

EX-POST EVALUATION REPORT
ON
THE COASTAL FISHERIES RESOURCES AND ENVIRONMENT
CONSERVATION PROJECT
IN MAURITIUS

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EX-POST EVALUATION STUDY
ON
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IN MAURITIUS

OCTOBER 2005

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LIST OF ABBREVIATIONS

AFRC	: Albion Fisheries Research Center
ARDA	: Association Réunionnaise pour le Développement de l'Aquaculture
C/P	: Counterpart
CIDA	: Canadian International Cooperation Agency
COREMO	: Coral Reef Monitoring
GPS	: Global Positioning System
ICOD	: International Center for Ocean Development
JICA	: Japan International Cooperation Agency
MOF	: Ministry of Fisheries
MOI	: Mauritius Oceanographic Institute
TOR	: Term of Reference
U.V	: Ultra Violet

1. THE OUTLINE OF THE EX-POST EVALUATION STUDY

1.1. Background and the Purposes of the Study

After the technical cooperation with the Mauritian Government for making the best use of the ocean and the coastal resources on a sustainable basis through Albion Fisheries Research center, JICA decided to dispatch a team to make the ex post evaluation of the project: "The coastal fisheries resources and environment preservation in Mauritius" under the different types of cooperation as follows:

- Grant aid for the construction of AFRC in 1982 and experimental facilities (fish ponds, etc.) in 1986
- Dispatch of long-term experts since 1991
- Technical cooperation project from December 1995 to November 2000
- Follow-up of the project from December 2000 to November 2002

The basic purposes of this study were as follows:

- To draw lessons and to give recommendations to improve future JICA planning and implementation capacity of the Implementing Agencies through evaluation of the impact and the sustainability of the project.
 - *Impact* : Impact of the project activities are identified as positive or negative change produced by the project directly and indirectly
 - *Sustainability*: sustainability of the project is focused on financial, organizational and technical aspects by examining the extent of its achievements.
- To meet the accountability to the Japanese tax payers through production of reports in both electronic and printed forms.

1.2. Evaluator(s) and schedule of the Study

The members of team of the ex post evaluation are :

Mr. Kaneyasu Ida (IC Net Limited), the Japanese Consultant and provide technical guidance to the other team members.

Mr. Rajaobelina Haja (Program Officer) as a National staff of JICA Madagascar and attended the field study with local consultant

Mr. Rasoanarivo Hariliva (Consultant) as a local consultant assist the Japanese one, conduct together the ex-post evaluation study of the project and ensure the data collection for the Evaluation Report.

The evaluation study was carried out from September 25th, 2005 to October 28th, 2005. The schedule of the evaluation is presented as follows:

Table 1: Schedule of the evaluation

Date	Tasks	Activities
September 25 th to October 30 th	Preparation of the evaluation	<ul style="list-style-type: none"> ■ Preparation Seminar for the team ■ Evaluation plan studies ■ Preparation of the field work ■ Finalization of questionnaire
October 1 st to October 13 th	Data Collection	<ul style="list-style-type: none"> ■ Collect and compilation of data ■ Interviewing and survey of the stakeholders like: Ministry of Fisheries, AFRC Managers, Counterparts, Fisherman, site visit ■ Data analysis and report writing
October 14 th to October 28 th	Finalization of the report	<ul style="list-style-type: none"> ■ Conduction of supplemental study ■ Proofreading ■ Finalization of the report

2. STUDY METHODS

2.1. Outline of the Project

Project Title: The coastal fisheries resources and environmental preservation in Mauritius

Project site: Albion Fisheries Research Center

Cooperation period: December 1995 – November 2000

Follow up of the project: December 2000 – November 2002

Responsible agency: Ministry of Agro Industry and Fisheries

2.1.1. Background of the project

In its 6th National Development Plan (1992-1994), Mauritius regarded the improvement of fishery research as an essential task for making the best use of ocean resources on a sustainable basis. The AFRC was then the only institute in Mauritius, which conducted studies on fishery and marine resources. A technical cooperation project was requested with the objective of enhancing the capacity of the center with regard to the preservation of coastal resources and the environment. In response to the request, the Japanese Government agreed to implement “The Coastal Resources and Environment Conservation Project”. The project lasted for 5 years.

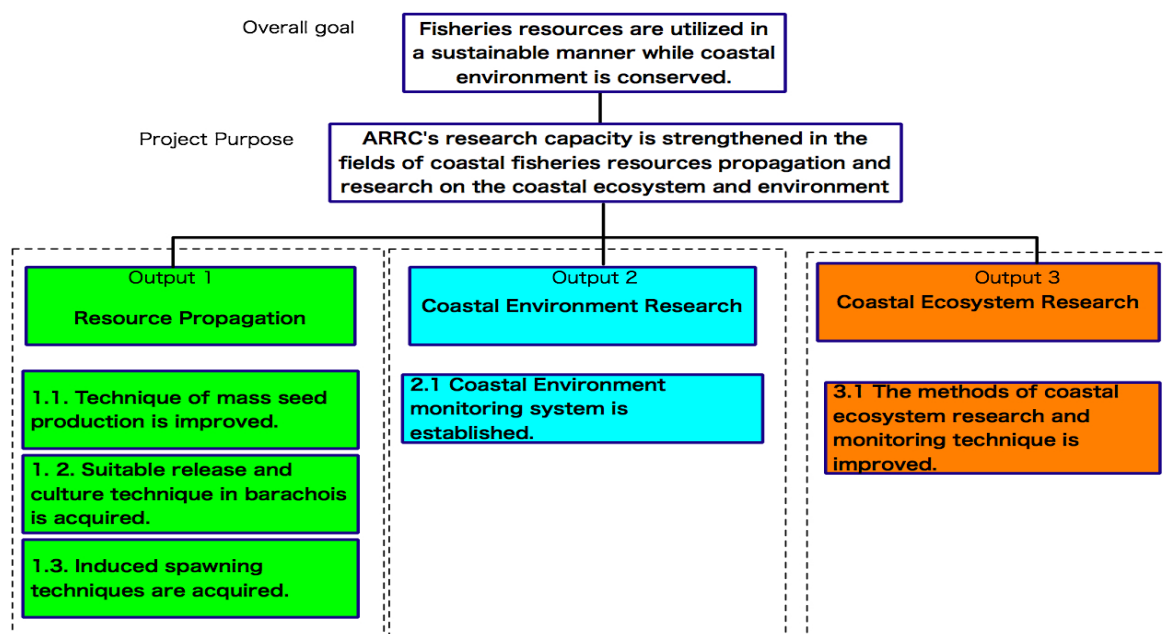
The project helped AFRC build research infrastructure in AFRC and develop the capacity of the researchers in resource propagation, coastal environment and coastal ecosystem researches. Through the project activities, several scientific papers and articles were published. The counterpart personnel had significantly enhanced their capabilities. Yet, some of the important activities planned at the beginning of the project were not completed. The Mauritian and Japanese sides agreed to extend the project for two years as the follow-up of the project.

2.1.2. Framework of the project

The figure as follows shows the the framework of the project throughout technical cooperation running on 1995 to 2000.

For the follow-up of the project, the outputs of technical cooperation are focused on the three following fields:

- Resource propagation of seed production of Mangrove Crab and Sea Bream.
- Improvements of techniques in marking, release and recapture (Sea Bream)
- Improvements of the methods of coastal ecosystem research and monitoring techniques relating to corals.



