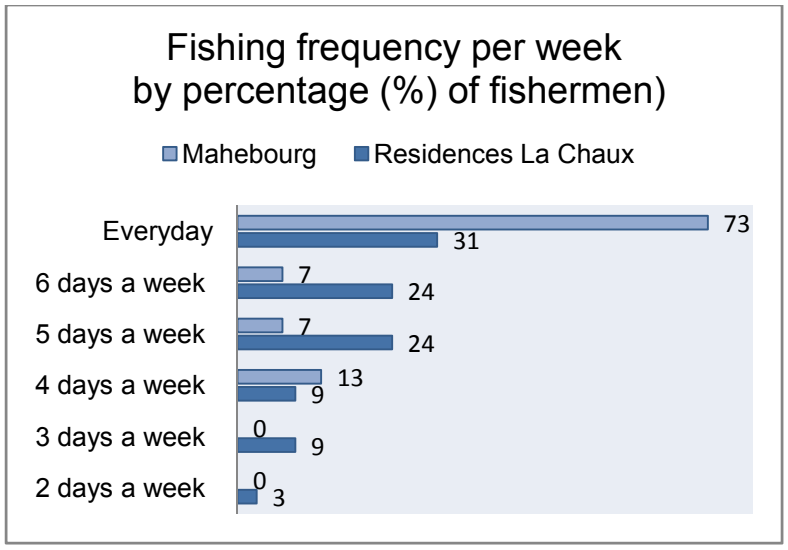


Graph 18:*Fishing frequency per day.*

Most of fishermen fish in the morning between 4am and 1pm. The majority fish once a day and more than 5 days a week.

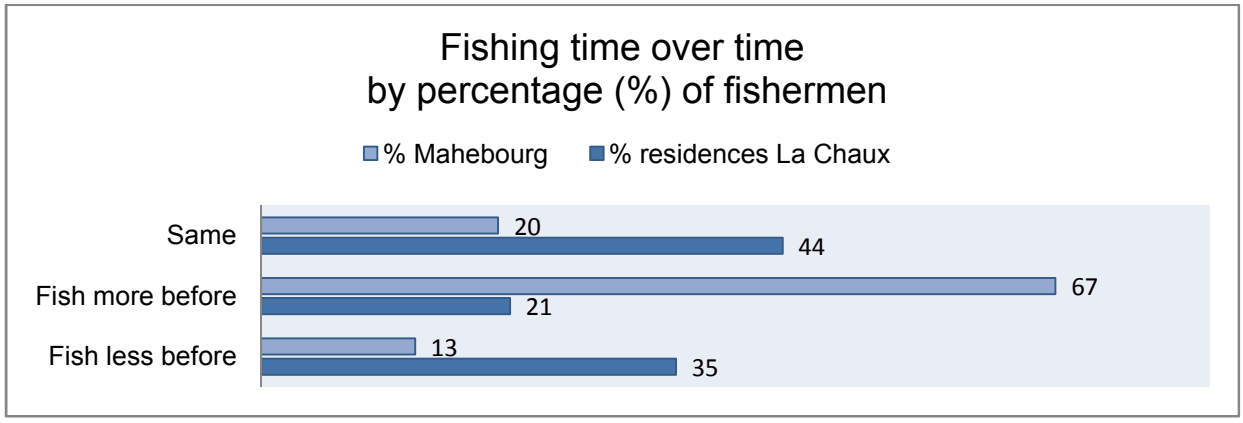
Fishing schedules by percentage (%) of fishermen	Residences La Chaux	Mahebourg
Between 4 am and 1 pm (Morning)	70	80
Between 4 pm and 6 pm (Day)	12	20
Between 5 pm to 8 am (Night)	12	0
No hours depending on tides	6	0

Table 15:*Respective fishing schedules*

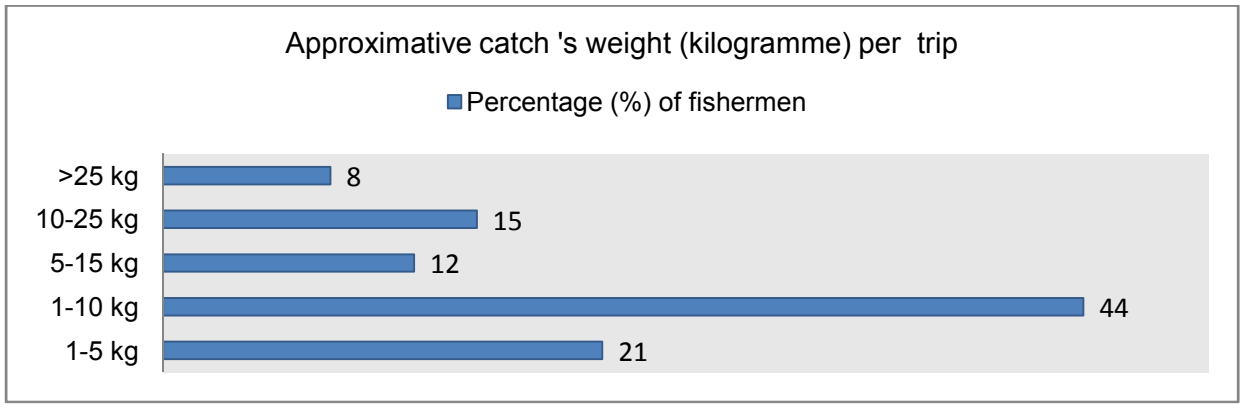


Of the fishermen surveyed, 73% fish every day, but the majority (67%) in Residences La Chaux have seen a decrease in the amount of time they spend fishing, while time spent fishing has remained relatively constant in Mahebourg, with 44% of respondents maintaining the amount of time they spend fishing.

Graph 19: *Fishing frequency per week.*



Graph 20: *Fishing time with temporal change.*

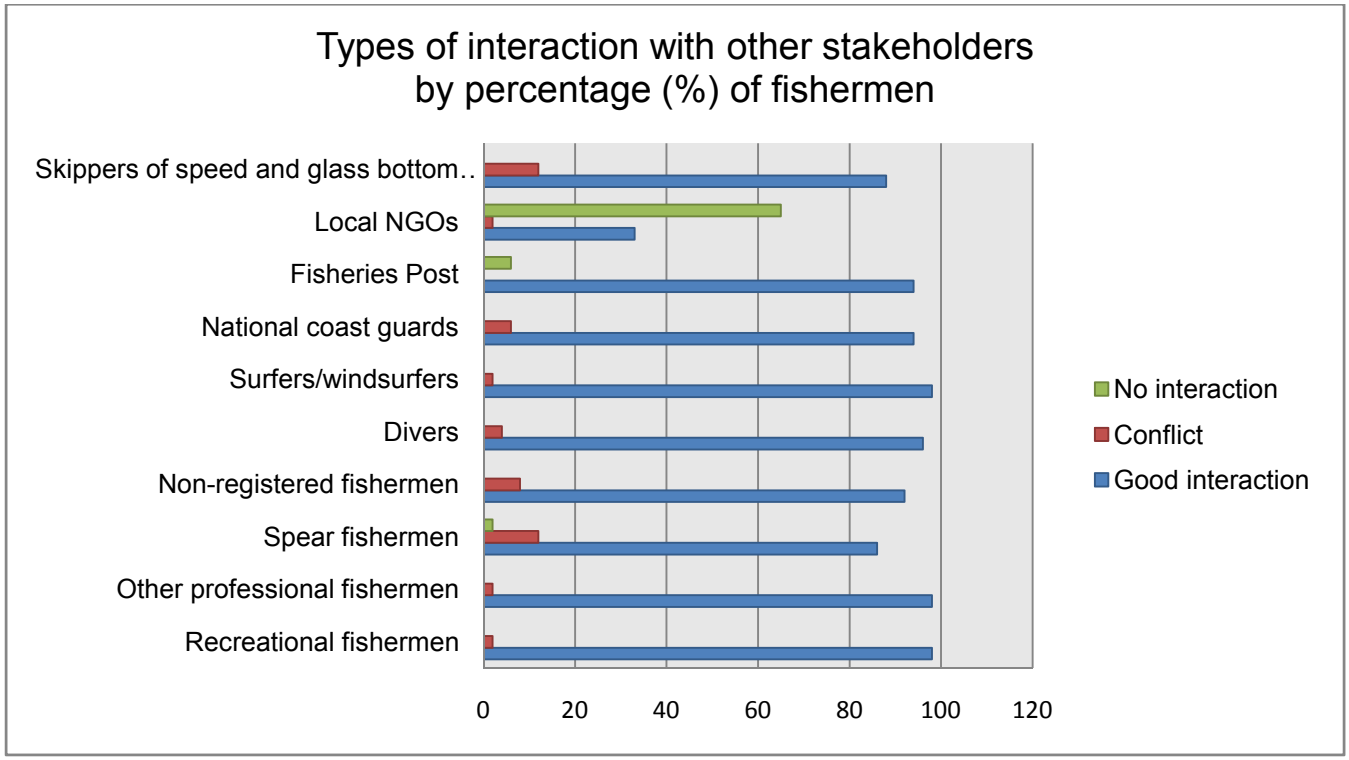


Graph 21: *Average catch's weight per fishing trip.*

Overall, the average catch per trip shows a temporal decrease. Indeed, 100% and 75% of fishermen from Mahebourg and Residences La Chaux respectively, noted that they used to catch more. Significant differences in catch per trip was recorded with temporal comparison.

Stakeholders interaction

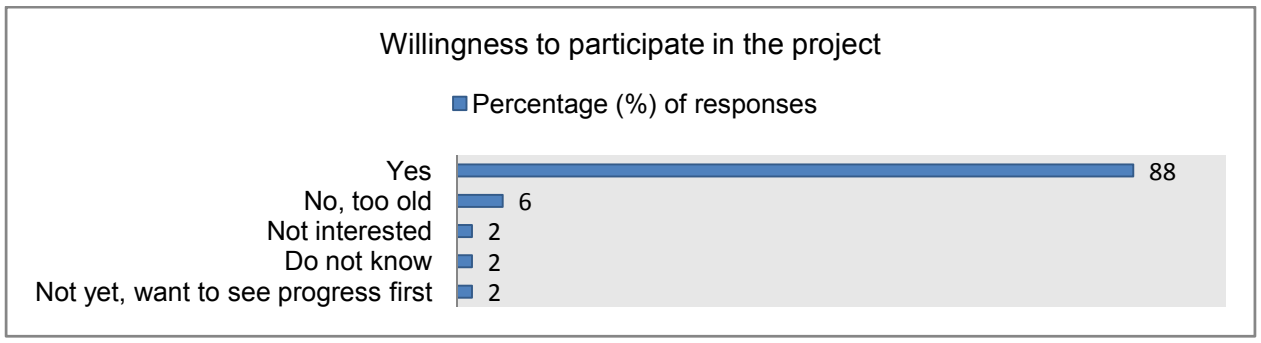
The fishermen generally have positive interactions within the community and other commercial interests within the area, reporting positive interactions with various other stakeholders.



Graph 22: *Fishermen's interaction with stakeholders.*

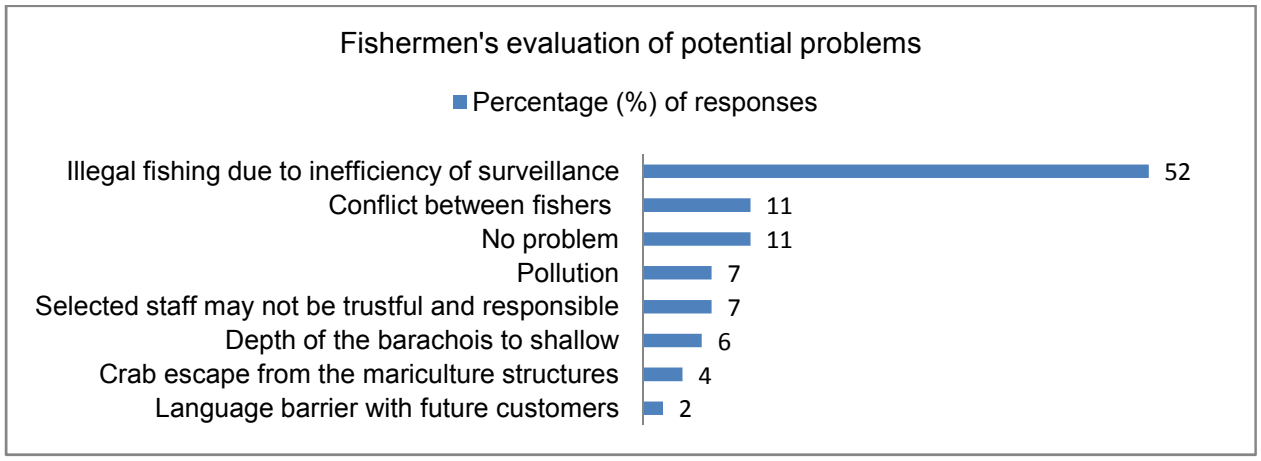
Project perception

The local fishermen's perception toward the project is exclusively positive. One hundred percent of the fishermen interviewed supported the establishment of the project and 88 % are willing to participate in project activities. Of those who are unwilling, 6% feel they are no longer physically able to contribute while one respondent is not interested, one would rather see progress first and one does not know.

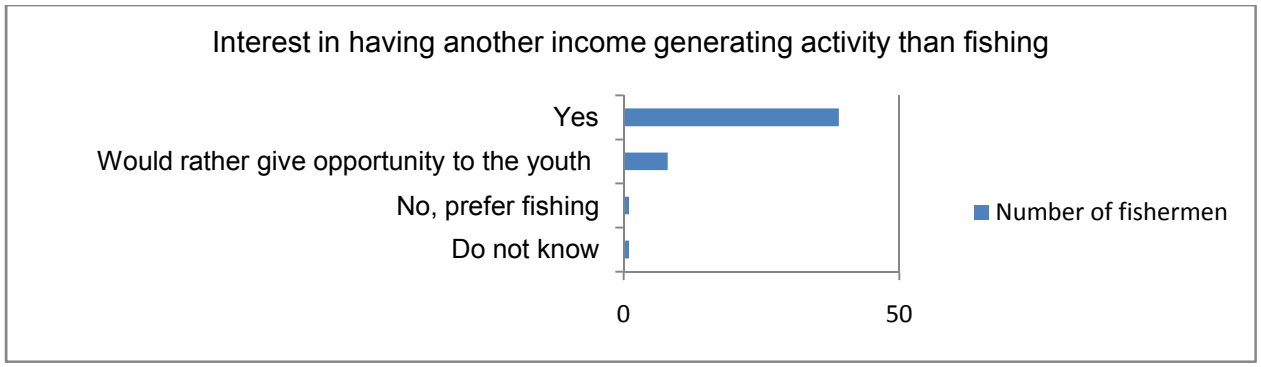


Graph 23:*Fishermen 's willingness to participate in the project.*

The main concerns with the project stem from fears of illegal fishing that would undermine efforts to share profits and positively impact the community investing in the project, with 52% of fishermen reporting this to be their major concern. Various other potential issues, including conflict from fishermen (11%) were also brought up, but the potential for the barachois project to invite other income-generating activities was positively reflected on by the community, with 39% of respondents interested in diversifying the scope of their commercial activities.