2.1.3. Inputs

Table 2: Inputs during the project are showed in the table below

Inputs	Technical cooperation project (1995-2000)	Follow-up (2000-2002)
<i>Japanese side:</i>		
Long-term experts	5 (300 M/M in total)	3 (72 M/M in total)
Short-term experts	14 (13 M/M in total)	3 (4 M/M in total)
Training in Japan	14 researchers	4 researchers
Equipment	137 Million Japanese yen (30.8 Million rupees)	17.7 Million Japanese yen (3.98 Million rupees)
Operation cost	25.6 Million Japanese yen (5.8 Million rupees)	4.9 Million Japanese yen (1.1 Million rupees)
<i>Mauritius side:</i>		
Counterpart personnel	12 researchers	8 researchers
Recurrent budget	45.4 Million Japanese yen (10.2 Million rupees)	22.5 Million Japanese yen (5 Million rupees)
Other inputs	Land, buildings, utilities, etc.	Land, buildings, utilities, etc.

(1 Japanese yen = 4.45 rupees)

2.2. Study Methods and Stakeholders

Table 3: Stakeholders

No.	Stakeholders	Descriptions	Respondents	Study methods
Implementing agencies				
1	Ministry of Agro Industry and Fisheries	The line agency responsible for the implementation of the project.	Decision makers in the Ministry Statistics division	Questionnaire by letter/ Interviewing Collection of secondary data (Fishery development plan, statistical data, etc.)
2	Management of AFRC	The management is responsible for sustaining the inputs and outputs of the project.	Director and unit heads	Questionnaire by letter Interviewing
3	Counterpart personnel	14 researchers. The prime target group of the project.	AFRC staff	Questionnaire survey Focus group discussion
Beneficiaries (Indirect)				
4	Local fishers	There are some small fishers in the area. Also, there is a fishery cooperative and AFRC occasionally has contact with them.	Local fishers	Interviewing
5	Mauritius Oceanographic Institute	MOI is a research institute and is also involved in policy issues and management of the marine resources.	Manager(s) in charge of the relevant fields	Interviewing

3. RESULTS OF EVALUATION

3.1. Impact

3.1.1. Impacts on the overall goals

The ten-year fisheries development plan formulated in 1998 gives policy priority to: the sustainable use of existing resources and protection of the marine environment; limited and cautious development of under-utilized resources and diversification into aquaculture where feasible; maximizing returns from existing fisheries through value addition; and training, capacity building and institutional reforms. In line with the plan, the project aimed at enhancing the research capacity of AFRC in the fields of aquaculture, coastal environment and ecosystem. The impacts of coastal environment and ecosystem components of the project have been strong and those of the aquaculture component is yet limited. The following are the impacts of the project identified by the evaluation team.

3.1.2. Impacts of coastal environment and ecosystem monitoring

AFRC's coastal environment monitoring activities have a direct impact on the conservation of the coastal environment because a coordination mechanism has been established where the concerned authorities share monitoring results produced by AFRC and take measures when a negative impact on the coastal environment is recognized. AFRC is also actively involved in formulating and updating relevant regulations.



Poudre d'Or site
Residual pesticides monitoring is regularly conducted as there are sugar cane fields along the river.



Grand Baie site
Water quality is regularly monitored at this popular tourist destination.

As for water quality monitoring, AFRC regularly submits the results of coastal environment monitoring to the inter-ministerial coordination committee that includes the Ministry of Environment, Human Resource Development and Employment, the Ministry of Agro-Industry and

Fisheries, and the Ministry of Health. When the result of monitoring exceeds an accepted level on any parameter and the same situation persists for a certain period of time, the committee is authorized to order the authority concerned to take action. The monitoring activities also benefit tourists and the tourism industry. One obvious benefit is that tourists are ensured the safety of the beaches. Beach authorities also benefit. When the monitoring results prove positive, they can promote the safety of their beaches. When negative, they will know what measures should be taken to improve the sanitary condition of their beaches. So far, monitoring is conducted for 13 beaches. Currently, two out of three beaches in Port Louis are closed due to an excessive level of Coli forms.

Results of water quality and coastal ecosystem monitoring are used for Environmental Impact Assessment (EIA). In compliance with the Environment Protection Act of 2001, the Environment Coordination Committee was established in 2002, consisting of the relevant government agencies, NGOs, universities and research institutes. Since then, monitoring data produced by AFRC are widely used for EIA purposes. In fiscal year 2003, the Ministry of Agro-Industries and Fisheries examined 61 EIA applications for coastal development (e.g., construction of breakwaters, dredging of lagoons and upgrading of beaches) and forwarded recommendations to the Department of Environment. Monitoring data are also provided to various stakeholders of coastal development projects.

3.1.3. Impacts on aquaculture development

Resource propagation, the first component of the project, has some positive impacts on the use of the fisheries resources because of the basic infrastructure and technical capacity of staff by improvement of staff knowledge, know-how and skills for experimentation and practice for production. During the project, physical infrastructure and basic techniques for seed propagation were built. This infrastructure has a good value for AFRC because it gives AFRC the capacity to receive cooperation and more new skills and know-how from different donors like India, and to get more knowledge about new species of aquaculture. One of those new species is the camaron (*Macrobrachium rosenbergii*) from Ferney Aquaculture Limited in December 2002. This experimentation is about broodstock for the first time, then seed production before growing out and sale to small farmers.

The following are the impacts on stakeholders that the evaluation team identified during its study:

- (1) For the scientists and processors, they acquired important knowledge by scientific and technical collaboration between seed production department of AFRC and different institution like the University of Mauritius, the Mauritius Research Council, ARDA (Association Réunionnaise pour le Développement de l'Aquaculture). This collaboration helped two sides improve their

capacity and produce more publications such as handbook for scientist and fisher in aquaculture by doing research together and skills exchange.

- (2) The private sector benefited from demonstration and assistance through close collaboration with AFRC concerning fishing and trade, feasibility analysis, conflicts prevention between them and local population and advice for their investment on fishing or about fish management. Also, many services are given by AFRC to help the Fisheries Protection Service with regard to registration of fishers and boats and permits distribution.
- (3) For fish farm and fishers, in 2003, more than 25% of 2700 fishers were introduced to some basics of fish farming as part of the fishers training program (fish production until trade system). A new School Fish Training was created by Japanese Grant Aid on 2005. For the same year, the school trains 100 fishers and plans to give every year, training for the same number of fishers.
- (4) One of the good impacts of the project is the awareness of the public about aquaculture through guided visits to the experimentation area at the center. There was a film shown about the seed production and aquaculture activities.

The impact of the fish release program is not significant as shown by the following data in the table below. Only 2% of fish released is recaptured. First of all, the number of sea bream stocked in lagoons has not been great. Also, marking, branding and tagging prior to release has been discontinued mainly due to two reasons:

- The marking process increase the mortality rate of fish by 60%, then the result is not reliable.
- As for the tagging, the tags came off easily. The tag numbers often faded away therefore, it is impossible to assess the impact of the program.