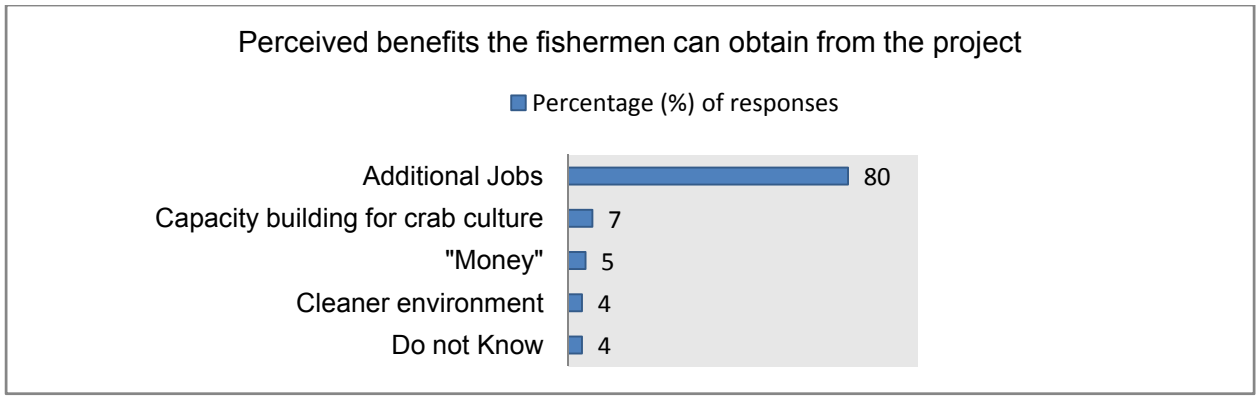


Graph 24:*Perceived problem that project implementation may potentially face.*

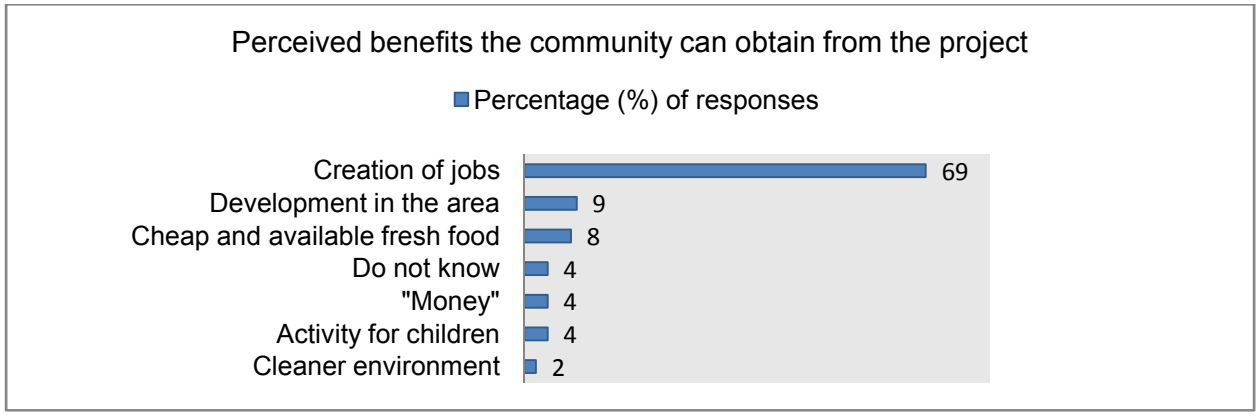


Graph 25:*Fishermen's interest in having another income generating activity.*

The fishermen see the creation of jobs as the largest boon to themselves and the community from the project. Additional benefits surveyed include the development of community and capacity building for crab culture.



Graph 26:*Perceived benefits for the fishermen.*



Graph27:*Perceived benefits for the community.*

4.1.3 Outputs of the Interview surveys with fishermen

- Clear dependency on natural marine resources for livelihood, as estimated by the number of registered and unregistered fishermen and associated family members who fish for a living.
- Fishing conditions have become more difficult due to overfishing and illegal activities, climate change and lagoon pollution.
- Incomes for fishing are low and insufficient to cover day-to-day expenses of the family.
- Market demand for seafood consumption is high at local level.
- Additional income generating activities are conducted by a small number of fishermen, emphasizing the difficulty in finding part-time income-generating activities.
- Clear idea of the frequency and timing spent fishing per day, as well as per week for each individual.
- High level of fishermen's awareness toward the project.
- Positive perception of future mariculture activities and strong willingness to participate in the project.
- While most fishermen enjoy their profession, most are interested in having an additional or alternative income-generating activity resulting from mariculture implementation.

4.2 Awareness raising and sensitization

4.2.1 Outputs of Meetings with women

- Focus group meetings established women's interest in the project and clarified their roles in the Barachois project.
- Women were informed as to the previous activities that had been undertaken with regards to the project, including interviews and the initial clean-up.
- Women completed household surveys and helped to organize a community-based event.
- Two women were fairly elected and assumed the role of representatives to the CMA committee.
- Regular meeting times were established and a schedule set.

4.3 Results of the Mangrove area clean-up by selected fishermen

Date	Attendance	Location	Recyclables		Waste		Big items	E-waste
			Kg	Sacs	Kg	Sacs		
14/06/2016	10	Mangrove forest in front of London Way (Zone 1)	53	20	214	42	20 tyres 3 big pipes many small pipes 3 chairs 3 mattresses and bases 2 fridge doors many buildings materials,	3 computer screens 1 television 2 washing machines 4 fridges
15/06/2016	11		102	19	215	38		
16/06/2016	11		150	16	217	44		
17/06/2016	11		218	20	250	60		
20/06/2016	11		13	3	433	54		
21/06/2016	11		2	1	591	79		
23/06/2016	11		19	4	426	65		
24/06/2016	11		18	8	731	78		
27/06/2016	10	Residences La Chaux (Zone 2)	25	5	739	68		
28/06/2016	12		157	28	449	56		
29/06/2016	11		0	0	686	81		
		Sub-total	757	124	4951	665		
		TOTAL	**5708 kg**					

Table : Number of bags, weight (in kg) and types of wastes collected in both zones.

The table above describes the amount and types of waste collected in both zones. The main varieties of wastes collected in Zone 1 included plastic and glass bottles,fridges and washing machines, dead dogs, cardboard boxes, cans, plastic bags, used syringes, boat ropes, cigarette boxes, fabrics and shoe soles. In addition, a large amount of broken glass and vinyl asbestos floor tiles, as well as linoleum tiling was collected along the coast of the Barachois in Zone 2. The participants also patrolled the Barachois by boat to collect floating plastic bottles.Overall, the activity was accomplished in an orderly manner; all participants were motivated, punctual and present all ten days (refer to App. 6).

V DISCUSSION AND FINDINGS

5.1 Summary of the design & planning phase

The design and planning phase concluded successfully with the engagement and support of the fishermen as well as the local community. Interest in the project was clarified and the benefits resonated with the fishermen whose livelihoods will be directly affected by the project, which catalyzed support of the general population in Residences La Chaux and Mahebourg, including traditionally disenfranchised populations such as women and the elderly.

Strong attendance at meetings facilitated by the project manager showcased the ability for the fishermen to come together and recognize the need for alternative streams of income. While the fishermen are in competition with each other when on the water, and voiced a strong fear of illegal fishing and poaching of crabs within the project area, their eventual willingness to cooperate is a testament to their belief in the social and economic benefits of the Barachois Project. The regular collaboration necessitated by the meetings created a framework for transparency and clear communication moving forward and strengthened relationships of the fishermen with each other and to the project manger and NGO.

The participation of the fishermen in accumulating background knowledge and suggestions for the project is supplemented by expert contributions that are testament to the feasibility of establishing mariculture within the barachois. In addition, collaboration with the University of Mauritius has confirmed the biophysical fitness of the zone, which will improve as the project remedies the environmental degradation the area has experienced through years of neglect and underutilization. These experts are willing to continue as consultants, acting as mentors and a support system to ensure the project's successful implementation.

The survey with the fishermen was critical in establishing the real need for a project to revitalize the community and provide alternative sources to fishing that can continue sustainably in perpetuity. Greater engagement with the community was achieved by a broad range of questions that created contacts for future activities in the project and created a community network based on trust and mutual understanding. The survey highlighted the vulnerability of the fishermen as an aging population who have seen a declining catch throughout their careers. Fishing has become less economically viable through their lifetimes, but other industries and job opportunities have not been created, leaving the younger generations in Residences La Chaux

and Mahebourg with diminished commercial prospects due to environmental degradation, increasing competition and overfishing. In particular, non-registered fishermen are particularly vulnerable to this decline, though registered fishermen have also been depressed into poverty, with monthly earnings that require fishermen to take up alternative part-time jobs to supplement their income in order to survive. The household survey that is currently conducted will also add information allowing to understand the magnitude and extent of the socioeconomic dynamism of the community. This is crucial to manage small-scale mud crab mariculture.

The barachois project comes at a time when the community is searching for viable options to invigorate their economy, and increasing market prices for both crabs and prawns suggest strong market demand for products the fishermen in Residences La Chaux and Mahebourg currently do not have access to, but will diversify the economy, particularly for younger fishermen who will be trained to work in the barachois.

The promise of future job creation has mobilized the community to volunteer their time during the first phase of the barachois project, cleaning the lagoon and actively engaging in meetings, showing that there is intrinsic support for the project, which can be considered a community-driven investment. The cleaning of the mangroves and lagoon showed the fishermen's interest in engaging with the environment and each other to drive progress toward the establishment of the barachois.

The fair election of the CMA committee established a long-term framework for engagement within the community and stakeholder awareness, both of which are critical to the project. The willingness of participants to volunteer their time as members of the CMA committee show a strong community motivation for the project.

The household survey being administered to the community will further increase shareholder awareness and sensitivity, and engage a greater number of shareholders.

A strategic plan has been developed based on local expertise and traditional knowledge. The mud crab (*Scylla serrata*), was selected for extensive cultivation as a start for mariculture initiative in the barachois considering its high value, good taste and high demand on the local market. The results of the baseline biophysical study emphasize the adequacy of of the barachois for cultivating crustacean species. The presence of mangrove species (*Rhizophoramucronata* and *Bruguieragymnorhiza*) and hydrographic parameters are favorable for the survival of mud crabs.Indeed, mud crabs are known to live in a wide range of

hydrological parameters. Indeed, Mud crab are known to be extremely tolerant to salinity variation and can survive in a salinity range from 2 to 50 ppt (Bhuyian & Islam, 1981), this statement is also confirmed by Khan and Alam (1991) who found that the Scylla serrata is distributed over a wide range of salinity from 2 ppt to oceanic waters. However, Chang (1997) recommended salinity ranging from 20–35 ppt with the lower value in the wet season, whereas Baliao *et al.* (1999) sugested that the culture site should have salinity in the range of 10–35 ppt. The pH found in the barachois is adequate within the recommended ranges of pH 7.5-8.5 (Cholik &Hanafi ,1988).*Scylla serrata* is also recognised as an extremely eurythermic species with a tolerance range of 3-45 ºC as mentioned by Islam and Bhuiyan (1981–1982).

The strategic plan emphasized the two rearing systems that will be used for mud crab culture in the barachois: an open system of mangrove pensand net enclosures and a closed system in which crabs are held individually in cages. Indeed, pen culture of mud crabs is recognized as feasible in East Africa, as long as the site is intertidal and has adequate hydrological parameters (Mwaluma, 2002). Similar to pen culture, drive-in cage culture is considered worldwide as economically and ecologically viable as it is associated with mangrove area conservation (Mwaluma, 2002). However, drive in cage culture has demonstrated better results, regarding growth (Chang & Ikhwanuddin, 1999) and is also low-cost and more profitable in the long run compared to studies of pen culture (Maluma, 2002). This plan also takes into consideration the recommendation from the study conducted between 1997 and 2002 in two barachois in Mauritius including: crab stocking density between 0.5 and 3/m2 and application of plastic linings on the top of the net pen (Hassea *et al.,* 1997-2002).

Finally, it is important to note that other sustainable financing mechanisms will be necessary to ensure mariculture effectiveness and sustainability in the long term. Indeed, the limited of jobs created by mariculture and surveillance,and the length of time to realize financial benefits can discourage and reduce the support of local residents. To ensure viability, other resident groups will have to be involved in other activities such as eco-tourism, education and mangrove forest conservation.

Having achieved the commitment of the community, particularly fishermen, anddrawn up the strategic plan, the second phase of the project can begin.

5.2 SWOT analysis

Developing community-based mariculture in the Barachois of Mahebourg /Residences La Chaux	
STRENGHTS (internal) Fishermen consulted and involved in the project Community is aware and concerned Improved environmental conditions Use of natural conditions Mariculture of native species High demand of cultured species, market potential Local support toward the project. Mangrove are healthy	OPPORTUNITIES (external) Enhancement of tourism Businesses enhancement of local community Integrated mariculture Contribution to environment and biodiversity Embellishment of the area through maintenance and waste removal Many people interest in the project Social use and recreational opportunities will reappear
WEAKNESSES (internal) Restoration may be costly Pollution from adjacent communities Difficult permitting process High manpower required for barachois rehabilitation Low depth in the barachois Surveillance strategy may be costly	THREATS-CONSTRAINTS (external) Project not viable without eco-tourism activities within the mangrove forest Lack of local and national expertise for crab culture Natural disasters (Cyclones, storm surges) Government responsiveness Pollution Diseases (presence of pathogens and disease problems) Seawage impacts from adjacent areas Illegal fishing activities, particularly at night Waste disposal

5.3 Recommendation

The following recommendations have been identified to ensure project effectiveness and sustainability:

- Renovation of barachois wall and creation of gate to increase tidal water movement in and reduce the potential effect of pollution on mariculture.
- Enhancement of environmental awareness in the local community and explain the need for respecting mariculture interventions.
- Immediate steps should be taken to stop the dumping of waste in the barachois area by adjacent communities (clean-up event, warning panels, surveillance, awareness activities and tools, waste disposal facilities, fencing).
- Appropriate steps should be taken to stop illegal activities in the barachois area.
- Deliberate efforts should be made to empower the community of Residences La Chaux with management and technical skills.
- Constant and continuous dissemination of mariculture updates to the local community and stakeholders.
- Ecotourism activities have to be designed as a management tool, to increase motivation and provide financial reward for residents participating in management work. It will simultaneously lead to economic wealth of the community as well as enhance and embellish the environment.
- Finally, approval to use Zone 2 "Cot Nicole", which must be obtained from the Ministry of Housing and Lands, will be primordial to ensure project effectiveness and sustainability for three reasons:

  - Ideal location for implementing sustainable financing mechanisms (eco-tourism, education)

  - Ability to reverse the process of environmental damage in the area through restoration and conservation while increasing the wellbeing of the adjacent coastal community.

  - Mangrove-friendly mariculture can be extended in Zone 2, which has great potential and will ensure profitability.

VI CONCLUSION

To conclude, the present study was characterized by several important advancements aiming to evaluate the feasibility of community-based mariculture in the barachois adjacent to the community of Residences La Chaux. A baseline socioeconomic study was conducted through questionnaire surveys, focus group discussions and key informant interviews highlighting the need to create additional and alternative income generating activities for the local fishermen who currently have insufficient income and have seen their fishing conditions slowly deteriorate. A baseline biophysical study of the barachois water showed the overall water quality adequate for crustacean culture supported by the presence of two mangrove species. The positive perception of local fishermen and willingness to participate in the project was also highlighted in the study. Awareness-raising activities have enhanced community concerns, involvement and support toward the project. The mangrove clean-up by selected fishermen was conducted successfully regarding the selection process and fishermen's dedication to their work and team spirit. The project management structure is currently in place through the CMA Committee and partnerships have been established with stakeholders. Worldwide, mariculture is considered promising to enhance wellbeing, alleviate poverty and enhance the livelihood of the coastal communities. In addition, the marked demand in Mauritius is high, the seed on which the crab culture depends is available and the proximity of local customers make the mariculture adequate, feasible and potentially profitable in the barachois of Mahebourg and Residences la Chaux. As a result, a strategic plan, aiming to initiate crab (*Scylla serrata*) culture as an experimental first steps to start mariculture in the barachois, was established based on local, regional and national expertise, as well as the knowledge of local fishermen. Crab cultivation will consist of crablets collection, a grow-out operation through two rearing systems, harvest and sale. The implementation of the project is thus ready to start.

Planned activities for the next three months	Months		
	Oct	Nov	Dec
Investigate local market opportunities for live crabs - local customers identification (hotels, restaurant and markets)	■	■	
Renovate and secure the store house which is lended by a local fishermen in Residences La Chaux to stock materials	■		
Set up the floating deck for facilitating mariculture monitoring and surveillance	■		
Build drive-in and floating prototype cages in various type of materials.	■	■	
Obtain permitting to fence Zone 1 and permitting to lease Zones 1 and 2 in order to design and implement ecotourism activities.	■	■	
Clean-up of Zones 1 & 2 (October 22nd, 2016 , with 100 students from the University of Mauritius)	■		
Design and create 2 information panels regarding the barachois project.	■	■	
Design and create 8 warnings panels (smaller size) to prevent dumping in the barachois and mangrove areas.	■		
Design and prepare the mariculture monitoring programme based on local and regional expertise.	■	■	
Clarify collaboration and partnerships with the University of Mauritius for the biophysical monitoring	■	■	
Conduct community-based event on November 6th to increase awareness and engage the residents of Residences La Chaux.		■	
Conduct CMA committee workshop to brainstorm project plans, build collaboration and partnerships and enhance local support from stakeholder groups.		■	
Finalize the baseline socio-economic study including the entire community.	■	■	■
Representatively elect future staff members and volunteers for surveillance monitoring, crab collection and marketing and sales.		■	
Set up the fences of Zone 1		■	
Implement experimental studies on cultivation of crabs, prawn and oyster species			■

References

Baliao, DD, MA De Los Santos and, NM Franco (1999).*Pen culture of mudcrab in mangroves.* Aquaculture extension manual, No. 29, March 1999. 10 pp.

Bhuyian AL and MJ Islam (1981).*Tolerance and distribution of Scylla serrata in response to salinity of Kamafuly river estuary (Bangladesh)*. Bangladesh J. Agrie, 6: 7-15.

Brummett RE and MJ William (2000).*The evolution of aquaculture in African rural and economic development.* Ecol Econ 33:193–203

Campbell J, E Whittingham and P Townsley (2006).*Responding to Coastal Poverty: Should We be Doing Things Differently or Doing Different Things?In Hoanh CT, TP Tuong, JW Gowing and B Hardy (eds) Environmentand Livelihoods in Tropical Coastal Zones. CAB International, London.*

Chang, WW (1997).*Pen culture of mud crabs in the mangrove ecosystems in Sarawak (East Malaysia). Aqua. Asia* II no. 4 Oct–Dec. pp. 3–5.