Table 4: Distribution of fish, crab and shrimp

Species		Released during the project period (Dec. 1995 – Dec. 2000)	Released on 2001 to 2004
Sea Bream	Released to Lagoon:	50,780	1,167,700
	Released to Barachois	72,678	
Crab	Released to Lagoon:	2,217	
Shrimp	Released to Lagoon:	155,098	85,650
	Released to Barachois		10,000

(Source: AFRC)

The fiscal and economic impact of the aquaculture is also still quite limited. Fish farming on the coastal areas has not attracted investors because of costly initial investment cost such as land price.

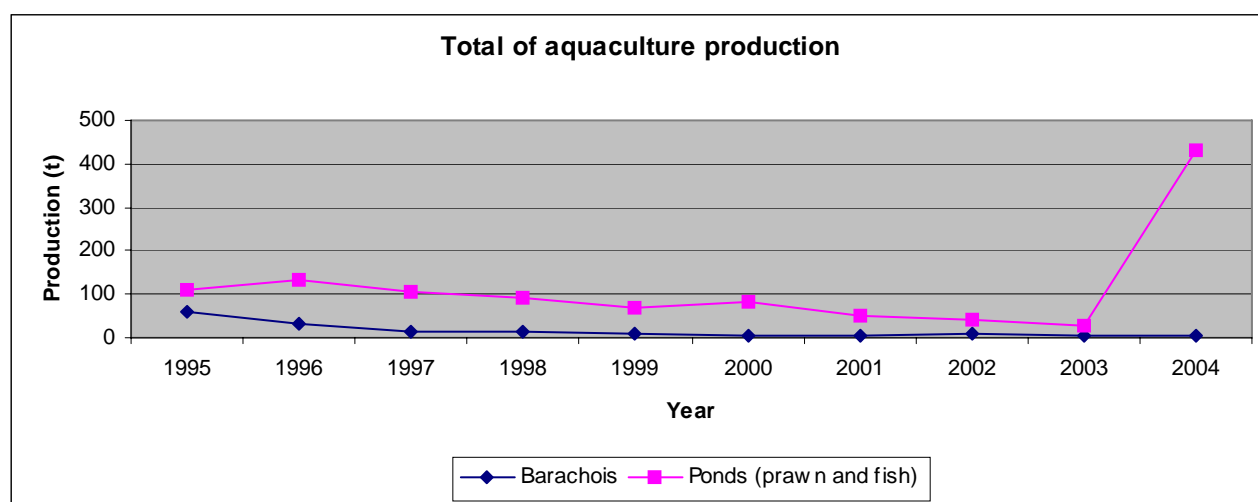
Currently, investment in tourism seems to be regarded as a more feasible option for them. For the same reason, artisanal fishers have little capital for investment. The fishers that the evaluation team interviewed also stated that they would prefer to invest in fishing gears including boat and engine as there are still good opportunities for pelagic fish like yellow fin tuna.

Also, the main idea for aquaculture practicing about barachois that was seen as a potential area during the project is not successful because, for a total of 33 barachois, less than 10 barachois are ongoing. The production in aquaculture in Barachois and freshwater ponds decreased as the table below shows. The rapid increase of fish production from ponds in 2004 owes to one foreign investor that started operation on 2003 with particularly one specie as red drum in lagoon.

Table 5: Total production of aquaculture (tones)

Sector/ Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Barachois	59	33	12	13	10	5	6	7	6	4
Ponds (prawn and fish)	111	132	105	93	71	82	52	39	27	433 ¹

(Source: AFRC)



3.1.4. Other impacts

As another impact, it is fair to say in this field how important the project is to ensure the sustainability of fisheries resources management because it is one of means to sensitize the public about the importance of costal environment protection and the importance of fisheries exploitation

¹ The production of 2004 includes both in fresh water and lagoon.

not only for local food but also for the national economy.

This situation is the result of public sensitization through visit of schools, free access to parks, marine and experimental sites for students and senior citizens, site visit and exhibition as the following statistics presents. It is fair to say that important people in coastal protection and fisheries exploitation are more interested in AFRC activities because a great number of visitors come from this sector as governmental and Non-Governmental Organizations, firms and the private sector on fisheries and institutions.

Table 6: Site visit to AFRC on 2002 and 2003

Institutions	2002	2003
School (primary / secondary)	7,855	4,119
Social organization and Welfare center	845	1,128
Governmental, NGOs, private firms, prevocational institutions...	61	547

(Source: AFRC)

Also, two types of training for students and graduates are granted by AFRC as follows:

- Skill land attachment that gives work experience to 4 trainees a year
- Study training from four to six months included in the university courses.

These students also benefit from the project as now they can receive more practical experience than before the project started.

3.2. Sustainability

3.2.1. Financial sustainability

The financial aspect of AFRC is not really a big problem particularly with regard to the operating budget to ensure the sustainability of its activities because this part is included in the Ministry's budget in the annual recurrent budget. It means that there is no change in the budget and the budget does not decrease. It is maintained at the same amount or increased as the case for the fiscal year 2003/ 2004.

Table 7: AFRC budget for the five latest fiscal years (Million Rupees)

Year	1999/ 2000	2000 / 2001	2001 / 2002	2002 / 2003	2003 / 2004
Annual recurrent budget for the Ministry of Fisheries	81.50	83.32	92.854	96.35	102.90
AFRC budget	3.00	3.00	3.00	3.00	3.50

(Source: Ministry of Agro Industries and Fisheries)

This AFRC annual budget is reserved only for operating and technical expenditures of the center but the salary is included in the Ministry's budget. Also, the investment part of the budget of the center is included at the Annual Budget Capital of the Ministry, e.g., Grant Aid from Japanese Cooperation for the construction of the Training School for Fishers in the budget 2003/2004 around 100 million Rupees.

3.2.2. Personnel

To ensure the sustainability of the staff capacity, different types of training were given to improve the capacity of AFRC personnel. For this year, 9 technicians from institutions included AFRC, the Environmental Development Unit, NGOs and the Mauritius Oceanographic Institute were trained by the center. Now, training is given by counterparts trained in Japan. That means that competence transfer exist throughout the center.

The movement of experienced personnel is ordered by the Government by promotion title or retirement. Senior staff members leaving the center are replaced by their assistants or by junior staff members who were trained by counterparts.

Now, the center has around 93 officers composed by 60 scientists and 33 administrators. This table below shows the number of the personnel for the last five years. During this post evaluation survey, each person interviewed talked about lack of staff members at all levels particularly in scientific and technical fields. This is because AFRC is in fact the only department in the Ministry that deals with all the technical aspects of fisheries, and the scientists and technicians in AFRC are compelled to be involved in various tasks such as administrative, advisory and counseling and coordination tasks.

Table 8: Staff allocation in AFRC

Category/ Year	2001	2002	2003	2004	2005
Technical Personnel	60	65	65	60	60
Administrators	43	35	38	32	33
Long term experts from JICA	3	4	1	0	0
National staff on leave		5	1	2	
Total	106	104	104	92	93

(Source: AFRC)

3.2.3. Technical aspects

- Research activities

The center continues to write and edit the results of its activities in different manners: documents and scientific reports, posters, textbooks for sale or free access for students or scientists. Here is an example after the end of the follow-up on the project: AFRC produced 200 titles of publications consisting of journals, abstracts, newspapers and 2 books. For this year, 20% of publications of AFRC are sold and the rest are distributed to scholarly organizations, universities and collaborators.

Because of those publications, AFRC still serves as a reference for regional coral reef monitoring project and the only center in the island that is involved in coastal resources management and protection. The results of data analysis are used by technical and scientists in other countries.