Chang, WWS and AM Ikhwanuddin (1999). Pen *culture of mud crabs, genus Scylla, in the mangrove ecosystems of East Sarawak, Malaysia*, *pp. 83-88. In: Keenan, C. P. and A. Blackshaw (eds) Mud crab Aquaculture biology. Proceedings of an international scientific forum held in Darwin, Australia, 21-24 April 1997, ACIAR Proceedings No. 78, 216 p.*

Cholik F and A Hanafi (1988).*A review of the status of the mud crab (Scylla sp,) fishery and culture in indonesia.* The Central Research Institute for Fisheries Agency for Agricultural research and Development, Jakarta, Indonesia.

Christensen MS (1995).*Small-scale aquaculture in Africa: Does it have a future?* World Aquaculture, 26:30-32.

Giasuddin M and MF Alam (1991). *The mud crab (Scylla serrata) fishery and its bio-economics in Bangladesh.* In: C.A. Angel (Ed) The mud crab: A report on the seminar convened in Surat Tahi, Thailand, November 5-8 1991. pp 29-40.

Hassea R, B Codabaccus, S Rathacharen, S Khadun, H Iwamoto and, T Shimizu (1997-2002). *Some results of the study on rearing of mangrove crab, Scylla serrata, juveniles in the barachois of Mauritius.* Albion Fisheries Research Centre and Japan International Cooperation Agency.

Islam, MJ and AL Bhuiyan (1981–82).*Temperature tolerance and its impact on the distribution of mud crab in the Karnafully River estuary*. Bangl. J.Agric. 6 & 7: 38–46.

Khan MG and MF Alam (1991). Mud crab (Scylla serrata) fishery and its bio-economics in Bangladesh. Proceedings of the report of the seminar on the Mud Crab Culture and Trade, November 2-8, 1991, Surat Thani, Thailand, pp:29-49.

Mirera DO and CC Ngugi (2009).*Sustainability and income opportunities of farming milkfish (Chanos chanos) to local communities in Kenya: assessment of initial trials of earthen ponds.* EC FP7 Project, SARNISSA. November,2009.

Shelley C (2008).*Capture-based aquaculture of mud crabs (Scylla spp.).* In A. Lovatelli and P.F. Holthus (eds). Capture-based aquaculture. Global overview. *FAO Fisheries Technical Paper*. No. 508. Rome, FAO. pp. 255–269.

Zanzibar Department of Statistics (1997).*Zanzibar Statistical abstract*. Zanzibar, Tanzania: Department of Statistics, 30 pp.

Appendices

Appendix 1: Final list of Registered Fishermen (RF) of Residences La Chaux

N	Card Number	Name
Registered Fishermen of Cite La Chaux		
1	MBG 117	ORANGE Andre Manfred
2	MBG 224	VURDAPANAICKEN Serge Simon
3	MBG 231	HANG HONG Christian Paul
4	MGB 285	LAMARQUE Jacques Allain
5	MGB 286	LAMARQUE Clovis
6	MGB 305	LAMARQUE Bruno Pierre
7	MGB 306	LAMARQUE Gervais Jean
8	MGB 307	LAMARQUE Jean Emmanuel
9	MGB 310	ARCANTE Jean
10	MGB 311	ARCANTE Joseph Louis
11	MGB 312	POTAGE Pierre Gerard
12	MGB 316	LAURENT Jean Noel
13	MGB 323	ROUSSEL Georges
14	MGB 424	RIVIERE Jacques Laval
15	MBG 428	VURDAPANAIKEN Edmond Bertrand
16	MGB 491	BONNEFEMME Louis France
17	MGB 509	VINCENT Pierre Jean Christian
18	MGB 536	EDGAR Jean Ridol
19	MGB 545	LACAZE Louis Steve
20	MGB 607	BETSY Paul Gervais
21	MGB 617	FOZOO Louis Pierre
22	MGB 637	ARCANTE Jacques Andre
23	MGB 639	KEISLER Roger Rosano
24	MGB 647	MADARBACCUS Jean Claude
25	MGB 724	VALERE L Henri
26	MGB 812	BUDE Sylvain
27	MGB 816	MUNGROO Dewanand
28	MGB 823	CHAMROO Sookraj
29	MGB 877	KEISLER Jean Robert
30	MGB 898	CALOU Francois Joseph
31	MGB 942	BARAT Bidjeye
32	MGB 1065	ROUSSEL Antoine Yves
33	MGB 1142	BAROSEE Joachim Barnabe
34	MGB 1220	RIVIERE Martiano
35	MGB 1223	MARIE May Jerry
36	MGB 1229	SUNTHANUM Kreshan
37	MGB 1242	GRENOUILLE Jeff Ivans
38	MGB 1245	MERCURE Jean Noel
39	MGB 1246	RABOUDE Jean Noel Magne

40	MGB 1253	BOODHUN Sadanand
41	MGB 1261	CHAMROO Gyaneshwar
42	MGB 1275	MAGON Pierre Dario Asthon
43	MGB 1277	MARDAY Jean Christopher Thierry
44	MGB 1278	MARDAY Jayson Giovanni
45	MGB 1284	KEISLER Louis Giovanni

Appendix 2: Final list of Registered Fishermen (RF) of Mahebourg involved in the project.

Registered Fishermen of Mahebourg		
1	MGB 215	RABAYE Maurice
2	MGB 280	DROOVNATH Seetaloo
3	MGB 289	LABUTOOLA S. Sydney
4	MGB 364	HURLALL Deepnarain
5	MGB 433	PANCHOO Ramparsad
6	MGB 594	HURLALL Jugduth
7	MGB 613	ETIENNE Jean Robert
8	MGB 713	MUKHOOD Rajman
9	MGB 743	MUKHOOD Heeralall
10	MGB 745	RAMGOOLAM Pradip
11	MGB 789	GAUNGOO Mahen
12	MGB 909	BEEJARAN Anand
13	MGB 1055	OVA Jean Noel
14	MGB 1270	ETIENNE Jean Denis
15	MGB	ARMOOGUM Ananda
16	MGB	GOONAMY Soodesh

Appendix 3: Socio-economic questionnaire survey to fishermen

Date: **Name of Interviewer:** **Duration of the interview:**

PERSONAL AND DEMOGRAPHIC

1) Name: **2)** Date of Birth: **3)**Address: **4)** Married: Yes / No

5) Level of Education: **6)** Card Number: **7)**Fishing Landing Station:

8)What is the number of people in your household?

9) How long have you been fishing?

10) Do you enjoy your profession as professional fisher? Yes / No

11)a) Personal evaluation of your fishing 's conditions? Difficult / Moderate / Easy

b)Over time? Easier / Similar / Harder c) Reasons for change in difficulty?

12) How many members of your family fish for a living?

Only one (himself)a) Number of family members who fish:

13)a)Do you fish alone or with a crew of fishers? Alone / In a crew

b)Average number of crew (including yourself)?

14) Are the fishers you fish with your family members? Yes/ No

15)a)Are you? Owner / Co-owner / Renterb)(If renter) Rental cost per trip? MUR

16) What are the main technical features of the boats you owned?

Boat Name	Boat Number	Type of boat (wood, fiberglass, pirogue)	Length (metres)	Type of Engine (hp)	Year of construction	Year of purchase

INCOME FROM FISHING

17) How much do you earn per month (net) from selling fish, after deducting fishing costs (per person)?

	Average (MUR/month)		
Currently	<6000	6000<> 150000	>15000
Before (more than 10 years)	<6000	6000<> 15000	>15000

18) Is your income from selling fish enough to cover your monthly expenses? Yes / No

19) To whom do you sell your fish?
Individuals (door to door) / Shop/ Restaurant -hotel / Middleman / Market

20) Do you manage to sell all of your fish catch? Yes/ No

21) What will you do with fish that are not sold? Use as bait / Eat/ Donate

22)a) How many kilos do you keep for yourself? kg;b) Which particular species?

23) What are the average costs in MUR of the following, per fishing trip?

Item	Cost
Petrol	
Bait	
Skipper	
Others: (Please specify)	

24) If you have a share system in place within your crew, how do you share profits and expenses?

ADDITIONAL INCOME

25)a)Do you have any other additional income generating activities to help sustain your household?
Activity/ No Activity

(If activity)
b) What kind of activity:

c) The time dedicated to this activity :% of your working time

d) Additional income per month: <4000 4000-8000 >8000 MUR

e) What are the reasons for this activity ?

26)a)Do you receive any pension?
b) What kind of pension? c) Pension income?

LOCATION OF FISHING ZONE

27) Where are the best fishing zones that you regularlyfish ? (Use ofmaps providing grid zones)

Year	Inside Lagoon	Species caught	Prices you sell them (Price/kg)	Outside Lagoon	Species caught	Prices You sell them (Price/kg)	In the CMA	Species Caught	Prices You sell them (Price/kg)
Current (2016)	Zone(s)?			Zone(s) ?			Zone(s)?		
Before (More than 10 years ago)	Zone(s)?			Zone(s) ?			Zone(s)?		

28) What are the major reasons influencing your choice of your current fishing zone?

	Select your choice
Abundance of fish population	
Your experience	
Accessibility and proximity of the fishing area	
Proximity of a marine reserve	
Few fishers in this area	
Few other activities conducted in this area (diving, kite - surfing, speed boat)	
Other: (please specify)	

29) Average distance and time required to travel to go to fishing zone your currently fish at?

Inside Lagoon	Outside Lagoon	In the CMA
Time	Time	Time
Hours/min	Hours/min	Hours/min

TYPE OF GEAR

30) What type of gear do you use to fish?

Gear	Period (year)
a) b)	Currently
a) b)	Before (More than 10 years ago)

CATCH CHARACTERISTICS

31) What are the main species you target?

32)a)Have you noticed a change in the size of fish you catch in the past 10 years? Yes / No
b) (if yes) Fish are smaller now / Fish are larger now / Other:(*please specify*)

33) What are the reasons for this change in observed size?
The fish are caught before maturity Too many fishers catching fish Other: (*please specify*)

34) Are there any marine species that you cannot catch now, but you used to catch before? Yes / No
a) (if yes) What species of fish?

CATCH PER UNIT EFFORTS (CPUE)

	Currently	Before (more than 10 years ago
35) How many hours do you fish a day?	starting from until	starting from until
36) How many times do you fish per day?		
37) Are your fishing trips single-day trips or multi-day trips?		
38) How many days do you fish per week?		

39) How much fish, on average, do you catch perfishing trip? (Individually)

Year	Average kg/trip
Currently	
More than 10 years ago	

STAKEHOLDERS INTERACTION

40) How isyour relationship with other stakeholders?

	Good interaction	Conflict	No interaction
Recreational fishers			
Other professional fishers			
Spear fishers			
Non-registered fishers			
Divers			
Surfers, windsurfers, kite-surfers…			
National Coast Guards			
Fisheries post			
Local NGOs			
Speed boats & glass bottom boats			
Other users (*please specify :)*			

PROJECT PERCEPTION

41) Perception towards the project? Positive / Negative / None

42) Are you willing to participate? Yes/ No

43) Main problems that may occur?

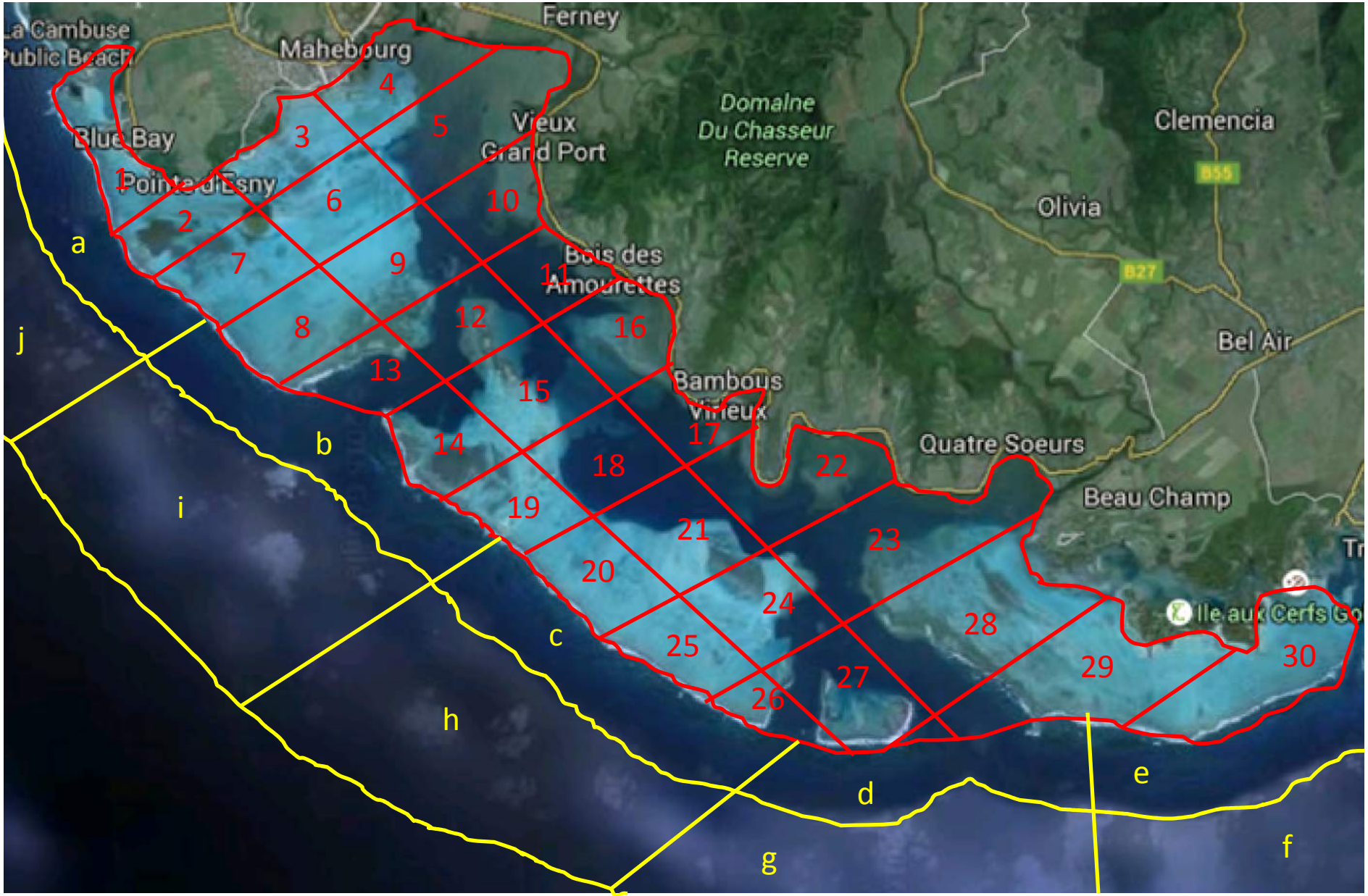
44) Would you be interested to have another income generating activities than fishing? Yes / No

45) What benefits do you think the fishers can obtain from The Barachois Project?

46) What benefits do you think the local community can obtain from The Barachois Project?

COLLABORATIVE MANAGEMENT AREA (CMA) GRID ZONES

MAP (Inside and outside lagoon Grid Zones)



Appendix 4: Household survey questionnaire

#	NAME AND SURNAME	ADDRESS	PHONE NUMBER (ADULTS: >18)	E-MAIL (ADULTS: >18)	FAMILY ORGANIZATION Householder Husband/Wife Son/Daughter Father/Mother Son in law/Daughter in law Brother/Sister Grand-father/Grand-mother Grand-son/Grand-daughter Other	EDUCATION LEVEL Elementary school Primary school Secondary school Tertiary School University/College	AGE
1							
2							
3							
4							
5							
6							
7							
8							

#	PRINCIPAL OCCUPATION Unemployed Student Retired Occupation?	PLACE OF WORK (CITY)	SECONDARY OCCUPATION	MONTHLY SALARY None <4000 4000<>8000 8000<>15000 15000<>25000 >25000	COMPETENCES PERSONNELLES Gardener Artist Painter Boat license Necklaces/Bracelet Sport DJ/Animator Experience with children Cooking Accounting Management Other ...	EXTRACURRICULAR ACTIVITIES/SPORTS Adults (Activities/Location) Children (Extracurricularactivities / Location)	ACTIVITIES IN THE BARACHOIS (B)Type of activities (N) Type of activities	PERCEPTION TOWARDS THE PROJECT Positive Negative None	WILLINGNESS TO PARTICIPATE YES NO DO NOT KNOW
1									
2									
3									
4									
5									
6									
7									
8									

1) Is yourmonthlysalarysufficient to coveryourdailyexpenses ? Yes/No

2) What are the main problemsencountered by yourcommunity ?

3) What are the main environmentalproblems in yourregion ?

LAGOON?

BARACHOIS?

COT NICOLE (Mangrove Forest Zone 2)?

MANGROVES?

4)Do youthinkthat the waste management in yourcommunityis efficient ? (recycle of waste, number of trash binspresent, frequency of waste collection) If not, explainwhy.

5)What type of marine species do you consume regularly ? (Circle the species) At whatprice and fromwhom do youbuythem ?

Species	**Price (MUR) / Pound**	**Where do youbuythem?**FishermenMahebourg / FishermenRésidences la Chaux / Market / Supermarket/Member of thefamily/ Other ?
Cordonnier		
Carangue		
Rouget		
Petit Rouget		
Vieille rouge		
Vieille gris		
Corne		
Cateau		
Capitaine		
Gueule pave		
Carpe		
Dame berri		
Madame Tombée		
Mullet		
Ourite		
Mougate		
Langouste		
Crabe Carlet		
Crabe Lami		
Crabe roche		
Sevrette de mer		

6) In context of the environment and the social, whatadvantage do youexpect the projectwillbring to yourcommunity ? (Justify)

Activitieswithchildren ? What types ?

Sensitization and environmentaleducation?How ?

Attracttourists to yourcommunity?How ?

Embellishment of yourenvironment?How ?

Promoteyour culture?How ?

Others ?

7) What do youthinkwillbe the benefitsthat the projectwilldeliver to yourcommunity ?

8) How would you like to be informed regarding project updates ? (Circle the right answer)

Letter to physicaladdressNewspaper E-mail Facebook page Word to mouth

Information panels in the community Information via the representatives of the community

Regarding "COT NICOLE"area (Zone 2)

#	Did you previously go to "Cot Nicole" area? Often Sometimes Rarely Never (Please specify)	Activities?	Do you currently go to "Cot Nicole"area? Often Sometimes Rarely Never (Please specify)	Activities?	Reasons for infrequency of visit?	What can be done to encourage you to go to the zone?
1						
2						
3						
4						
5						
6						
7						
8						

Appendix 5: Report of the biophysical study prepared by the University of Mauritius.

Report

Marine Environmental Assessment of a Barachois at Cite La Chaux, Mahebourg

Prepared by:

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&

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University of Mauritius

Reduit, Mauritius

09th August 2016

Executive Summary

Cite La Chaux is located near the coast of the village of Mahebourg, in the south east of Mauritius and in the district of Grand port. This district is well known in history, bearing the testimony of the Dutch and the French colonies and Mahebourg waterfront is a famous attraction to many tourists. The geographical location of Cite La Chaux, Mahebourg is GPS position: $20^0$25'03.35''S ; $57^0$42'47.35''E. It is situated near the main road and surrounded by the two species of mangroves namely *Bruguieragymnorrhiza* and *Rhizophoramucronata*found in Mauritius. The area features a tropical weather, encouraging activities like fishing and recreational activities along the Eastern coasts. However, to prevent illegal fishing in the Mauritian lagoons around that area, the Ministry of fisheries has established a fisheries post known as Mahebourg Fisheries port at the site. The small region around the barachois harbors many fishermen and their families who derives their earnings by exploiting the sea itself. The common fish they sell are 'Guele pave', 'cordonnier', 'vielle rouge', 'poisson corn' amongst others fished around the lagoon of the eastern coast and off-lagoon also.

Benthic surveys showed that the substrate around the barachois was dominated by the presence of sandy bottom covered with a thin layer turf algae and few patches of rocky substratum with few macroalgae density. Patches of corals were observed in the northern part of the barachois, the species *Porites lutea*were the most dominant while other species encountered were *Cyphastreamicrophthalma*, *Porites rus* and *Montiporacalcarea*.

The main conspicuous invertebrate to have been observed during the survey were the small urchins with the thin and long spines of the *Diademasp* which were found anchored in between rocks.

Fish surveys revealed the following common fishes encountered during the survey which included the species *siganussp (cordonnier), Upeneussp (rouget), Valencienneasp (cabot), Mugilcephalus (Mullet).*Furthermore, fish surveys revealed that the fish species richness is very low in this region due to fishing practices, low water depth and local population just next to the barachois.

1.0 Introduction

1.1 Historical Background

The ecosystem studied is a closed system with a physical enclosure made of rocks. This area was once used by the Ministry of Fisheries as a mariculture site for fish with smaller side ponds for culture and/or fattening of fish and crustaceans such as lobsters and crabs. The actual site being studied had a depth that reached 2 meters in the central areas. Today this same site has an average depth not exceeding 1 meter at low tide. This gradually decline in depth has been mainly due to continuous sedimentation and the bed consists mostly of silt deposit. The artificial wall has allowed sedimentation across and deposition within the closed system. In those days the annual catch of fish was in tones and comprised of mainly species like *Rhabdosargussarba, Mugilcephallus, Lethrinusharak*and *Siganussutor.* The edible and commercial crab "carlet" once were also very common in this area.

1.2 Survey Logistics

The major items of equipments that have been used to carry out this present survey were asfollows:

1. Boat with outboard engines
2. Garmin 60 GPS
3. Mares Dive Computer "Matrix"
4. Underwater still camera
5. Underwater video camera
6. 50 m fibre-glass measuring tapes
7. Underwater slates and pencil
8. Ropes, floats and dead weights
9. Hawk Eye H22PX handheld depth finder
10. 1m x 1m plastic quadrate

2.0 Methodology

2.1 Survey Sites

The survey was carried out in winter season between June and July 2016 at Cite La Chaux, Mahebourg extending over the Barachois (A) and adjacent lagoon (B) and wetland earmarked (C) as represented in Figure 1 below.

Figure 1: Picture representing the Barachois, Adjacent lagoon area and the connecting wetlands.

Source: modified from google earth

2.2 Surveyed stations

The whole area was divided into three distinct zones as follows:

Zone A: BarachoisZone B: LagoonZone C: Wetlands

The above mentioned zones were further divided into stations:

Stations	Zones	GPS Locations	Remarks
Station 1	C	20°25'13.87"S ;57°42'48.72"E	-
Station 2	B	20°24'52.96"S ;57°42'46.96"E	-
Station 3	B	20°24'55.50"S ;57°42'59.90"E	-
Stations 4-10*	A	20°25'2.66"S ;57°42'48.00"E	Down the red line

*The red line drawn in figure 2 represents the 7 equally divided stations (4-10), Station 4 starts from the far west and Station10 is found in the far east.

Figure 2: Picture representing the stations in the Barachois and surrounding areas.

Source: modified from google earth

2.3 Water quality sampling and analysis

The following physico-chemical analysis were performed for each stations: pH, Dissolved Oxygen, Nitrate, Phosphate, Salinity, and Temperature. Samples were taken around 20±10 cm from surface by opening sealed plastic bottles at the appropriate depth. Plastic bottles were used to contain the water samples for laboratory analysis. Temperature, pH, salinity and dissolved oxygen were immediately recorded from the bottle once completely filled. The water samples were stored in cooler box at a temperature below 10°C and in complete darkness during transportation for further analysis such as Nitrate and Phosphate.

2.3.1 Temperature

A glass thermometer was used to analyse the seawater directly on-site from the sampling bottles. (No calibration required).

2.3.2 pH

A pH meter (HANNA, HI 991001) with extended range waterproof pH/Temperature Meter was used to analyse the seawater directly on-site from the sampling bottles. (Calibration was performed using the manual provided).

2.3.3 Dissolved Oxygen (DO)

A DO meter (SPER Scientific DO Pen) was used to analyse the seawater directly on-site from the sampling bottles. (Calibration was performed using the manual provided).

2.3.4 Salinity

A refractometer was used to analyse the seawater directly on-site from the sampling bottles. (No calibration required).

2.3.5 Nitrate and Phosphate

A multi-parameter photometer (HANNA HI83203) was used to analyse the seawater. Samples were taken to a proper location and were analysed (all samples were analysed within 2hours after sampling). Cadmium Reduction method was used for Nitrate analysis while Ascorbic Acid method was used for Phosphate analysis. (No calibration required).

2.4 Sediment sampling and analysis

A total of 3 samples (S1, S2 and S3) of sediment with 3 replicates (R1, R2 and R3) each were collected randomly along the virtual red line as represented in figure 2. They were stored in plastic bags and transported to laboratory where initial tests such as pH and electrical conductivity test were conducted on the fresh samples. The sediments were then allowed to air-dry on a tray for one week and eventually each sample was passed through a 2mm sieve and collected in a clean plastic container for further analysis:

2.4.1 Determination of Organic Matter

Organic matter in the 3 samples S1, S2 and S3 was determined according to the protocol stated by Rowell (1994) with minor modifications. 1g of sediment sample was weighed in a conical flask and 10ml of 5% Potassium Dichromate and 20ml of concentrated sulphuric acid was added. The mixture was allowed to cool and 50ml of barium chloride was added and left to stand overnight. Known concentration of standard solutions containing 0, 2.5, 5, 7.5, 10 and 12.5 mg/ml of carbon were prepared and both standard and sample solutions were read at 600nm using a spectrophotometer. For accurate results, each sample was replicated thrice.

2.4.2 Determination of Total Nitrogen

Total nitrogen in the 3 samples S1, S2 and S3 was determined according to the protocol stated by Rowell (1994) with minor modifications. 0.5g of sample was weighed into the digestion flask and one kjeldahl tablet was added followed by 15ml of concentrated sulphuric acid. The solution was then heated on a digestion rack at a temperature of 380^0C until no charred organic matter remaining. After cooling, the obtained solution was diluted with deionized water and passed through a distillation flask. The distillate was then titrated with 0.01M of hydrochloric acid. For accurate results, each sample was replicated thrice. The concentration of total nitrogen in the sediment was eventually calculated using the formula provided by FAO Soils Bulletin (1980).

Total nitrogen (mg/100g of soil) = (ax14)/P, where a is HCl/ml and P is soil/g.

2.4.3 Determination of Sulphur

Sulphur in the 3 samples S1, S2 and S3 was determined according to the protocol stated by Rowell (1994) with minor modifications. 25g soil was weighed and 1g of activated charcoal was added followed by 50ml of Calcium chloride. The mixture was placed on an automatic shaker for 1 hour and then filtered. 1ml of the filtrate was diluted with 39ml of deionized water and used to determine the concentration of Sulphur in the sediments. Known concentration of standard solutions containing 0, 5,

10, 20, 30, 40 and 50 mg/ml of sulphur were prepared and both standard and sample solutions were read at 480nm using a spectrophotometer. For accurate results, each sample was replicated thrice.

2.2.4 Determination of Total Phosphorus

Total sulphur in the 3 samples S1, S2 and S3 was determined according to the protocol stated by Rowell (1994) with modifications. The weight of the crucible was taken prior to ashing. The crucible was then half filled with sediment and their weight was taken again and then placed in a hot furnace and initially ashed at 300^{o}C for 8hours. The weight recorded before ashing and after ashing at 300oC was used for the determination of total carbon in the sediments.

The sediments were again ashed at 500^{o}C for 8hours and after cooling 0.5g of ashed sediment was mixed with 15ml of concentrated hydrochloric acid in a crucible and placed in a sand bath at 100^{o}C. After drying, 5ml of concentrated Nitric acid was added and heated. After the acid digestion, the content was diluted with deionized water and filtered. 2ml of the filtrate was mixed with 8ml of Ammonium molybdate and 8ml of Ascorbic acid and allowed to stand for 30min. Known concentration of standard solutions containing 0, 1, 2, 3, 4 and 5 mg/ml of phosphorus were prepared and both standard and sample solutions were read at 880nm using a spectrophotometer. For accurate results, each sample was replicated thrice.

2.2.5 Sampling and determination of Heavy Metal

The sediment sample was first oven-dried at 70 °C until constant weight was reached. All laboratory equipment's used were carefully clean to avoid cross contamination with other samples. In a crucible, 2 grams (record to the nearest 0.01 gram) of sediment was taken. Then 10 ml of water was added and a stirring rod was used to pulverize the sample. Concentrated Nitric acid (HNO_3) was used for the digestion of the sediment sample. 5 ml of HNO_3 was added to the sample and allowed to cook in a sand bath uncovered for approximately 15 minutes in a fume hood at 60 °C before dryness. Following to this, another 5 ml of HNO_3 was added to the sample and the crucible was covered with a watch glass and samples were gently reflux. When most of the bubbling has stopped, 2 ml of HNO_3 was added, covered and heating continued. The same step was repeated for another 2 ml portion of HNO_3. The crucibles were removed from the sand bath and allowed to cool at room temperature. Another 2 ml of $HNO_3$was added and sample were gently warmed while uncovered for several minutes. The watch glasses and stirring rods used were rinsed two times with water and the rinsing was collected separately in a 100 ml beaker. The solutions were filtered through filter paper placed in a glass funnel directly into a 100 ml volumetric flask. The crucibles were rinsed twice and the rinsing's were poured into the funnel

containing whatman filter paper (125 mm). The solutions were diluted and marked to the line of the volumetric flask and were mixed for further analysis atomic absorption spectroscopy (AAS). Each metals were detected at a specific wavelength and using a specific lamp. The selected heavy metals were determined by the atomic absorption spectrometer with flame type air-acetylene at particular wavelength. Chromium and lead were analysed by the flame type nitrous oxide-acetylene. Arsenic and mercury were determined by the hydride system.

2.5 Benthic Survey

Given that the site is very shallow with a maximum water depth of only 1m at low tide, we not only surveyed the stations but also the whole Barachois first using the line transect intercept (Loya, 1978; Mundy, 1991; English et al., 1997; Leujak and Ormond, 2007) and visual assessment. The survey methods used in the present survey has been modified from the standard methods described in English et al. (1997). Surveys at each station involved firstly a swim over the survey area to determine a representative location for the surveys transect lines. Each site was surveyed for coral and substrate cover, fish populations, invertebrates and flora. The fish surveys were conducted over 50m while the benthic surveys were conducted over 20m. Both surveys were conducted using the same transect lines, with the benthic surveys being in the first 20m of each line. Three replicate survey lines were deployed randomly but in parallel at each station such that they do not overlap. Due to very shallow water, 50m distance long were virtually assessed biodiversity.

The following survey requirements for each station were met, except where indicated otherwise:

General environmental parameters of each station:

- 3 x 50m fish identification and abundance surveys.
- 3 x 20m benthic line-intercept transects surveys for coral and substrate identification, species abundance and health surveys, including a general description of the area.
- Flora identification and abundance survey along the 20m benthic survey lines.
- Conspicuous invertebrates identification and abundance survey over 50m of each transect line

2.6 Fish Surveys

The fish surveys were conducted at each station and over the whole Barachois area. Due to very shallow water at the site, fish surveys were conducted while snorkeling and visual assessment. The observer first waited for 5-15 minutes after deploying the transect line whereby possible before starting the actual counting survey so as to allow fish to resume their normal behavior. Divers then conducted the fish survey along each of these transects, giving a total of 3 surveys at each station. The survey was conducted as a single pass along the transect line, and not broken down into smaller units. Fish were identified to species level. Notes were taken if any endemic species were encountered.

2.7 Conspicuous invertebrates survey

Conspicuous invertebrate species and other life-forms were recorded over the whole Barachois by visual assessments as well as 1m x 1m quadrats. Most of the invertebrates were later identified using Richmond (1997) and Debelius (1998).

2.8 Underwater Photographs

In this report, representative pictures have been provided with the objective to give a general impression of the site and at the same time to better illustrate the substrate cover for the area. The pictures also contain some of the coral, fish and any other marine species encountered during the surveys.

3.0 Results and Discussion

3.1 Marine water quality

The results of physical and chemical parameters measured at the various stations are given below. Some of the data were referenced against available coastal water quality requirements from the Guidelines for coastal water quality requirements for various categories Govt. Notice No. 620 0f

1999 9CWQG *(Annex 1)*.

Table 1.0: Marine water quality results for the different stations

Date - 24.06.16							
Station	**Zone**	**pH**	**DO mg/L**	**Salinity ‰**	**T °C**	**Nitrate mg/L**	**Phosphate mg/L**
1	C	7.8	3.2	37	24	2.5	0.25
2	B	8.1	4.8	35	24.1	0.2	0
3	B	8.1	4.5	35	24.1	1.8	0.02
4	A	8	5.9	36	24.3	2.6	1.23
5	A	8.2	4.6	36	24.3	0.6	0.01
6	A	8	5	36	24.2	1.2	0
7	A	8.2	5.6	36	24.2	2.2	1.42
8	A	8.1	5.3	35	24.3	0	0
9	A	7.9	5.1	36	24.3	1.4	0
10	A	7.9	4.3	36	24.2	3.5	1.12
		Guidelines Category A / Class A2 (Natural Areas)					
		7.0 - 9.0	>2	-	Ambient	1	0.1

3.2 Sediment Quality

3.2.1 pH and Electrical Conductivity

Table 2.0: pH and Electrical Conductivity results

Fresh Samples	**S1**	**S2**	**S3**
pH	**8.23**	**8.29**	**8.27**
Electrical Conductivity (mS)	**2.93**	**3.83**	**2.69**

3.2.2 Total Sulphur

In water Sulphur predominantly exist as sulphates. With an average concentration of 2700 mg/L, sulphate is the third most common species in seawater, after Na and Cl (Hem 1992). Sulphates are considered a less toxic element although present in relatively high level (>1000 mg/L) but it may cause adverse effects in some aquatic species and catharsis and gastrointestinal irritation in human. The sample analysed (Table 2.0) indicates very low concentrations within the threshold (<500 mg/L).