- Maintenance of research equipment

To ensure the sustainability of the center and its activities, different initiatives are taken by managers and scientists. For the environmental and ecosystem monitoring, for example, equipment maintenance is ensured by some external manufacturers or local companies.

As for seed propagation, most of important equipment items have not been in use since 2003 such as sand filter, U.V. fertilizer, seawater pump, outboard motor because of the following reasons:

- After the technical cooperation, the center cannot repair equipment items because of lack of budget and shortage of spare parts in the local market.
- The maintenance personnel is not able to do any repair. They were only trained for primary maintenance.
- Equipment items are now old and cannot be used anymore.

Accordingly, technicians and scientists make sure that activities continue by the use of local

equipment items such as small filters that must be cleaned regularly.

3.3. Sustainability of the Project's outputs

3.3.1. Project purpose

At this stage, it is fair to say that the capacity of research of AFRC in the field of coastal fisheries resource propagation and research on coastal ecosystem and environment is maintained at a good level because the majority of project components progressed so much. The number of the experimentation sites increased, the species promoted continue with some important species for production and for consumption like sea bream and red drum.

3.3.2. Outputs

Resource propagation

The activities of the center in terms of resource propagation are focused on two major areas:

On shrimp culture, the impact of the project is rather low except for the production and propagation of giant freshwater prawn (*Machrobrachium resembergii*) that started in 2003 and continues to get good results as the table below shows. At the moment, the center tries in this way to maintain good propagation of different and new species to ensure that the seed production is sustainable. But some species production and propagation have stopped, e.g., giant tiger prawn for seawater (*Panaeus monodon*) and red drum for fresh water because of high cost of investment. Small farmers cannot invest on it and people who have money do not want to invest in aquaculture but prefer to invest in tourism or the sugar industry.

Table 9: Seed production for the last five years

Specie/ Year	2001	2002	2003	2004	2005
Giant tiger prawn for seawater (<i>Panaeus monodon</i>).	232,000	204,100	61,700		
Berri rouge for fresh water (<i>Oreochromis sp.</i>)	18,795	31,485	85,472	20,055	
Camaron for fresh water (<i>Machrobrachium resembergii</i>)			120,000	625,200	113,000 ²

(Source: AFRC)

One can see that new species of shrimps have been introduced in this sector since 2003 as the giant

² Quantity of production for year 2005 on january to april

freshwater prawn. Site visits revealed factors that can ensure the continuation of shrimp activities. In this case, basic infrastructure is important for promoting new species and improving basic techniques for an effective technical assistance. The center also received around 50 small farmers requesting technical assistance to diversify their activities, or to supply fingerlings.

Concerning sea breams (*Rhabdosargus sarba*), 292,000 sea bream fry were produced in 2003, which is fewer than 338,000 in 2002. The number continued to decrease as the table below shows but sea bream production is one of the main activities of seed production with a good chance for sustainability because it is appreciated by consumers.

Table 10: Seed production for sea bream

Year	2001	2002	2003	2004	2005
Production	182,000	338,200	292,000	255,000	275,000 ³

(Source: AFRC)

The production target has been attained by improvement of live seed and larval production and by the capacity of the AFRC to provide eggs, fry, fingerlings and juveniles sea bream for barachois and fish farmer owners. Increase in stock on silver sea bream on selected sites and sea ranching are done together with stock assessment. However, stocking lagoon on sea bream is not significantly high because tagging and fish marking are less efficient and have been discontinued.

For other activities, production of mangrove crab and giant tiger prawn on seawater stopped in 2002 and no more impact is registered. But AFRC tries to introduce different new species such as barramundi for fresh water.

Coastal environmental monitoring

Through the project, such necessary equipment items as high performance liquid chromatography, atomic absorption spectrophotometer and mercury analyzer were installed at AFRC's chemical laboratory. In addition, technology transfer in chemical analysis and data processing completed. For bacteriological analysis, JICA's dispatched a short-term expert and installed some equipment.

Coastal environment monitoring was initiated by AFRC in cooperation with ICOD at eight sites

³ Quantity of production for projection 2005

prior to the project. During the project, two more sites and more parameters on chemical residues were added. To date, AFRC regularly monitors water quality on 17 parameters⁴ at 15 sites, and plans to set up three more sites where wastewater treatment plants are scheduled to be constructed. AFRC also monitors trace metal and residual pesticides at eight sites in Mauritius and five sites in Rodrigues in order to assess the impact of industrial activities and the impact of pesticides used for sugar cane cultivation.⁵

As shown in the table below, since the end of the project in 2002, AFRC has monitored water quality regularly at an interval of every one to four months a year. The results of monitoring are compiled and submitted to the Ministry of the Environment every three months. AFRC also assists the Ministry of the Environment in monitoring the water quality of the sites in the coastal areas where environmental impact assessment is required. Such monitoring activities are listed under “Extra study” in the table below. In addition, the beach authorities that have been established for public beaches increasingly request AFRC to check water quality in order to ensure the sanitary conditions of their beaches.

Table 11: Record of coastal environmental monitoring

Year	Chemistry				Bacteriology
	Monitoring (Number of sites)				Sites
	Regular monitoring	Barachois Study	Extra study	Total	Regular monitoring
1996	37	6	9	52	60
1997	40	13	9	62	69
1998	46	8	26	80	60
1999	46	6	29	81	84
2000	39		5	44	84
2001	63		27	90	120
2002	53		33	86	120
2003	49		15	64	144
2004	54		18	72	144

(Source: AFRC)

Sixteen sets of analytical equipment were installed and are functional except for the atomic absorption spectrophotometer and the mercury analyzer due to the unavailability of spare parts. The models are too old for the agent to keep spare parts in stock. AFRC has renewed these apparatus

⁴ 17 parameters required by the guidelines are: pH, temperature, suspended solids, dissolved oxygen, chemical oxygen demand, total Coli forms, faecal Coli forms, nitrate-nitrogen, phosphate, oil and grease, phenol, arsenic, cadmium, cyanide, chromium, copper and lead.

⁵ The metals and residual pesticides analyzed are: lead, zinc, copper and cadmium (trace metals) and Atrazine, Diuron and Hexazinone (residual pesticides).

with its own budget. Local agents are able to deliver necessary supplies such as standard reagents for chemical analysis, and proper maintenance work. Therefore, most of the equipment in the laboratory can be kept in good condition.

The accuracy of chemical analysis also appears to be maintained. This year, the crosschecking of analysis in pesticides was conducted with the National Environment Laboratory, and the results proved to be positive. Now, AFRC plans to establish its laboratory as accredited laboratory.

In sum, the sustainability of coastal environment monitoring is high. The staff's technical level is sustained and necessary analytical equipment is functional. Now, coastal environment monitoring is well integrated into the Government's standard procedure for environmental protection and conservation. Thus this activity is quite sustainable. Another indicator of good sustainability is that AFRC is accepted as the inspection center for coastal environment monitoring by other agencies so that there would be an increasing demand for environmental monitoring activities.

One concern is that opportunity is limited for the staff in the chemical and bacteriological laboratory to obtain techniques for new parameters as well as upgrade their technical know-how and analytical skills. This may pose a problem when the guidelines for coastal water quality will require higher precision (hence, new analytical methods and apparatuses) or additional parameters.

Coastal ecosystem research

During the project, data on 330 fish species were collected (This represents two-thirds of the reported fish species in Mauritius) and 50 coral species were identified. By the end of the follow-up period, 154 species were identified (From the bio-geographical point of view, it is assumed 282 species might exist in Mauritius.). COREMO (Coral monitoring software) was introduced for data analysis in ecosystem monitoring. "Field guide to Corals of Mauritius" was published. Through this activity, AFRC researchers have obtained important know-how in coral taxonomy. Regular monitoring on coastal ecosystem started in 1998.

As shown in the table below, AFRC has continued to conduct monitoring activity at all of the sites selected during the project, using the same methodology as the researchers learned from the experts. One site has been added since 2004. More sites are scheduled to be introduced. Data such as percentage cover of substrate (coral, algae and abiotic) and abundance of fish, sea urchins and sea cucumbers are collected. Monitoring results are added to the database and used by other agencies for decision making on the approval of various development projects such as sewage installation and hotel development projects that would affect the ecosystem in the coastal zone.

Table 12: Record of coastal ecosystem monitoring

Site	Monitoring (Number of sites monitored)							
	1998	1999	2000	2001	2002	2003	2004	2005 ⁶
Albion	2	4	2		3	3	3	1
Pointe aux Sables	2	4	2		4	2	4	2
Trou aux Biches	2	4	3	1	3	3	3	1
Anse la Raie	2	4	2		2	4	4	
Trou d'Eau Douce	2	4	3	1	2	4	4	2
Bambous Virieux	2	4	4		4	2	2	2
Bel Ombre	2	4	2		2	4	2	2
Ile aux Benitiers	2	4	2		6	3	4	1
Baie du Tombeau			2		2	2	2	
Poudre d'Or			2		2	4	2	2
Belle Mare (New site)							2	2
Total	16	32	24	2	30	31	34	15

(Source: AFRC)

While AFRC monitors the impact of human activities that potentially threaten the coastal ecosystem, it also manages to protect coral reefs from natural processes such as the outbreak of crown of thorns starfish (*acanthaster planci*). Crown of thorns is a predator on coral reefs, and coral bleaching and predation by crown of thorns poses a real threat. A key to alleviating reefs from further destruction is a timely intervention.⁷

To date, regular monitoring enables the researchers to identify abnormal increase of crown of thorns. In 2003, an increase of crown of thorns on a small scale in a patch reef in the lagoon at Trou d'Eau Douce was identified and the infestation was controlled by injection of dry acid. In 2004, crown of thorns was controlled at Trou d'Eau Douce and Ile aux Benitiers sites, applying the same method.

Table 14: Crown of thorns starfish eradication

Year	Month	Site	Quantity eradicated	Size (cm)
2003	October	Trou d'Eau Douce	28	20 - 50
2004	October	Trou d'Eau Douce	25	25 - 40
2004	September	Ile aux Benitiers	49	40 - 65

(Source: AFRC)

⁶ For 2005, from January to August.⁷ MS Koonjul, V. mangar and JP Luchmun. 2003. "Eradication of crown of thorns starfish infestation in a patch reef in the lagoon off Ile aux cerfs, Mauritius". Proceedings Sixth Meeting of Agricultural Scientists, Food and Agricultural Research Council.

Equipment provided for the Ecology section during the project includes GPS, diving gear and cameras. All of them are functional and most of them are frequently used. During the project, senior researchers obtained techniques and know-how in ecosystem monitoring and conservation, and they are now teaching such techniques and know-how to junior staff.

4. FACTORS THAT HAVE PROMOTED THE PROJECT

4.1. Impact

The overriding factor was the timely introduction of various legislative measures by the Government for environmental protection and conservation. Since the Environment Protection Act was enacted in 2001 (one year before the termination of the project), amendments have been made and regulations and their requirements under the Act strengthened (AFRC played important role in the preparation of standards and regulations.). Therefore, results of studies conducted by AFRC are effectively used by various stakeholders.

4.2. Sustainability

The employment system in Mauritius is one of the main factors promoting the development of the project and its success. This system enhanced motivation of personnel by improving the social workers' conditions by reduction of tax and free access to social services. Besides, there is no politicking in the workplace. It encourages technicians and scientists to continue to work for the center. For those reasons, resignations are rare.

5. FACTORS THAT HAVE INHIBITED THE PROJECT

5.1. Impact

The lack of the master plan on research and seed propagation activities to develop the exploitation of underutilized resources and diversify aquaculture is an inhibiting factor for the development of AFRC activities.

The tagging and marking program was discontinued due to technical problems. Therefore, it is difficult to measure the effects of the stocking program.

Some equipment items for the aquaculture department are out of order. This is a detrimental factor for AFRC because it caused the reduction of certain activities, particularly in broodstock and seed production.

5.2. Sustainability

A factor inhibiting the sustainability of the project is the workload in the center because technicians and scientists have to do too much paper work and attend too many meetings. This factor sometimes disrupts their research activities.

At the governmental level, the activities of the center cannot be much further developed because of the restriction on the budget of the Ministry of Agro Industry and Fisheries. The total budget for the technical department of the Ministry of Fisheries as AFRC is only around 3 million Rupees each year.

6. CONCLUSIONS

In summary, the project was largely successful. It produced different positive impacts on environmental protection level and improvement of its technical and scientific capacity in terms of environmental and ecosystem monitoring. The center is self-reliant particularly in these fields.

For the aquaculture component, the center tries to do its best to identify and introduce new species through research, increase in seed production and sites of propagation in spite of the equipment problem. But this component has not yet fully developed to have a tangible impact on resource propagation or fish production.

7. RECOMMENDATIONS

7.1. To AFRC and the Ministry of Agro-industry and Fisheries

- Currently, the Ministry of Fisheries along with AFRC is planning to develop a master plan for aquaculture development. It is recommended that the Ministry will give this task a higher priority, provide necessary support to AFRC and complete the plan as soon as possible so that AFRC can concentrate its efforts and allocate its resources on prioritized activities. In the preparation of the master plan, a detailed feasibility study with focus on marketability should be conducted to identify the species to be promoted.
- AFRC should always ensure sufficient inputs and resources for regular monitoring activities. In 2001, administrative restructuring of AFRC and its subsequent delay in administrative procedures resulted in the interruption of coastal ecosystem monitoring. If there were any interruption in longitudinal monitoring as coastal ecosystem monitoring, the data's reliability would be significantly affected. In order to avoid such a risk, it is suggested, if regulations

permit, that a minimum budget (and if possible, the sufficient number of staff) required for maintaining daily activities be secured at annual planning and reimbursable flexibly for designated expenditure items. This way, regular monitoring can be continued without being affected by change in external environment.

- Many of AFRC's activities directly benefit the private sector, particularly the tourism industry. AFRC's budget is limited to approximately three million rupees per year, rendering it very difficult to expand such programs as fish stocking in the lagoons. Therefore, it is recommended that AFRC pursue the possibility of raising fund by involving the users of the coastal resources in AFRC's program. Such users may include sport fishers' clubs, divers' clubs and other marine sports and leisure operators, hotels and travel agents. One way of promoting the program is to make it a joint program between the public and private sectors where AFRC distributes juvenile fish at an affordable price to member companies or organizations, and they stock fish for their events as an environmental conservation activity. Financial contribution can be also pursued by such means as placing donation boxes at their offices, and negotiating with boat owners to add a small amount to boat charter fee as donation to the fish stocking program. In order to solicit support for the program from the public as well as the users of coastal resources, AFRC will need to launch a campaign to promote the program and publicize its achievements.
- The Ministry of Fisheries should ensure that the sufficient number of researchers is allocated for AFRC so that the researchers can concentrate their efforts on research activities.