Table 3.0: (Total Sulphur content from 3 samples sediment)

Samples	S1	S2	S3
Final concentration (mg/L)	**161.58**	**129.90**	**137.82**

3.2.3 Total Organic Carbon

Total organic carbon (TOC) and total nitrogen (TN)content, in soils and sediments are important parameters to assess the environmental status of terrestrial and aquatic ecosystems. The soil and sediments organic carbon and nitrogen are mainly derived by decomposition of the plants and animals or plankton or anthropogenic sources such as chemical contaminants, fertilizers or organic rich waste and leaching. The sediments TOC and TN ratios can be used as biomarkers, to distinguish the marine or terrestrial sources of organic matter as well as aerobic/anoxic and sulfur reduction conditions and thus give a qualitative indication of the redox status.

Table 4.0: Percentage of Total Organic Carbon by dry ash method

Samples	Weight after 500^{o}C/g	Total Carbon/g	Organic carbon/g	Inorganic Carbon/g	% Total Organic Carbon
S1	**25.76**	**1.34**	**0.069**	**1.271**	**0.268**
S2	**28.04**	**1.38**	**0.06**	**1.32**	**0.211**
S3	**27.77**	**1.35**	**0.069**	**1.281**	**0.248**

Table 5.0: Concentration of Total Organic Carbon in sediment

Samples	S1	S2	S3
Final concentration (mg/mL)	**0.69**	**0.60**	**0.69**

The Organic Carbon level was normal, that is, below 0.5% which is indicative of shallow seas. Thus, the actual ecosystem shows no evidence of past eutrophication events and thus indicate less leaching from coastlines.

3.2.4 Total Nitrogen

Nitrogen is present in marine system in various forms with nitrate being the principle form of fixed dissolved inorganic nitrogen. As photosynthetic organisms can assimilate dissolved organic nutrients, there has been a growing interest in dissolved organic nitrogen (DON).Indeed,nitrogen has a great contribution to the nutrient cycle. The atmospheric nitrogen is fixed to ammonium by nitrogen-fixing bacteria in soil and aquatic systems. The ammonium (nitrates and nitrites) is then used by crops and animals. When decayed the different forms of nitrogen are released back to soil and marine environment.

Similar to phosphate, any disruption in nitrate normal threshold value in sea water will lead to a destabilized marine ecosystem. For instance, a high level of nutrient would cause eutrophication and a low concentration of nitrate would be the limiting factor for growth of phytoplankton. Concerning sediments, the total nitrogen is an important component as it can be used to distinguish between marine and terrestrial sources of organic matter, as pollution indicators and assessing factor sediment quality. It had been shown that the absence of Dissolved Inorganic Nitrogen (DIN), the Directed Ortho Metalation of benthic community is accelerated. In contrast, a high occurrence of DIN concentration increased the microbial breakdown of organic material. In summation, the availability of DIN in sediment enhances the ability of the benthic community to process refractory organic matter. For this survey Total Nitrogen was a preferred indicator for its simplicity to indicate aerobic or anaerobic conditions and source of organic carbon (Leaching from soil or marine).

Table 6.0: Concentration of Total Nitrogen and OC/TN ratio

Samples	S1	S2	S3
Total nitrogen (mg/100g)	**0.02856**	**0.02716**	**0.02352**
Total Nitrogen expressed as %	**0.02856**	**0.02716**	**0.02352**
Organic Carbon / Total Nitrogen ratio	**9.3**	**7.7**	**10.5**

When the source of Organic Carbon is terrestrial, the ratio of OC/TN is greater than 15 (C/N >15), when the source of OC is marine the ratio of OC/TN is lower than 10 (C/N < 10). For sample S1 and S2 it is clear that the source of Organic carbon was marine while for sample S3 which was closer to the shoreline there can be some mixing from shoreline.

3.2.5 Total Phosphorous

The occurrence of phosphorus in the oceans is in the form of dissolved and inorganic phosphate as well as dissolved organic phosphorus compounds. In fact, the forms of phosphate (orthophosphate, metaphosphate and organically bound phosphate) occur in living and decaying organisms as free ions. They are also found to be either chemically bound in aqueous systems or chemically bound to sediment. It is important for the nutrient to have a threshold value so that there is optimum productivity. At 3.5% salinity, sea water has been found to have a composition of $8.8x10^{-5}$g/kg of phosphorus. An increased availability of phosphorus would lead to eutrophication and reduced calcification, hence destabilizing the ecosystem. On the other side, a reduced amount of phosphorus in sea water will cause the growth rate of phytoplankton to become dependent upon the phosphate concentration. Furthermore, the sediment plays an important role in the overall nutrient (phosphate) dynamics in estuaries and closed systems like barachois. During a normal state, a certain amount of phosphorus entering the shore is retained in the sediment. The net retention of phosphate in the sediment would be the difference between the two extreme opposite directed flux rates; (a) the downward flux caused by sedimentation of particles entering the sediment (b) the upward flux generated by decomposition of organic matter.

Table 7.0: Concentration of Total Phosphorus

Samples	S1	S2	S3
Final concentration (µg/mL) in 25g sediment	**1.25**	**3.91**	**2.31**
Final concentration expressed as mg/Kg	**0.05**	**0.16**	**0.09**
Final concentration as g/kg	**$5x10^{-5}$**	**$1.6x10^{-4}$**	**$9x10^{-9}$**

The total phosphorous values are within the threshold levels in the sediment and indicate a balanced ecosystem far from eutrophication and atrophic conditions.

3.2.6 Heavy Metals

Parameters	Units	Results
Arsenic, As	ppm	1.57
Cadmium, Ca	ppm	1.44
Chromium, Cr	ppm	6.85
Copper, Cu	ppm	2.23
Iron, Fe	ppm	7.45
Lead, Pb	ppm	4.46
Manganese, Mn	ppm	3.23
Nickel, Ni	ppm	5.63
Zinc, Zn	ppm	1.93

Heavy metals exist naturally in the environment due to mineral weathering. Other sources of heavy metals include industrial activities like manufacture of metallic products, chemicals, agricultural run-offs which contain fertilizers, inappropriate waste disposal and also leisure activities (Nasser., 2013). Further tests should be conducted in the barachois periodically and with more sampling around to ensure a reliable data and constant monitoring. Filter-feeder marine organism's aquaculture is directly related to heavy metal bio-accumulation. To ensure a safe product, a vigorous monitoring plan should be set-up given that the barachois is surrounded with human habitation, agricultural lands and commercial activities.

3.3 Marine Biodiversity

3.3.1 Algal diversity

As per our survey algae diversity comprised mostly of *Gracillaria sp* (red algae). This was the most dominant algal species and covered maximal live benthic cover. Though this red algae species is not being commercially exploited in Mauritius for now, it has over the years been under pilot studies by the Mauritius Research Council for commercial exploitation. Other than this species other algal species was rarely encountered. Common Mauritian green algal species (cholorophytes) and brown algae (pheophytes) usually need a hard substratum for growth, but with such a high silt deposition most of the available rubbles would have sank in the sediment. Gracillaria colonies form rigid networks of tubular thalli that lie on the sediment and thus easily thrive over this ecosystem without any hard substrate requirement. In the barachois, those common species were only found on the hard rocky substratum found near the rock barriers.

3.3.2 Invertebrate diversity

The most commonly encountered groups of invertebrates include: sponges, crustaceans, molluscs (bivalves and univalves), echinoderms (sea cucumbers), annelids (sea worms) and coelenterates (jellyfish).

Sponges: The most common sponge species encountered were *Tethyarobusta*(spherical in shape) *Axinyssatopsenti*and*Clathriafrondifera.* Of these sponges*C. frondifera* was the most abundant and was found as patches over the sediments.

Crustaceans included crab species such as *Pilumnusverspertilio* (spider crab) and *Ucaannulipes*, sea anemones such as *Aiptasiaspp* and the common inverted jellyfish, *cassiopea sp*. Common shrimps were also found abundant near the mangrove areas. One barnacle species (*Chelonibiatestudinaria*) was encountered on few rocks around barachois.

Of the molluscs encountered the following univalves were common: *Monetaria annulus* and *Planaxissultanus* were very common. Edible species like “KonoKono” were not encountered in this region, because these species usually prefer reef areas with ample algal cover. The most common bivalves were, *Gafrariumpectinatum, Tellinamadagascarenis* and *Ctenoidesscaber*. The first 2 species mentioned are edible and are collected by locals for consumption. These bivalves usually burry in the sediments and are dug out by local fishermen.

3.2.3 Fish Species Diversity

With a closed system over the years and a diminishing depth with high level of silt deposition fish species diversity should have gradually decreased. The common fish species encountered during our survey include the common*siganussp* (cordonnier), *Upeneussp* (rouget), *Valencienneasp* (cabot), *Mugilcephalus*(Mullet). Herbivorous fish such as *Siganussutor* (rabbit fish), *Nasounicornis*(corne) and *Acanthurussp* (surgeon fish) which were once common in the region were not encountered most probably because of the lack of algal growth. These herbivorous fish eat green algae such as *Enteromorphasp*, *Ulva lactuca* as well as brown algae such as *Sargassumsp* as their diet.

3.2.4 Crab Density

Crab density in an area indicate ecosystem richness and sustained hood webs. More than 30 random quadrats ($1m^2$) were placed along the shoreline lines. The first set ran from along the left side of the shoreline while the second set was on the right side and included the mangrove forest on the small islet. It was worth noting that some of the shorelines were extremely rocky (islet). For the first set minimal value was 2 per m^2 while the maximal was 57per $m^2$and an average of 22 per m^2.The minimal values of crab holes per quadrat corresponded to rocky shorelines. For the second set including the islet the minimal value recorded was 7 per m^2 while the maximal was 69 per $m^2$and an average of 31 per m^2. These values indicate a healthy marine ecosystem for this species of crab.

3.2.5 Coral Species

The coral species found during the survey were: *Porites lutea*, *Cyphastreamicrophthalma*, *Porites rus* and *Montiporacalcarea*. *Porites lutea* were the most dominant species to be found. They were large and found mainly near the rocks on the northern part of the barachois. The low density of coral species and cover is due to the very shallow water depth and mostly sandy bottom. The coral recruit survey also revealed only one small recruit of 1mm with the flashing blue light. Therefore, indicating that the area is not appropriate for coral to grow.

3.2.5 Representative pictures in and around the barachois











4.0 Conclusion and Recommendation

Being very shallow at low tide (maximum water depth of 1m in the middle of the barachois), we find that this ecosystem is very limited in terms of diversity of marine organisms. In regards to an integrated aquaculture, it would best fit for culture of edible oysters using cages. Edible molluscs such as clams are available in the sediment and can be harvested in a sustainable way in patches (segmented areas). While one patch is harvested the other areas are left to grow for a sustainable catch. Culture of crabs in cages is possible as there are mangroves of both species (*Rhizophoramucronata* and *Bruguieragymnorhiza*) around the barachois, but care would have to be taken due to the sediment quality which is highly clay and silt. Culture of herbivorous fish following larval ranching is not advisable due to the low patches of macroalgae in this area. Nevertheless, these fish can be cultured if enough substratum (rocks) are placed to allow more green algal growth or artificial feeding is supplied. For carnivorous fish such as groupers and sea breams the first thing to deal with would be the depth. Through proper sand removal or dredging, depth of the area can be increased, but that would greatly increase the costs of investments. High density of shrimps was also observed along the islet near the mangrove shores. This indicates that the environment is good for crustaceans. The area if properly managed and with clear investments in specific aquaculture projects can be lucrative, but the choice of species would be critical. Since the area is open on all sides, there is also a high risk of tampering with amenities set for aquaculture.

5.0 References

Bohnsack, J.A., 1979. Photographic quantitative sampling of hardbottom benthic communities. Bull. Mar. Sci. 29, 242–252.

Chiappone, M., Sullivan, K.M., 1991. A comparison of line transect versus linear percentage sampling for evaluating stony coral (Scleractinia and Milleporina) community similarity and area coverage on reefs of central Bahamas. Coral Reefs 10, 139–154.

Daby D, Turner J and Jago C., (2001). Microbial and nutrient pollution of coastal bathing waters in Mauritius. *Environment International 27:555-566*

Debelius H. 1998, Indian Ocean Reef Guide. IKAN – Unterwasserarchiv, ISBN-10: 3931702677.

Debelius H., 1998, Nudibranch and Sea Snails Indo-Pacific Field Guide. IKAN -Unterwasserarchiv, ISBN-10: 3931702987.

English S., Wilkinson C., and Baker V., 1997, Survey Manual for Tropical Marine Resources, 2nd Edition. Australian Institute of Marine Science. ISBN-10: 0642259534

FAO Soils Bulletin 38/1 (1980). Soil and Plant Testing and Analysis. 250 pp.

Glenn De'ath and Katharina Fabricius (2010). Water quality as a regional driver of coral biodiversity and macroalgae on the Great Barrier Reef. Ecological Applications 20:840–850. http://dx.doi.org/10.1890/08-2023.1

Grasshoff, K., Ehrhardt, M., Kremling, K. and Anderson , L. G. (1999). Methods of seawater analysis, 3rd ed. Weinheim • New York • Chichester • Brisbane • Singapore • Toronto:WILEY-VCH.

Greenberg A. E., Cleceri L. S., and Eaton A. D., 1992, Standard Methods for examination of water and wastewater, 18th Edition.

Greenberg, A. E., Clesceri, L.S. And Eaton, A. D.(eds.) (2005). Standard methods for the examination of water and wastewater. 21st ed. Washington: American Public Health Assiociation.

Guidelines for coastal water quality requirements for various categories. 1999. Govt. Notice No. 620, 9CWQG.

Joseph W. LeFevre, (1991). Metal Analysis of sediment from Oswego Harbor. Metal Analysis of Sediment by Atomic Absorption Spectroscopy: A New Laboratory Exercise.

LaSalle, M.W., Clarke, D.G., Homziak, J., Lunz, J.D., and Fredette, T.J. (1991). “A framework for assessing the need for seasonal restrictions on dredging and disposal operations”. Technical Report D-91-1, U.S. Army Engineer Waterway Experiment Station, Vicksburg, MS.

Leujak W., Ormond R.F.G., 2007. Comparative accuracy and efficiency of community survey methods. J. Exp. Mar. Biol. Ecol. 351, 168-187.

Loya, Y., 1978. Plotless and transect methods. In: Stoddart, D.R., Johannnes, R.E. (Eds.), Coral Reefs: Research Methods. UNESCO, Paris, pp. 197–217.

McLellan, T.N., Havis, R.N., Hayers, D.F., and Raymond, G.L. (1989). “Field studies of sediment resuspension characteristics of selected dredges,” Technical Report HL-89-9, U.S. Army Engineer Waterway Experiment Station, Vicksburg, MS.

Michael J Kingsford (1992). Drift algae and small fish in coastal waters of northeastern New Zealand. Marine Ecology Progress Series. Vol 80: 41-55

Moothien Pillay R., Terashima H., Venkatasami A. and Uchida H., 2002, Field guide to corals of Mauritius. Albion Fisheries Research Centre, Albion, Mauritius.

Mundy, C., 1991. A Critical Evaluation of the Line Intercept Transect Methodology for Surveying Sessile Coral Reef Benthos. James Cook University. MSc: 127pp.

Narayanaswamy BE, Coll M, Danovaro R, Davidson K, Ojaveer H, et al. (2013). Synthesis of Knowledge on Marine Biodiversity in European Seas: From Census to Sustainable Management. PLoS ONE 8(3): e58909. doi:10.1371/journal.pone.0058909

Humood A. Naser (2013).Assessment and management of heavy metal pollution in the marine environment of the Arabia Gulf: A review.Marine Pollution Bulletin. Elsevier.

Oliveira E. O., Österlund K. and Mtolera M. S. P., 2005. Marine Plants of Tanzania, A field guide to the seaweeds and seagrasses. Stockholm University, Sweden. ISBN 91–631–6510–4.

Richmond M. D., 1997, A guide to the seashores of Eastern Africa and the Western Indian Ocean Islands. Sida/SAREC. ISBN-10: 916304594X.