7.2. To JICA

- Although the capacity of the researchers in regular and research activities has been well developed, they need to upgrade their techniques and skills. Yet since the end of the project, they have had limited opportunities to upgrade their technical know-how and skills as well as be exposed to new developments in fisheries technologies. Therefore, it is suggested that JICA will assist AFRC in two ways. First, JICA is to promote AFRC as the host for Japanese researchers and graduate students in order to facilitate an exchange between the two sides. Second, short-term experts should give advice to AFRC researchers when regional training courses are organized in Mauritius and experts are dispatched from Japan.

8. LESSONS LEARNED

- During the project, many of the AFRC staff members were trained in Japan in the use and maintenance of the equipment that they would use for their research activities. Yet, no further relationship was established between them and the manufacturers and dealers in Japan. Once the guarantee period was terminated, it was very difficult for AFRC to get supplies and spare parts. In order to address this problem, it is suggested that JICA set up a system for supplied equipment where it will facilitate communication between the counterpart organizations and the distributors of equipment in Japan.
- Technical assistance to enhance research activity for resource conservation can be very effective when it comes with the introduction of a legislative framework and the strengthening of law enforcement. Therefore, it is recommended that, when the research component of a similar project is proposed, the planner will carefully examine the needs and readiness of the relevant legislative and administrative branches of the Government to utilize the enhanced research capacity.
- Main functions of the technical unit for aquaculture development are usually to improve and develop seed production techniques, ensure good brood stock and provide guidance and advice to the private sector. The technical unit may not have sufficient financial resources to expand its resource propagation programs but it has the technical and physical capacity to produce sufficient seeds. Therefore, effects of technical assistance for seed production techniques for resource propagation can be further enhanced if the planner examines and set strategies on how propagation programs should be expanded after seed production techniques have been transferred.

ANNEX

Annex 1: List of the key informants and interviewees

Identification	Responsibilities
Mrs. Nirmala BOODHOO	Permanent Secretary in the Ministry of Agro Industry and Fisheries
Mr. Munesh MUNBODH	Chief Fisheries Officer
Mr. Satish HANOOMANJEE	Scientific Officer
Mr. Atmanun VENKATASAMI	Ag Principal Fisheries Officer
Dr A. LAXIMINARAYANA	Advisor in the Ministry of Agro Industry and Fisheries
Mr. Vinod B. D. RATHACHAREN	Divisional Scientific Officer, Marine Science
Mr. V. SOONDRON	Divisional Scientific Officer, Fisheries Research
Mrs. S. RATHACHAREN	Divisional Scientific Officer, Aquaculture
Mr. S. K. KHADUN	Scientific Officer, Fisheries Research
Mr. S. RAMSAHA	Scientific Officer, Aquaculture
Mr. S. JEETAH	Scientific Officer, Aquaculture
Dr. Mitrasen BHIKAJEE	Director of Mauritius Oceanographic Institute
Dr. Asha D. POONYTH	Project Officer, Mauritius Oceanographic Institute

Annex 2: References

N°	Title
1	“Preliminary survey report”, JICA and Ministry of Fisheries, August 1994
2	“Record of the discussion between Japanese Implementaion survey team and Authorities concerned of Government of Mauritius, JICA and Ministry of Fisheries, September 1995
3	“Final evaluation survey report”, JICA and Ministry of Fisheries, July 2000
4	“Evaluation report on the Follow up project for Coastal Fisheries and Environmental Conservation Project in Mauritus”, JICA and Ministry of Fisheries, April 2002
5	“Ministry of Fisheries Annual report 2001”, Ministry of Fisheries , 4 th edition, June 2004
6	“Ministry of Fisheries Annual report 2002”, Ministry of Fisheries , July 2004
7	“Ministry of Fisheries Annual report 2003”, Ministry of Fisheries , January 2005

Annex 3: List of Equipment

Facilities and Equipment	Year installed	Condition *	Utilization**	Reason(s) - when utilization is low	Problem(s)	Remarks
Artemia inoculation tank	1995		Occasionally	During SIC		
UV Water filtration system	1995		Frequently			
Vinyl tube	1997, 00, 01, 02		Frequently			
Flexible hoses	1997		Frequently			
Digital balance	1999		Frequently			
Oxygen diffuse			Frequently			
Plankton net	1996, 00, 02		Occasionally			
Polyethy net	2000		occasionally			
Flexible hoses	2000, 02		Frequently			
Polycable tank	2002		Frequently			
FRP tank	1997		Frequently			
UV filter	1995		Not in use	No spare part	Broken	
Water pump	1995		Not in use	No spare part	75% broken	
Cold room	1995		Not in use		Broken	
pH meter	1996		Frequently			
DO meter	1996		Not in use		Broken	
Digimatic calipea	1996		Frequently			
Digimatic miniprocessor	1996		Frequently			
Large net	1996, 1999		Frequently			
Cartridge filter	1996, 00, 02		Frequently			
Micropipette			Frequently			
Polycarbonate	1996		Frequently			
Inverted microscope	1996		Frequently			
Air blower	1997, 99		Occasionally	During SIC		

Saline mater	1997		Frequently			
Air pump	1997		Not in use		Broken	
Titanium meter	2002		Frequently			
Sawing machine	1999		Occasionally			
Facilities and Equipment	Year installed	Condition *	Utilization**	Reason(s) - when utilization is low	Problem(s)	Remarks
Live fin	1995		Frequently			
Acer computers (PC Pentium 2)	1998	Good	Occasionally	Computers outdated, incompatibility	Low memory space	
HP Deskjet printer (colour)	1998	Good	Frequently			
UW video camera Carl zeiss and housing	1998	Good	Occasionally			
Sony digital camera and housing	2000	Good	Frequently			
Camera Nikonos	1998	Good		Use of digital camera is easier and faster		
Camera Nexus Master	2000	Good		Use of digital camera is easier and faster		
GPS Garmin	2000	Good	Frequently		Spare part unavailable	Model obsolete
Diving equipment	1998	Good	Frequently		Spare part unavailable	Model obsolete
Mercury analyzer	1999	Unable to use			Spare part unavailable	Model obsolete
Auto analyzer	1996	Unable to use				
Atomic Absorption Spectrometer	1999	Unable to use				
High performance liquid	1999	Good	Occasionally			

Chromatograph						
Distillation apparatus	1996	Good	Frequently			
Drying oven	1996	Good	Frequently			
Spectrometer	1996	Good	Frequently			
Bacteriology laboratory						
Incubator	1996	Good	Frequently			
UV sterilizer (Millipore)	1996	Good	Frequently			
Electrical balance	1996	Good	Frequently			
Centrifuge Kokusan	1996	Good	Frequently			
Autoclave Hirayama	1996	Good	Frequently			
Deionised distillery	1996	Good	Frequently			
Incubation box	1996	Good	Frequently			
Mermet oven	1996	Good	Frequently			

Classifications:

*Condition: Good, Fair, Poor, unable to use

**Utilization: frequently used, occasionally used, used sometimes, rarely used, not in use

Annex 4: Questionnaire formats

Questionnaire

Questionnaire to the Ministry of Fisheries and Cooperatives

Part I: Request for information

1. Please provide documents indicating relevant government policies relating to AFRC.
2. Please also provide documents showing the Government's policy for the promotion of fish culture and conservation of coastal resources.