Rogers, C.S., Gilnack, M., Fritz, I., 1983. Monitoring of coral reefs with linear transects: a study of storm damage. J. Exp. Mar. Biol. Ecol. 66, 285–300.

Rogers, C.S., Miller, J., 2001. Coral bleaching, hurricane damage, and benthic cover on coral reefs in St. John, US Virgin islands: a comparison of surveys with the chain transect method and videography. Bull. Mar. Sci. 69, 459–470.

Rowell, D.L. (1994). Soil Science, Methods and Application. UK Longman

Samways, M.J., Hatton, M.J., 2001. An appraisal of two coral reef rapid monitoring manuals for gathering baseline data. Bull. Mar. Sci. 69, 471–485.

Terashima H., Mosaheb J. I., Paupiah C. N. and Chineah V., 2001, Field guide to coastal fishes of Mauritius. Coastal Fisheries Resources and Environment Conservation Project. Albion Fisheries Research Centre, Ministry of Fisheries and Japan International Cooperation Agency (JICA).

Veron, J. E. N., 2000, Corals of the World. 3 Volumes. Australian Institute of Marine Science.

Annex 1

The following guidelines are published for the information of the public with regards to coastal water quality requirements for various activities around the Republic of Mauritius.

The Mauritius Government Gazette *30 April 1999*

General Notice No. 620 of 1999

MINISTRY OF ENVIRONMENT, HUMAN RESOURCE DEVELOPMENT & EMPLOYMENT

Department of Environment

Guidelines for coastal water quality

The following guidelines are hereunder published for the information of the public with regards to coastal water quality requirements for various activities around the Republic of Mauritius.

Classification	*Principal Beneficial uses/objectives*
Category A – Conservation	
Class A1 – Conservation of coral community	A1 – Conservation of coral community
Class A2- Conservation of natural areas	A2 – Conservation of natural areas such as mangroves, sea grass, wild life habitat and marine spawning, nursing and feeding grounds.
Category B – Recreation	
Class B1 – Primary contact	B1 – Water sports like swimming, diving, surfing where there is direct contact.
Class B2 – Secondary contact	B2 – Water sports such as boating, fishing and other activities involving less body contact or where direct contact with water may occur but the probability of body immersion is minimal.
Category C – Fisheries	
Class C1 – Aquaculture	C1 – Propagation of marine life such as fish, crabs, shrimps, and other marine fauna.
Class C2 – Shellfish	C2 – Culture of shellfish – oysters, mussels, clams.
Category D – Industrial	
Class D – industrial and others	D – Natural water resources used as a receiving water body for industrial and agricultural discharges (harbour, power station and other industrial activities). There should be no unpleasant odour to people residing nearby.

Each activity requires different water quality and this is indicated underneath:

Category A is meant for the conservation of the coral community and natural areas.

Class A1 is intended for the coral ecosystem and requires seawater quality that will not hamper healthy coral growth.

Class A2 is for the conservation of natural areas as mentioned in the table above and requires a slightly less stringent water quality.

Category B is intended for recreation purposes.

Class B1 defines the water quality needed for sports such as swimming, diving, surfing, etc. where there is maximum body contact with the water. For this class the potential health hazards due to pathogenic microorganisms have been considered.

Class B2 is intended for water sports such as boating, fishing, etc. where there is likely to be minimal body contact with water, and so the quality of the water is less stringent especially with regards to pathogenic micro organisms.

Class C concerns fisheries.

Class C1 is intended for the production of fish, crabs, shrimps, etc.

Class C2 is for the culture of shellfish where the requirements for pathogenic organisms are very stringent.

Category D comprises the remaining coastal areas, which act as receiving body for industrial and agricultural discharges and include the harbour, power generating plants, and other industrial activities. No limits are imposed for pathogenic microorganisms but there should be no unpleasant odour to people residing nearby.

The Mauritius Government Gazette *30 April 1999*

Coastal water quality requirements for various categories

CATEGORY		A Conservation		B Recreation		C Fisheries		D Industrial
Class		A1 Coral Community	A2 Natural Areas	B1 Primary Contact	B2 Secondary Contact	C1 Aqua-culture	C2 Shellfish	D Industrial & others
Parameters	Unit							
pH	-	7.5-8.5	7.5-8.5	7.5-8.5	7.5-8.5	7.0-8.5	7.0-8.5	7.0-9.0
Temperature	^{0}C	ambient	ambient	ambient	ambient	ambient	ambient	ambient
Suspended Solids	mg/l	5	5	5	10	15	15	15
Dissolved Oxygen	mg/l	>5	>5	>5	>5	>5	>5	>2
Chemical Oxygen Demand[1]	mg/l	2	2	3	3	5	5	5
Total Coliforms	CFU[3]/100 ml	1000	1000	1000	5000	1000	70[2]	---
Faecal Coliforms	CFU/100 ml	200	200	200	1000	200	14[2]	---
Nitrate-Nitrogen	mg/l	0.2	0.3	0.8	0.8	0.8	0.8	1.0
Phosphate	mg/l	0.04	0.05	0.08	0.08	0.08	0.08	0.1
Oil & Grease	mg/l	Not detectable by N-hexane extraction method						
Phenol	mg/l	0.05						
Arsenic	mg/l	0.05						
Cadmium	mg/l	0.02						
Cyanide	mg/l	0.01						
Chromium	mg/l	0.05						
Copper	mg/l	0.05						
Lead	mg/l	0.05						
Total Mercury	mg/l	0.0005						

1 by alkaline potassium permanganate method
2 organisms per 100 ml by MPN method
3 CFU: Colony Forming Unit

Date: 16 April 1999

SCHEDULE

(regulation 3)

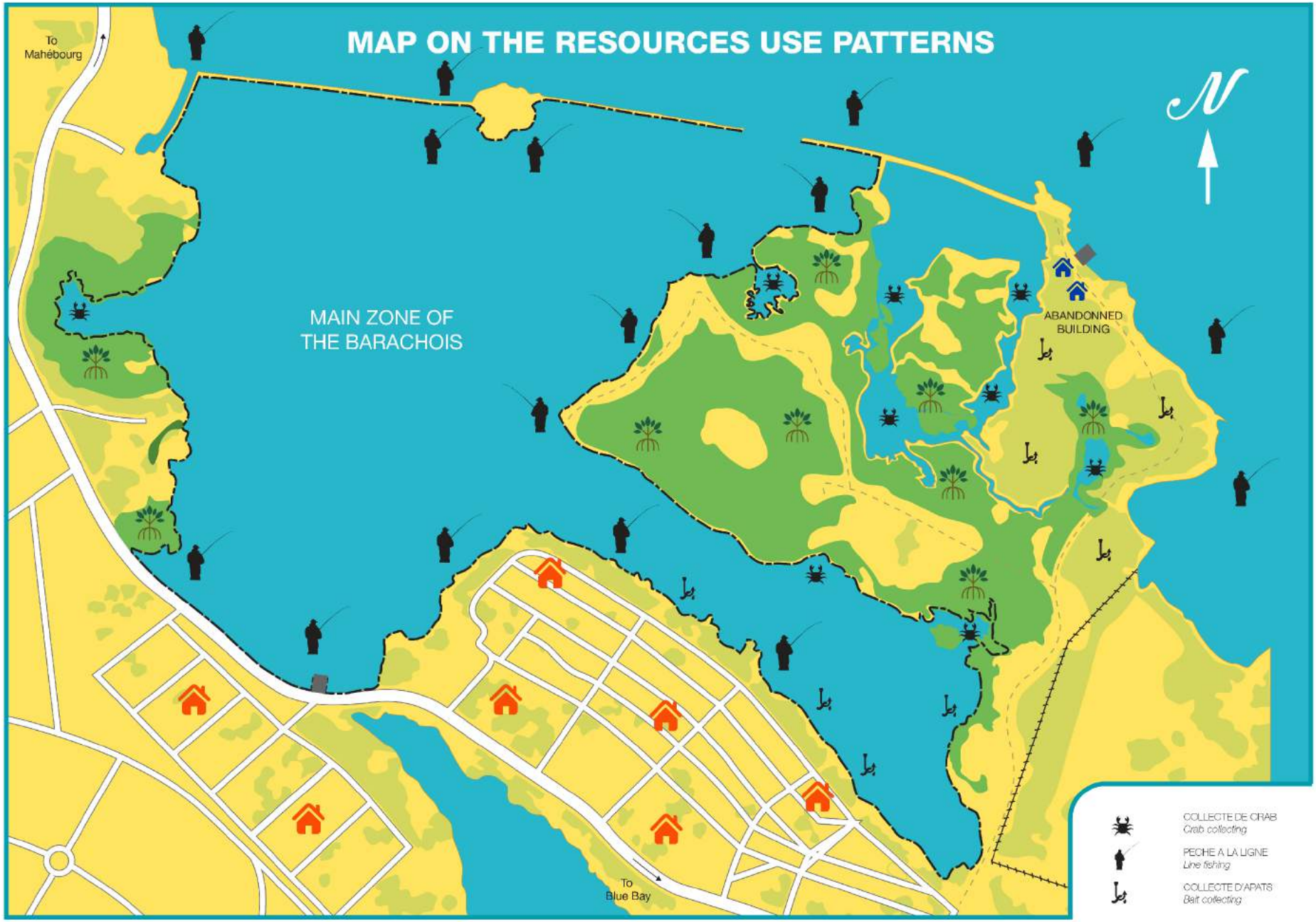
The following standards are permissible limits or range for the corresponding parameters:

Parameter	Unit	Permissible limits
Temperature	***℃***	***40***
PH	*-*	*5 – 9*
Floatables	*mm*	*6*
Biochemical Oxygen Demand (BOD5)	***mg/l***	***250***
Chemical Oxygen Demand (COD)	*mg/l*	*750*
Suspended Solids	*mg/l*	*300*
Cadmium	*µg/l*	***20***
Chromium (VI)	*µg/l*	*100*
Chromium, Total	*µg/l*	*500*
Cyanides (as CN-)	*µg/l*	*100*
Lead	*µg/l*	*2*
Nickel	*µg/l*	*2*
Zinc	*µg/l*	*2*
Total Mercury	*µg/l*	*10*
Arsenic	*µg/l*	*200*
Total pesticides	***mg/l***	***1***
Oil & Grease	*mg/l*	*20*

Appendix 6: Pictures illustrating the clean-up by selected local fishermen.


LOVE ALL
SERVE ALL

Appendix 7: Map on resource uses in the Collaborative Management Area.



Appendix 8: Strategic Plan of mariculture in the Barachois of Residences La Chaux.

COMMUNITY-BASED MARICULTURE IN THE BARACHOIS OF MAHEBOURG/RESIDENCES LA CHAUX

Strategic plan

September 2016

Environmental Protection and Conservation Organisation (EPCO)

TABLE OF CONTENTS

I INTRODUCTION

The goal of the mariculture initiative, as part of The Barachois Project, is to uplift the livelihoods of the community, particularly the fishermen, by creating new activities that generate income through the following objectives:

- Introduce crab culture systems in the barachois to provide additional and alternative source of local income for fishermen.
- Build local capacity and mariculture skills.
- Increase local awareness on benefits of mariculture with cooperation between local residents, including fishermen.
- Determine the performance of the mud crab rearing systems (net pen and cages), installed in tidal flats with existing mangroves in the barachois area.
- Evaluate the return on investment from drive-in and floating cages culture with different cage construction materials.

II TARGETED SPECIES FOR MARICULTURE

2.1 Mud crab (Scylla Serrata)

The mud crab Scylla serrata is the most widely distributed species(Shelley, 2008) and the only species of the genus *Scylla* in the Indian Ocean (Mirera, 2009). Locally, it is called crab "carlet" or "asoir". The crab inhabits mangrove forests, usually burrowing in mud or sandy mud and has both ecological and economic importance to the adjacent coastal fishing communities (Keenan *et al.*, 1998) due to its preference for estuarine habitat and less aggressive behavior (Cowan, 1984), as well as its fast growth rate and tolerance for a wide range of biophysical parameters compared to other species. Moreover, it is considered as quality food for local community consumption and for sale in hotels as they have high value due to their excellent taste, texture and nutrition value (Cowan, 1984; Trino & Rodriguez, 2002).

2.2 Others targeted species

In order to spread out the risks against mortality, cannibalism, poaching and other uncertainties, polyculture will be conducted during project implementation but at a later stage. Different native species are expected to be cultivated in the CMA. The extensive cultivation of fish ("mulet, Gueule pave, Rouget and cordonnier") and prawn ("sevrette de mer and crevette keble")

species will be considered at a later stage depending on community involvement, perception and compliance for crab mariculture. Indeed, the cultivation of different species will require a significant extension of mariculture zone. An expert of oyster culture has been advised and will be contracted to test the feasibility of oyster cultivation. A nursery for sea cucumber in the barachois, has been also recommended by the University of Mauritius (UOM).

III CULTIVATION OPERATIONS

Experimental culture of crabs will be conducted in two determined locations of the barachois area. Both sites are intertidal area which is adjacent or surrounded by mangrove area. The duration of the experiment will be 8 months.Only grow-out operations will be conducted as hatchery and nursery operations will have higher costs and infrastructure and expertise is lacking at national level. Consequently, the cultivation of crabs will consist in crabs collection, growth-out and harvest when reaching market size. It will be undertaken in two main systems: an open system of mangrove pen and net enclosures in zone 1 and a closed system in which crabs are held individually in cages (refer to Fig. 1).Indeed, the use of a pen net in the mangrove area is known to offer a good alternative for rearing crabsbecause the enclosures are simple to construct, easy to operate and require a low investment in comparison to pond construction (Mwaluma, 2002). Moreover, the system is environmentally friendly and offers great potential for securing the livelihoods of adjacent communities (Baliao et al., 1999). Indeed, the mariculture will put value on the mangrove ecosystem encouraging conservation and re-planting as mangrove ecosystems are critical to sustain mud crab fisheries.

Figure 1:*Map of the barachois providing the two first zones of culture for crabs.*

IVGROW-OUT OPERATIONS

4.1 Mangrove pens design and construction

A mangrove pen (approximately 5m x 12m) will be designed and constructed with plastic (UV resistant) netting with wooden supports. The vertical support wooden posts will made of treated Strawberry Guava (*Psidium cattleianum*) to be resistant to marine borers and minimize their environmental impacts. They will be interspersed 2m apart and will be then secured with bending wire and polypropylene rope. The selected size of the netting will be 1.5 cm mesh to ensure that the smallest legally collected crablets sized (approximately 2.5 cm) will not be able to escape. The lower end of the enclosure will be dug 0.5m into the mud to reduce the risk of crabs burrowing while the upper edge will be lined with plastic sheet 30cm wide to prevent crab stock from climbing out of the pen. Local labour will be used for construction, particularly local fishermen who will be assisted and supervised by technically trained supporters.

The pen will be located in the "trou sevrette" of the mangrove area zone 1 which is deeper that the other place as it is like a hole with a depth of approximately 30 cm in king low tides. Crablets with size varying between 2.5 and 10cm will be stocked in the pen.The net of the pen will be 1m higher than the local maximum king tides in order to avoid potential escape of crablets. It is important to notice that additional conservation measures including regular monitoring will be conducted while undertaking mariculture activities to verify potential negative impacts on mangrove ecosystem.

4.2 Preparation of mud crab pens prior to stocking

The pens will be cleared of any potential predators, as well as larger-sized mud crabs, over several days using baited traps before crablets are restocked.

4.3 Crablets collection from the wild

Figure1 :*Picture illustrating bait traps that will be used for crablets collection.*

This activity will rely on wild caught stocks and crab collectors. Indeed, mud crabs in Mauritius are usually collected by local crab collectors in the coastal area of the Grand Port lagoon. Mud crabs are currently collected by crab collectors. Collectors are mainly fishermen engaged in part time collection. Contact details from many collectors have been collected and will be sufficient for implementing mariculture activities. The peak harvesting season in Mauritius occur between end of May and end of September for collection of juvenile crabs. The availability of seed stock seems to be high according to local crab collectors. However, due to uncertainty of wild crab seed supply, local fishermen will be contracted for collection simultaneously with the construction and preparation of the pens.

The gear for collection will include baited traps (fig.) and crab traps with small sized mesh. Permit for crablets collection from the wild has been requested to the ministry of Ocean Economy, Marine Resources, Fisheries, Shipping and Outer Islands.

4.4 Stocking

Approximately 120crablets of legal size (approximately 2.5 cm in carapace length) will be collected, transported using a bucket of water and stocked in the pensat a density of 2 crabs/m2to reduce mortality and with mixed sex. The smaller crablets collected will be stocked in the pen while the bigger one will be disposed in individual cages. The number of stocked crab will be monitored to ensure the appropriate density. Each crabs will examined for morphological condition, carapace length and width using a cernier calipers, sexed and weighted. After growing to maturity, as gauged by size, they will be transferred into individual cages to prevent the cannibalistic nature of crabs and predation.

4.5 Feeding and feeds

Crabs feed naturally on an omnivorous diet of a wide range of animal and plant resources (Hill, 1976) and grow well in mariculture on a wide variety of feeds (Shelley, 2008).

During the first month after stocking, wild-collected crablets do not require supplementary feeding. After this interval, the crabs will be fed before and during incoming tides, which are the times that mud crabs traditionally emerge in search of food. Crabs will be fed with trash fish including fish heads, fish skin, broken fish and fish entrails at 10% body weight. Feed will be chopped into small pieces before being weighted and spread in the pens and individual cage compartments.

In keeping with the asset-based community development strategy of the project, feed will be sourced from local fishermen, who have agreed to provide trash fish to the project at regular intervals using a calendar to designate responsibility. However, research will be ongoing as to the optimal formulated feed to be use afterwards in the project; livestock feed will be approached as a potential option.

4.6 Harvest for fattening system

It has been suggested that routinely undertaking partial harvests of market-size crabs can be an effective strategy to minimize cannibalism in grow-outsystems (Say & Ikhwanuddin,1999). It will leave sub-harvest sized crabs to grow to harvest size in more space, with areduced incidence of predation and less competitionfor feed (Christensen, Macintosh andPhuong, 2004).

4.7 Crab fattening

4.7.1 Overview

After moulting, crab musculature takes time to fill its new shell. During this time, the crab is considered as “empty”, “thin” or a “water crab” with little meat and excessive water content (Shelley & Lovatelli, 2011).

Mud crab fattening describes the process whereby mud crabs are assessed as "empty" crab" and thus stocked and fed, or ready to be harvested (either from the wild or mariculture stock)(Shelley & Lovatelli, 2011). This process typically takes between 14 to 60 days depending on the degree of fullness of the crab at the beginning of the fattening process, its size, the temperature and the type of feed provided (Shelley & Lovatelli, 2011).

4.7.2 Cages design and construction

Fishermen will construct floating and drive-in individual cages with a capacity to hold approximately 100 crabs in cages having 20 individual drive in cages. Experimental cages will be constructed using three different materials; (1) Plastic materials; (2) Bamboo stems;(3) china gavas stems and;(4) PVC . The floating and drive-in cages will be located at two different locations in the barachois area and will be used to address the cannibalism behavior that occurs during moulting as part of the fattening process. The pictures below illustrate examples of aplastic cage from the Mauritius Plastic Industry andcages in bamboo stems (L=270cm, l=90cm, H=35cm divided into 16 compartments of L=45cm, l=33cm and h=35cm) designed and made recently by fishermen from Residences La Chaux. Cages will be sewn together using binding wire and nylon cord. Cage covers will be permanently attached on one side and the other side tied with rope. The movable covers will facilitate monitoring and feeding.

The cost and durability of cages will be the criteria used to selectthe adequate type of cages for project sustainability.

The system that could potentially be used in the barachois for floating plastic cage is explained below (Fig.2). The floating deck will be used as a platform where floating cages which are attached together with a PVC piping and roping system will be able to move backwards and forwards in order to facilitate monitoring and feeding.

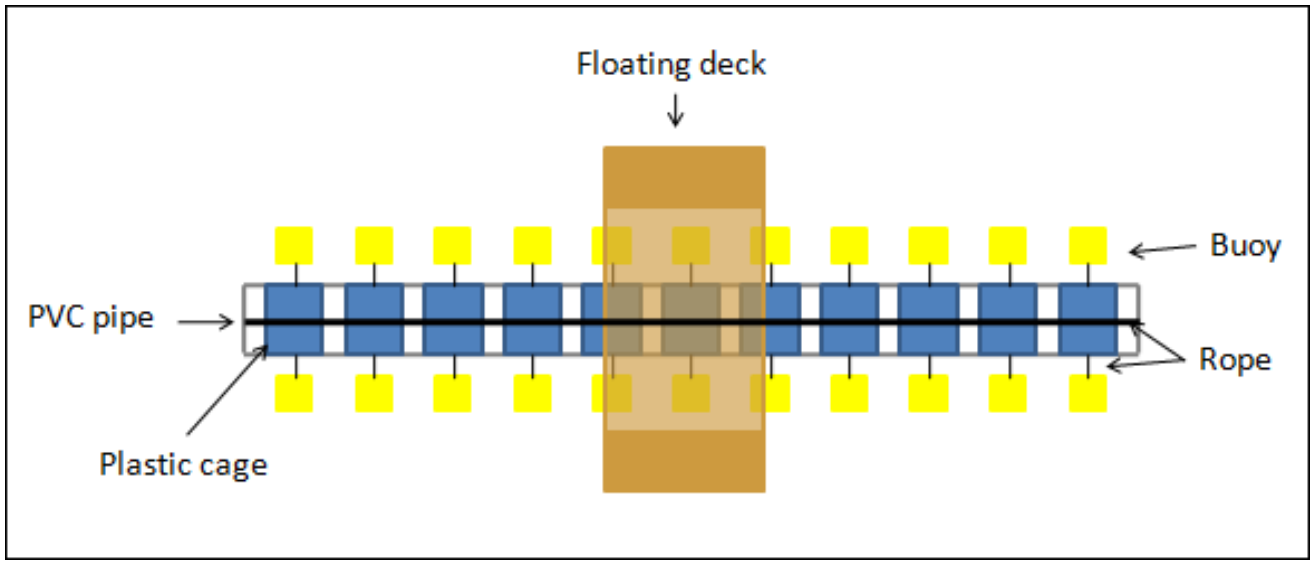


Figure 2: *Diagram of the floating cages system.*

4.7.3 Assessing crab (empty or full)

A test developed in the Northern Territory of Australia and considered 99 % accurate, will be used to assess the suitability of male and female crabs for fattening (Shelley & Lovatelli, 2011).

4.7.4 Stocking

The fattening system will include stocking mud crabs in individual cages to make their assessment simpler. The cages are designed to be large enough for only one market-size crab to fit.

4.7.5 Feeds and feeding in fattening systems

Based on best practices, mud crabs in the fattening system will be fed 10% of their total body weight per day using trash fish. The frequency of feedings will be two times per day.

4.7.6 Harvest

The size at harvest will be chosen according to the needs of local markets that the project is servicing. In Mauritius, the minimum market size is about 500g which crabs reach approximately 6 months after collection, if fed on a daily basis. When hard-shell crabs of a marketable size are assessed as full, they will be removed from the fattening system, processed, secured and sold live.

4.8 Maintenance

On a daily basis, the perimeter fencing of mud crab pens and all crab cages will be checked in order to ensure that no damage has occurred so the crab stock cannot escape.

V SURVEILLANCE AND ENFORCEMENT

Mud crabs are valuable on the local market, and therefore the management team will have to be vigilant to prevent and reduce losses from poachers. Surveillance and security will be most important when stock is nearing harvest and the mud crabs are considered the easiest to catch and market. Surveillance will be carried out through a CCTV system and also by night boat patrols within the culture area. In the beginning, pirogues will be borrowed from local fishermen willing to participate in the nightly surveillance. One boat will eventually be purchased to cover the culture area. A defined number of fishermen will be appropriately selected in a voting process and trained to become rangers. Training will cover verbal communication skills, education and awareness raising, first-aid and inspection techniques. They will be paid CMA personnel with 8 hours shifts and their role will be clearly defined using TOR, as mandated by the CMA committee and fully understood by all stakeholders. The rangers will not undertake any direct enforcement actions but will be responsible for ensuring that the CMA regulations and fishing legislations are known, understood and respected by local people. They will also discuss infractions with offenders and record information regarding illegal activities particularly the areas most frequented by poachers, which will be accompanied by photographs as proof of illegal occurrences. The information will be reported to local law enforcement personnel for necessary action on their end. Consequently, the ranger will operate in partnership with local government agencies such as the fisheries department, the national coastguard and the forestry department. Finally, the incorporation of warning and information panels as well as a camera trap at different locations will assist the rangers and allow a “no-force” approach that will facilitate early warning against intruders. A community-based coastal watch strategy will be implemented to promote ownership of the project by the community, and will include residents assisting crab farmers in enforcing the surveillance of the culture. Community meetings will be carried out to increase resident's awareness of mariculture activities and provide detailed information on what to do in case of the presence of intruders.

VI MONITORING AND EVALUATION STRATEGY

Biophysical, socioeconomic, CMA governance and mariculture monitoring programmes will ensure accurate and representative data is available to assist the selected local staff in optimizing production. Each program will occur at designated frequencies throughout the project.

6.1 Mariculture monitoring

Indicator	Criteria
Growth rate	Date crablets stocked
	Number of crablets stocked
	Average size of crablets stocked
	Average size of crablets (every fortnight)
Ratio of gain in body weight to the weight of feed provided (FCR)	Supplementary feed provided per day
	Feed used / feed left on feeding trays
	Average size of crablets (every fortnight)
Mortality rate (f)	Number of crablets stocked
	Number and mass of crabs harvested
	Any signs of disease
Poaching rate	Number of crabs missing (in cage)
Farming effort	Date, time and duration of operations
	Number of pirogue/day
	Number of crew/day
	Type of boat, gears and equipment
Surveillance effort	Date, time and duration operations
	Identity of rangers per night
Cost and revenues	Market price by species
	Number of individual sold
	Gear cost
	Fuel cost
	Wages
Trade development	Number and nature of markets
Market response	Stock sold / stock left over

6.2 Bio-physical monitoring

Indicator	Criteria
Water condition	Temperature
	Salinity and freshwater input
	Dissolved oxygen content
	Turbidity
	Sedimentation rate
	Nutrient loading
	pH and acidity levels
	Presence and density of toxins/heavy metals/pesticides/fertilizers
Biodiversity marine	Focal marine species
	Marine species abundance and average size
Mangrove health and regeneration	Community structure and biomass
	Species composition and percentage cover
	Number of new seedlings established naturally
	Number of dead and fallen trees
	Number of cut trees and stumps
	Area being replanted
	Number of seedlings being replanted
	Height and No of leaves and branches of replanted seedlings
Dumping of garbage	Area , volume and frequency of dumping practices
	Type and amount of waste dumped
	Digital photographs
Spread of invasive alien species	IAS species identity, abundance and area of spread
	Visual impacts

Biophysical monitoring will be conducted in collaboration with the Ocean Study department of the University Of Mauritius (UOM), which is currently planning a continuous biophysical monitoring program in the barachois of Mahebourg and Residences La Chaux. This will be implemented in the beginning of 2017.

6.3 Governance monitoring

Indicator	Criteria
Degree of stakeholders' involvement	Adequacy and effectiveness of decision making process
	Frequency of meetings and consultation with stakeholders
	Attendance and participation at consultation strategies (workshop, meetings)
	CMA committee meetings (frequency, attendance, minutes)
	Perceptions and satisfaction towards Collaborative Management
Level of conflict over resource uses	Identification of stakeholders concerned
	Identification of the issue at stake in the conflict
	Time period and intensity of the conflict
	How the conflict has been managed and resolved
Local understanding of rules and regulations	Dissemination of information (rules/legislations/institutions)
	Local awareness and understanding towards the CMA rules
Compliance and enforcement	Degree of information dissemination encouraging compliance
	Level of surveillance (boat patrol, coastal watch)
	Number of recorded incidents of illegal practices
	Source of information regarding incidents
	Measures taken to curb the observed incidence
	Number of successful prosecutions brought to court

6.4 Socio-economic monitoring

Socio-economic monitoring will be conducted through various consultation strategies including focus group and individual interviews, key informant interviews, household surveys, participatory mapping and observational walks and boat trips. The monitoring programme will be conducted once every two years.

Socio-economic monitoring	
Indicator	**Criteria**
Level of community involvement and participation in the project	Number of people willing to be involved in management activities
	Number of local people participating in management activities on a voluntary basis
	Number of local people participating in management activities as paid staff
	Type and frequency of supportive local initiatives
Level of community satisfaction toward the project	Local residents perception toward management activities
	Local residents attitude toward management activities
Local knowledge and understanding	Local awareness regarding the objectives and benefits of management activities
	Development of environmental education programme
	Community knowledge regarding their surrounding environment (fauna & flora)
Income generating activities	Number of income generating activities created over time
	Type of income generating activities created over time
	Training process and personal management
Local livelihood enhancement	Level of small businesses development in the community
	Increased well-being of the community
	Poverty alleviation in the community (average income/ employement rate)
	Increased number of recreational activities for the community
	Increased number of activities created and provided to children
Empowering women	Level of women participation in management actions and in the decision making process
	Number and type of activities created of job for local women

VII PRODUCT QUALITY

7.1 Post harvest

As the majority of mud crabs are sold as a live product, the establishment of quality control systems with input from individuals or companies with professional experience is mandatory to ensure the delivery of a quality product to the customer.

All facilities and operating procedures will be developed to meet standards upheld by the government of Mauritius and minimize the transmission of food-borne diseases carried by crustaceans.

The mud crabs will be examined, cleaned and stored before being transported to the processing facility, and tied with string of rafia (pictures below) to ensure they do not cause mortality to the surrounding crabs. Crab size and fullness will be monitored to ensure they are suitable for market resale, and placed into containers as previously described. The priority throughout the supply chain will be to reduce post-harvest mortalities by minimizing stress to the crabs post-harvest.

Various guidelines on mud crab culture have been consulted to develop strategies to minimize stress on crabs throughout the supply chain, including maintenance of temperature post-harvest, reduction of ammonia accumulation, maintenance of moisture, use of a recovery tank to hold mud crabs, and storage in mud or hessian-lined containers to avoid draughts (Shelley & Lovatelli, 2001).

7.2 Processing

The processing of crabs will be standardized, with records kept on a receiving form as part of the overall quality control system. The temperature of containers during processing will be monitored, and crabs will be maintained at temperatures between 18 and 30 degrees Celsius to minimize stress. All containers will be weighed, and transporters will obtain receipts, with containers being taken to a cool room to maintain crabs in a low-stress environment and ensure that the idea temperature range is not exceeded. Processing will be done in dedicated clean, tidy and organized areas including crates, rubbish bins, scales, pallets and forms, and appropriate sanitary measures, including closing doors to exclude flies or vermin, will be taken. The product will be monitored through the facility with details of the grading, sorting and processing of the crabs recorded.

7.3 The grades

Preliminary grading of mud crabs will be carried out before the packing stage. The grading system will be appropriately documented, with checklists and posters describing the process, and graders trained to be proficient in following these regulations.

Based on published guidelines (Shelley & Lovatelli, 2011), the table below provides the procedure for allocating grades to harvested mud crabs.

GRADES	CHARACTERISTICS
Grades A, B (further sorted by sex/ size/ weight)	Lively/robust with claw intact and strong leg and antennae movement ➢ Packed for market
One claw (separately graded)	Lively/ robust but missing a claw ➢ Packed for market
Slow ("Crab lage")	Leg and antennae movement slow or weak when handled or legs will not walk if placed on surface. Crab that show "bubbles" from around the mouthparts. ➢ Send to grow-out system under strong management
Commercially unsuitable crab (CUC)	Soft-shell or empty that have moulted on the way to the processing facilities ➢ Sent back to the fattening system Bleeding crabs ➢ send for freezing for crabmeat production Crab with holes in crab's shell / old crabs covered with dark marks or worn claws / crab with unacceptable appearance ➢ Send for freezing for crabmeat production
Discard	Dead or diseased ➢ Send to waste immediately in strong plastic bags.Bins will be emptied regularly to prevent bad smell, flies or vermin.

7.4 Food handling

All employees will be adequately trained in basic hygiene and food handling with regard to their personal responsibilities, including washing, wearing protective clothing, and preventing diseases. Procedures will be developed to reduce the risk of mud crabs being contaminated, including sanitizing all surfaces prior to mud crab exposure. Supervisory staff will consistently monitor and update these protocols, which will be visibly posted.

7.5 Packing

Both prawns and crabs will be packed by grade into cartons and polystyrene crates for transportation to local markets immediately after harvest. The boxes will be prepared prior to crab and prawn harvesting by staff who take appropriate safety measures of protective clothing and footwear.

Crabs will be packed into cartons with humidified foam placed on the bottom of the carton and on top of each layer of crabs. The crabs will be packed with their head and claws tilted toward the top of the box to minimize stress and potential damage to the carrying containers. Each box will be clearly labeled as to the grade, harvest date and weight of the product inside, as well as logistic information on the packer and receiver.

Prawns will be arranged in polystyrene boxes (fig.2)with a layer of ice followed by a layer of prawns with humidified foam on top. This pattern (ice, prawns, foam) will be replicated to effectively pack the prawns for transport.

The packing location will be sanitized, including all equipment, after packages have been readied, and the facility will be kept securely locked at all other times to avoid contamination and maintain proper conditions for packing.

Figure 2:*Picture illustrating polystyrene box that will be used for shrimp packing.*

7.6 Transportation process to the market

The crabs will be immediately transported after harvest and packaging to local markets less than thirty minutes of the packing location, ensuring that crabs are not exposed to temperatures outside their preferred range, thus minimizing causes of stress for the crabs.