Part II: Questionnaire

Q1: AFRC's Mission

Has the Ministry's policy on the role of AFRC changed? If yes, how has it changed?

- No
- Yes

If the answer is Yes, please state new missions, roles, challenges, etc:

Q2: AFRC's performance

From the perspective of the Ministry, the current performance of AFRC is:

- much more than expected.
- almost as good as expected.
- less than expected.
- very poor..

Please state the reason(s):

Q3: Government strategy for AFRC

The main objective of the project was to increase the research capacity of AFRC; however, it is unclear to the evaluator how the Ministry intends to make use of the increased research capacity of AFRC. For instance, the project placed its focus on the mass propagation of mangrove crab and sea bream. Yet, the rationale for having selected these species as well as a strategy for propagation is

not clear. Similarly, it is unclear to the evaluator how the results of environmental monitoring at selected coastal areas are utilized. Please briefly state how AFRC has contributed to achieving the goals of the current plan of the Ministry in the following fields respectively.

(1) Resource Propagation:

(2) Coastal Ecosystem Research:

(3) Coastal Environment Research:

Thank you very much for your cooperation.

 Questionnaire

Questionnaire to AFRC

Part I: Request for information

1. Please provide the following information/data:

- Annual reports of AFRC (2002 – 2005)
- List of publications (papers, reports, guidelines, manuals, leaflets, etc.) (2002-2005)
- The latest organizational chart of AFRC and a staff list
- Financial records (Annual budget allocation) for 2002 – 2005

2. Please provide the following information in the format shown below:

2.1 Seed production (Unit: 1,000)

Species	1 st year	2 nd year	3 rd year	4 th year	5 th year	6 th year	7 th year	8 th year	9 th year
Black tiger shrimp	150	538							
Sea bream	34	198	85	93					
Mangrove Crab	186	0	1600	2951	4486				

* The figures above are from the Appendix 5 of the evaluation report of July 2000.

2.2 Distribution of fish, crab and shrimp

Species		Released during the project period (Dec. 1995 – Dec. 2000)	Released since the termination of the project up to day
SEA BREAM	RELEASED TO LAGOON:	50,780	
	DISTRIBUTED TO BARACHOIS:	72,678	
	OTHERS:		
Crab	Released to Lagoon:	2,217	
	Others:		
Shrimp	Released to Lagoon:	155,098	
	Distributed to private farms:		
	Others:		
Other species			

2.3 Record of Coastal environmental monitoring

Year	Monitoring (Number of sites)			Total
	Regular monitoring	Barachois Study	Extra study	
1996	37	6	9	52
1997	40	13	9	62
1998	46	8	26	80
1999	46	6	29	81
2000	39		5	44
2001	63		27	90
2002	53		33	86
2003	49		15	64
2004	54		18	72

2.4 Record of coastal ecosystem monitoring

Site	Monitoring (Number of sites monitored)											
	1 (June-Oct.98)	2 (Jan-May 99)	3 (Jul-Oct 99)	4 (Jan-May 00)	5	6	7	8	9	10	11	12
Albion	2	2	2	2								
Pointe aux Sables	2	2	2	2								
Trou aux Biches	2	2	2	2								
Anse la Raie	2	2	2	2								
Trou d' Eau Douce	2	2	2	2								
Bambous Virieux	2	2	2	2								
Bel Ombre	2	2	2	2								
Ile aux Benitiers	2	2	2	2								
Baie du Tombeau				2								
Poudre d'Or				2								

3. Current conditions of the facilities and equipment procured during the project

Please list all the main equipment procured during the project and indicate the current status of O&M, using the format shown below:

Facilities and Equipment	Year installed	Condition *	Utilization**	Reason(s) - when utilization is low	Problem(s)	Remarks

Classifications:

*Condition: Good, Fair, Poor, unable to use

**Utilization: frequently used, occasionally used, used sometimes, rarely used, not in use

Part II: Questionnaire

Q1: Please list important contributions and achievements of AFRC after the termination of the project (e.g. AFRC's contributions to a Government policy formulation for coastal resource conservation, academic society, the general public for awareness raising, etc.)

- 1.
- 2.
- 3.

Q2: In your assessment, what are the positive effects of the Project? Please list 3 major effects.

Effects to the AFRC and its staff:

- 1.
- 2.
- 3.

Q3: Effects to other organizations, fishery-related establishments, local communities and general public:

- 1.
- 2.
- 3.

Q4: What are the current problems or new challenges for AFRC?

- 1.
- 2.
- 3.

Annex 5: Interview note

Project Title: The Coastal Fisheries Resources and Environment preservation in Mauritius

Date: October 13, 2005

Informant: Aquaculture department

1. Mr. S. RAMSAHA
2. Mr. S JEETAH
3. Mr. S.K. KHADUN

Results and findings:

History of aquaculture:

Introduction of freshwater shrimp by Japanese in 1970, introduction of giant freshwater prawn and beginning of collaboration between Mauritian and Japanese in 1982 followed by extension to develop private sector.

Private sector is not interested because of lack of market, then release program in lagoon and marking program

Reasons of stopping or discontinuing of production for different specie:

Mangrove crab: low survival rate, not efficient

Giant tiger prawn: stopped in 2002 caused by private sector failure and problem of equipments; resumed in 2004 because of Indian cooperation

Giant freshwater prawn: seed production stopped in 2000 because of high cost of production caused failure of private sector; small farmers do not have enough money for investment, change of activities for big investment. Resumed in 2003 by governmental initiative.

Culture in barachois: reduction of barachois number because of low level of water, water circulation is not intense, water salinity is very high and there is no regular monitoring.

Equipment:

During cooperation, Japanese side had budget for regular maintenance

After the follow up of the project, maintenance is not ensured because of lack of spare parts and budget. Now, equipments are more than 10 years old and must be renewed

Lack of qualified personnel to do any repairing

Solution: The managers have already tried to contact manufacturers to change spare parts and requested the Ministry of Fisheries but it didn't have budget for buying of spare parts (example: motor for water pump is around 70million Rupees). Reparation of big equipments is very difficult.

Besides, the center tries to use local equipment to maintain its activities.

Fish farmer request:

Around 50 fish farmers per year come to the center to get information

The request is about: juvenile and fingerlings supply, technical help.

Big farmer come also to request technical advice for red drum culture.

The problem is the lack of equipments for monitoring and for helping small farmers

Impact to project purpose

1. Objective on seed production was reached but there are problems:

- Lack of parents brooders
- adults recapture in lagoon is difficult
- existing of disease such as *Oodinium*

2. For release: it is important to know the movement, displacement and growth of fish.

About release and recapture: survival rate of fish after marking is low around 40% and marking with tag is not successful because of loss of tags. Recapture rate is only 2%. The program has stopped and now the center focuses only on production and release.

Project Title: The Coastal Fisheries Resources and Environment preservation in Mauritius

Date: October 13, 2005

Informant: Fisher man

Place: Tamarin

Results and findings:

About Tamarin: there are 156 fishers, sport fish club, governmental fishing cooperative, fisheries post.