VIII MARKETING STRATEGY

8.1 Pricing for local market

In Mauritius, *S.serrata* is most commonly harvested at weights over 500g. Price will vary depending on weight and grades. Local prices for mud crab (grade A& B) are provided in the table below. Weights are presented in grams (g) and kilograms (kg).

Weight	500g	750g	1kg	1.25kg	1.5kg	2kg	2.5kg
Market Price	MUR 300	MUR 400	MUR 800	MUR 1000	MUR 1200	MUR 1400	MUR 2000

Crabs witha missing claw will fetch a lower price. Crabs with two missing claws cannot be sold and will need to bereturned to the grow-out system for their claws to regenerate. Both females and males are usually sold locally at the same price, however, customers seem to have more interest in purchasing females.

8.2 Labeling

Every seafood species produced in the barachois area is expected to be labeled as part of a marketing strategy. The labelscurrently being considered are: 'Made in Mauritius', 'Mangrove-friendly mariculture', 'Community-based mariculture' and ' based on fair market'.

8.3 Marketing methods

Various marketing methods will be used to increase awareness and market demand toward the potential seafood. Information and communication tools will be created and disseminated. Such tools will include brochures and a website.

8.4 Targeted local customers

At present, the market is expected to be conducted locally. Customers targeted include hotels, hostels, restaurants, shopping centers, markets, individuals and middlemen. In 2014, a list of potential customers was obtained through consultation. Five hotels, five restaurants and three supermarkets were responsive and interested in the potential products of the mariculture project. A secondary consultation with a clear understanding and potential market will be conducted in the coming phases of the project.

IX MANAGEMENT STRUCTURE

9.1 Present management structure (project duration)

About 10 people will be employed initially to implementmariculture activity and this will be increased at different phases of the project depending on benefits and project viability. Two will be responsible for mariculture including monitoring, while eight will turn successively to conduct surveillance at night. The selected residents will becomeCMA salaried staff and will be part of the local management team (CMA staff). As mariculture activities aim to provide additional income to community, selected fishermen will work on a part-time basis depending on their actual fishing schedule recorded in the survey. The selection process will be carried out with priority given to those who have shown involvement in the management activities in the previous 6 months, and through a voting process. All candidates will be appropriately trained to conduct their respective work.The local management team will be controlled by the CMA Committee as provided below.

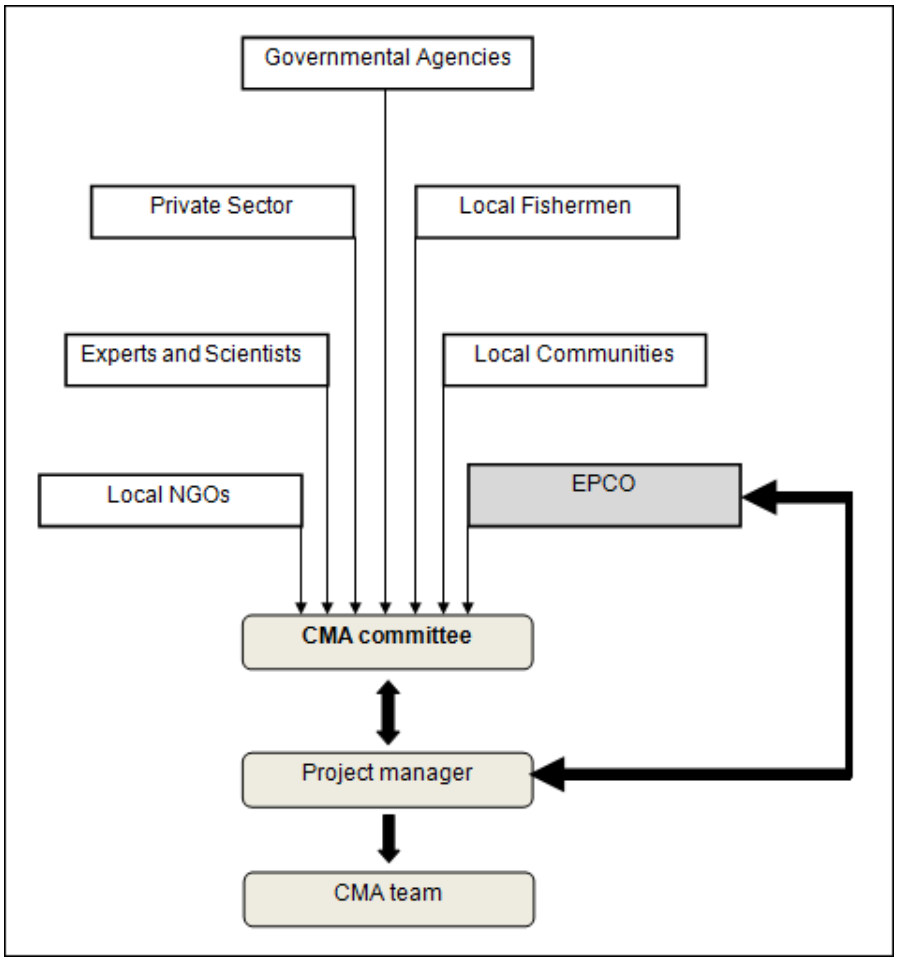


Figure 3:*Organizational structure of management over the three years' project.*

9.2 Ongoing management structure

9.2.1Localmanagement team (CMA staff)

The local management team will be responsible for day-to-day operations in the CMA including mariculture, surveillance and mangrove restoration activities. The team will be managed by the CMA manager, who will be previously selected and trained by theproject manager in collaboration with the local committee and local management team and with the final approval from the CMA committee. Consideration will be taken regarding training and capacity-building to manage funds transparently and efficiently to avoid poor management and potential mistrust between staff and committee members. The local management team will meet once a week to discuss project updates.

9.2.2 Local committee

The area of operations will be managed collaborativelywith the local committee. This committee will include representatives of local groups and structures including president of the community, representatives of women, representatives of fishermen and others key informants of Residences La Chaux. It will be responsible for decision-making in collaboration with the CMA manager, representatives of the local management team. They will be responsible for authorizing budgets and others expenditures. The local committee will meet once every two months to follow and guide management actions of the local management team with transparency. The local committee will be responsible forattributing expenses and benefits of the project after the three year period under strict control from the CMA Committee. After subtracting expenses designated to local staff salary, and management activities and maintenance and day-to-day operations, the benefits that have cumulated over the months can be used to upgrade the community of Residences La Chaux, in terms of facilities and infrastructures, ensuring increased local support and satisfaction.

9.2.3 CMA Committee (CMAC)

The entire project will be collaboratively controlled over the long term under the CMA committee (CMAC) which has been established during the first phase and will be modified through the future partnerships when the project will be ongoing. The organizational structure of the CMA is illustrated in the figure 4. Workshops and report submissionsincluding personal and financial management will be submitted every 5 months by the local management team and a workshop will be conducted at the same frequency.

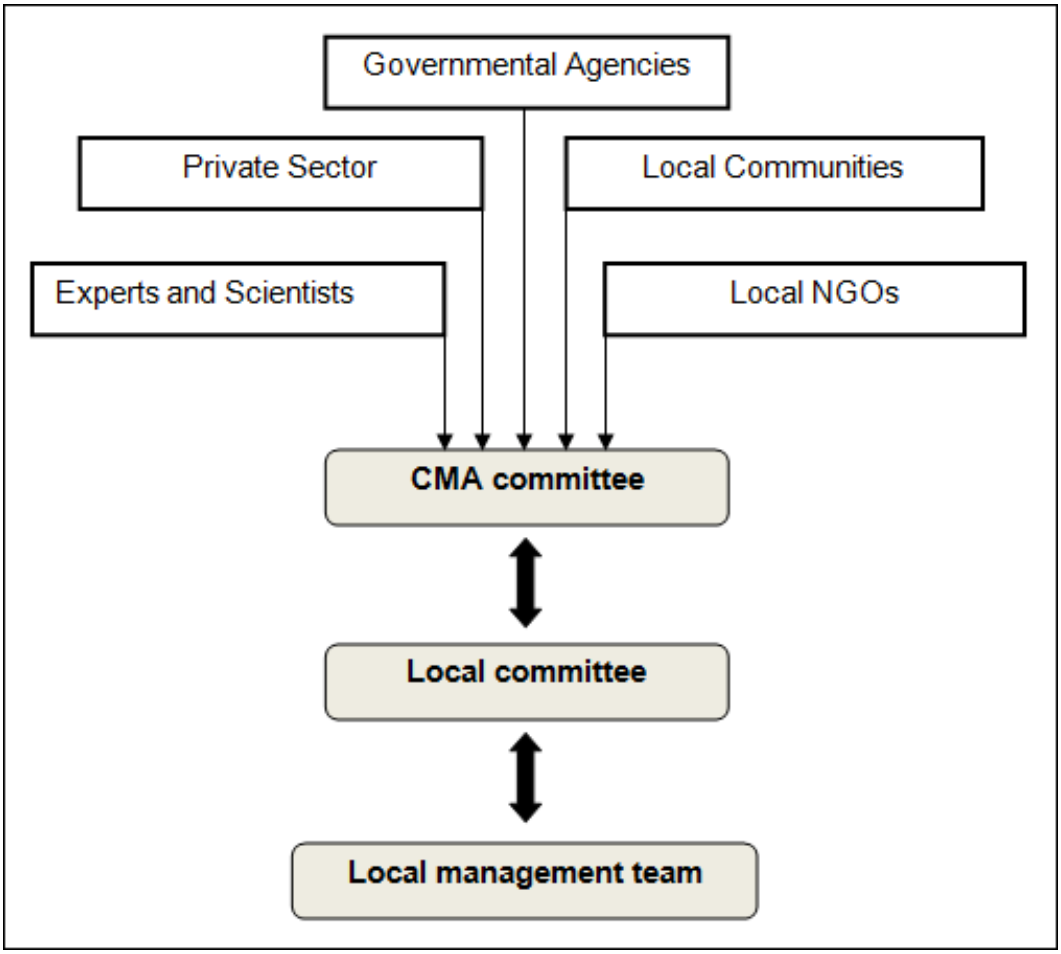


Figure 4:*Organizational structure of project management.*

9.2.4 CMA Management Plan (CMAMP)

A management plan will be developed and finalized at the end of the three years' project period by the project manager. The plan will cover all aspects of management including as day-to-day operations, business and financial management. It will facilitate continuity in the case of staff changes, and improve communication and information dissemination with all stakeholders over the long term and clarify objectives and set priorities for improving human and financial resources, and guide the management team. Moreover, it will provide the constitution outlining local management team, Local Committee and CMA Committee responsibilities and activities, elections, meetings, Terms Of References (TORs) and penalties.The management plan will have to be renewed by the local management team, once every 6 years to ensure project effectiveness and sustainability.

X INNOVATION

- The present initiative will implement pilot innovative community-based and collaborative management schemes for mariculture activity in Mauritius.
- This pilot project will develop and test suitable techniques for mariculture of crab "carlet" using different grow-out strategies in the barachois.
- The project will pilot innovative participatory biophysical, socio-economic, governance and fisheries monitoring programme.
- It will demonstrate and disseminated information on mariculture best practices and lessons learned that can be replicated on other unused barachois and degraded coastal wetlands in Mauritius
- It will also enhance the promotion and consolidation of public and private sector partnerships that are innovative and primordial for the project's success and sustainability.
- This project will support the development of innovative integrated management for sustainable coastal wetland based on best practices and Monitoring and Evaluation (M&E) strategy that can be replicated on other.
- The project will also promote fair trade in a safe, healthy and clean environment.

XISUSTAINABILITY

The gradual transition from community-based mariculture initiative with external technical assistance to a mainstream operation in which the local community permanently conducts and manages day-to-day operations will be supported by the development of added value initiatives to generate new income from "No take" products. Such sustainable financing mechanisms, include ecotourism (guided visits and other activities such as recreational fishing, kayaking), and the sale of traditional items that are hand-made by the community and inspired by the biodiversity of the site as well as sea-food barbecues cooked traditionally by local residents, which will further encourage the sustainable use of natural resources without causing biodiversity loss.

Products from the site will be branded.

Children will betargeted due to the proximity to the project andtheir position as future 'coastal resources managers' as well as their ability to influence their parents' attitudes and behaviors towards the environment.

All local residents will be trained and subsequently assisted and mentored by national and international experts during the implementation phase of the project. It is expected that they will then be able to pass on their knowledge and practices to future generations in order to continue the project sustainability.

Finally, the management plan will be a crucial tool to guide the long term management of the project and disseminate all aspects to stakeholders to ensure effectiveness, transparency and sustainability.

CONCLUSION

The present plan has been designed with local expertise and traditional knowledge collected during fishermen's meetings and others consultation strategies including participatory mapping, observational walk and boat trip with fishermen. It focuses initially on mud crab culture (*Scylla Serrata*) as a start for developing community-based polyculture in the barachois area and potentially in the entire CMA. The experimental study is considered a pilot to evaluate cost-effective systems for rearing mud crabs based on scientific data resulting from the socio-economic, biophysical, governance and mariculture monitoring programmes. It will be also an important steps to assess community perception and attitude toward mariculture and guide, evaluate and review further initiatives that will be implemented to enhance profitability and ensure the long term effectiveness and sustainability of the project.

The small-scale maricultureinitiative will empower the fishing community by giving them the ability to conserve, manage and monitor their coastal resources sustainably including mangrove thar are multiple values for the adjacent community. It will ultimately alleviate poverty through alternative income generating activities and capacity-building.Giving a secondary purpose to the Barachois will make the area productive, healthy and more appealing, and demonstrate the tremendous contribution of biodiversity towards the achievement of sustainable economic development. It will generate local community business and additional income through means other than direct fishing for the most needy who are currently entirely dependent on coastal resources, which will in turn decrease pressure on lagoon fishing. Finally, small-scale aquaculture will reduce vulnerability of the coastal fishing community and their surrounding ecosystems by sustaining coastal residents's income and food supply(Giasuddin & Alam 1991; Kador 1991; Primavera *et al.,* 2000, 2010; Primavera, 2006; Mirera 2009, 2011).

Reference

Baliao DD, De Los Santos MA, and Franco NM (1999). *Pen culture of mudcrab in mangroves.* Aquaculture extension manual, No. 29, March 1999. 10 pp.

Cowan L (1984).*Crab farming in Japan, Taiwan and the Philippines.* Queensland Department of primary Industries, Brisbane, QLD. Australia Information series Q 184009.

Giasuddin M and MF Alam (1991).*The mud crab (Scylla serrata) fishery and its bio-economics in Bangladesh.* In: Angel CA (ed) The mud crab: a report on the seminar convened in Surat Tahi, Thailand, Nov 5–8, 1991, pp 29–40.

Kador A (1991).*Mud crab—a potential aquaculture resource of Bangladesh.* In: Angel CA (ed) The mud crab: a report on the seminar convened in Surat Tahi, Thailand, Nov 5, 1991, pp 95–102

Keenan CP, Davie PJF, and Mann DL (1998).*A revision of the genus Scylla De Haan, 1833 (Crustacea: Decapoda: Brachyura: Portunidae)*. Raffles Bull. Zool. 46, 217-245.

Mirera OD (2009).*Mud Crab (Scylla serrata) Culture: Understanding theTechnology in a Silvofisheries Perspective.* Western Indian Ocean J. Mar. Sci. Vol.8, No. 1, pp.127-137, 2009.

Mirera OD (2011).*Trends in exploitation, development and management of artisanal mud crab* (Scylla serrata-Forsskal-1775) fishery and small-scale culture in Kenya: an overview. Ocean Coast Manag 54:844–855

Mwaluma J (2002).*Pen Culture of the Mud Crab Scylla serrata in Mtwapa Mangrove System, Kenya.* Western Indian Ocean J.Mar. Sci. Vol. 1, No. 2, pp.127-133 , 2002.

Primavera JH (2006).*Ocean and coastal management.* Overcoming Impact Aquac Coast Zone 49:531–545

Primavera JH, LMB Garcia, MT Castanos and, MB Surrtida (2000).*Mangrove-friendly aquaculture.* In: Proceedings of the workshop on mangrove-friendly aquaculture organized by the Seafdec aquaculture Department, Jan 11–15, 1999. Iloilo, Philippines

Primavera JH, JB Binas and GPB Samonte-Tan, MJJ Lebata, VR Alava, M Walton and L Levay (2010). *Mud crab pen culture: replacement of fish feed requirement and impacts on mangrove community structure.* Aquac Res 41:1211–1220

Shelley C and A Lovatelli (2011). *Mud crab aquaculture – A practical manual*.FAO Fisheries and Aquaculture Technical Paper. No. 567. Rome, FAO. 2011. 78 pp.

Trino AT, Rodriguez EM (2002).*Pen culture of mud crab Scylla serrata in tidal flats reforested with mangrove trees.Aquaculture*. 211:125-134.