Types of fish: Tuna, yellow fin,

Fishing technique: line fishing

Place of fishing: in lagoon and off lagoon, to FAD around 5km to the village.

Quantity of fish captured: 200 to 300 kg per day

Situation of fish production: reduction of fish in 1985, construction of the FAD

About fish farm:

Fish farm is not developed in Mauritius and there is problem of Policy of fish management and Coastal resources protection.

Barachois also is not developed because of bad quality of water and the low level of water.

Fishing in lagoon and off lagoon:

In lagoon: during the year or when the fish off lagoon decreased, particularly from October to February.

Off lagoon: from June to august

Problems:

- The Governmental Policy of management and protection of coastal area and fishing is unclear.
- Pollution from highland and destruction of the ecosystem in lagoon
- Constructions near the beach for tourists are very developed and reduce area of fishing
- The costs of fish investment is around 200,000 to 300,000 Rupees (price of outboard motor, boat...) and recovery is more difficult for fishers

About fish institutions: Interviewee knows about AFRC but he has not received training in training center.

The cooperative is set up by the Government not by fishers and interviewee doesn't sell his products to the coop but to others.

Interviewee's wish: clarification of government policy in terms of management of marine and coastal resources.

Project Title: The Coastal Fisheries Resources and Environment Conservation in Mauritius

1. Data: October 05, 2005

Informant: AFRC Management

Place: AFRC Office

Results and findings:

Policy on fisheries and role of AFRC:

The fisheries division has a ten year Fisheries Development Plan developed with FAO in 1998 and runs until 2008.

Actually, the Ministry develops five years Development Plan which determine the policy of Ministry. This plan focused on 7 points.

The government definite the priority about fishing activities.

AFRC keep some roles in this plan with the Ministry through this priority like: to be a Facilitator, to grant different services for people as permit for fisherman and results of research for the public.

AFRC produce every year an annual report for the Ministry of Agro Industry and Fisheries

Aquaculture:

Existing of 33 barachois (12 private barachois) who does not productive and know negative aspect for AFRC.

Integrated and development project on barachois are planned to strengthen aquaculture in barachois.

About species: Sea bream production is on going again, shrimp farm began on 1997 with different species; production marine shrimp was stopped on 2003 because of high capital investment and inexistence of sea water park.

Collaboration:

To maintain AFRCs reputation and activities, AFRC has close collaboration with private sector for activities demonstration; to analyze project feasibility, prevent conflicts between population and private sector and solve problem.

Close collaboration also with Ministry and Promoters in fish sector.

The collaboration with Cooperative is not effective because there is only one Cooperative of fisherman; AFRC help this one.

AFRC have collaboration with veterinary by giving Quality Certificate.

With fisherman AFRC give training for them concerning fish production and commercialization.

Project Title: The Coastal Fisheries Resources and Environment Conservation in Mauritius

Informant: Counterparts in different division

Place: AFRC Office

Results and findings:

Aquaculture division:

Equipment:

The aquaculture division has some problem with equipment:

- water filter is not working but technical use small filter and clean it very often, new sent filter in 1995
- UV fertilizer is not in use
- Some equipment is sophisticate and the spare parts not available in local market
- The sea water pump must be change but the cost is very high around 3 million Rupees

Equipment problem has no effect in the program but the technical staff still being their work more difficult.

Solution is: government tries to look for finance and buy new equipment but the budget restricted only around 3 million Rupees a year.

Collaboration:

The collaboration with small fisherman is free but individual or small farm is not so much. AFRC is interested by small square group to diversify activities but the economic impact is small.

AFRC does technology transfer for private sector about aquaculture in fresh water view the degradation of sugar cane growing.

Realization:

Stock assessment in lagoon for 9 species

Sea bream culture since 1998 to 2002

Marking and tagging for 810 000 fish in different places

Publication about sea bream, publication of hand book at local level, 2 publication of annual meeting, 4 publication on National Marine Science Forum.

Perspective:

Development of aquaculture by new specie like baramundii for fresh water

Development of collaboration with Mauritius Research Council about integrated problem for using cool water

Ecosystem and environmental monitoring

Ecosystem monitoring:

Lots of technical staff received training after the end of the project about: how to do monitoring, to choose station, to collect data.

Ecosystem monitoring team have know how to monitor coral reef in 8 sites through: collecting information; data collect (taxonomy, fish species), methodology to manage coral predator, identification of new specie and training junior staff on data collection.

Most of equipment on this division still used like computer, printer, GPS...

Environmental monitoring

Existing of additional site for environmental monitoring.

Presentation of results and collaboration with Lagoonal Monitoring Committee composed by Ministry of Fisheries, Ministry of Health, Ministry of economy...

For coliform bacteria and sanitary monitoring water; 12 to 13 sites are monitored and need more for public beach and for decision maker about beach management (opening or closing of the beach, access of 2 closed public beach for swimming))

Listing of toxic fish and sensitization of the public about toxic fish

Existing of cross checking inter laboratory and results comparison with Mauritius Oceanographic Institute, Ministry of Environment, National Environmental Laboratory

Perspective:

- maintain relationship between JICA and technical staff
- refreshing courses and new training about new parameters by short time expert
- to train personnel for other field like sediment analysis

Project Title: The Coastal Fisheries Resources and Environment Conservation in Mauritius

Informant: Mr. Satish HANOMANJEE (Scientific Officer)

Place: Ministry of Agro Industry and Fisheries Office

Results and findings:

Discussion and documentation about budget and personnel.

Discussion about aquaculture:

The different species for aquaculture: sea bream, shrimp, sea cucumber, crab

Silver sea bream is successful because it is an important marine fish species in Mauritius; it is highly appreciated due to its white flesh and very good taste, high price in local market and great commercial value.

Berri fish compose 85% of total catch fish.

Other project:

- culture of berri rouge for private sector but they have a problem concerning marketing, consumers prefer sea water fish and request is very low.
- Baramundii from Australia increase aquaculture production but it is mainly about cage culture.
- Erd drum: production of 400 t for one big fish farm

Actually restocking program is stopped because:

- it is capially project
- land near the sea side is expensive
- existing of competition with shrimp farming in Madagascar and other countries

Stock assessment with FAO and South African technical cooperation is not effective because of very low quantity recapture.

Banking in lagoon is important for aquaculture but it is actually in preliminary stage.

Perspective:

To encourage private sector in aquaculture

Summary

Evaluation conducted by: JICA Madagascar Office

1. Outline of the Project		
Country : Mauritius		Project title: The Coastal Fisheries Resources and Environment Conservation Project
Issue/Sector : Fisheries		Cooperation scheme: Technical cooperation
Section in charge : Fisheries Cooperation Department		Total cost (equipment and project operation costs only): Technical cooperation project: 162 Million yen Follow-up: 22.6 Million yen
Period of Cooperation	Technical cooperation project: December 1995 – November 2000	Partner Country's Related Organization: Albion Fishery Research Center (AFRC)
	Follow-up: December 2000 – November 2002	Supporting Organization in Japan: N/A
Related Cooperation	Prior to the project, JICA supported AFRC as follows: ① Grant aid for the construction of AFRC in 1982 ② Grant aid for experimental facilities (fish ponds, etc.) in 1986 ③ Dispatch of long-term experts since 1991	

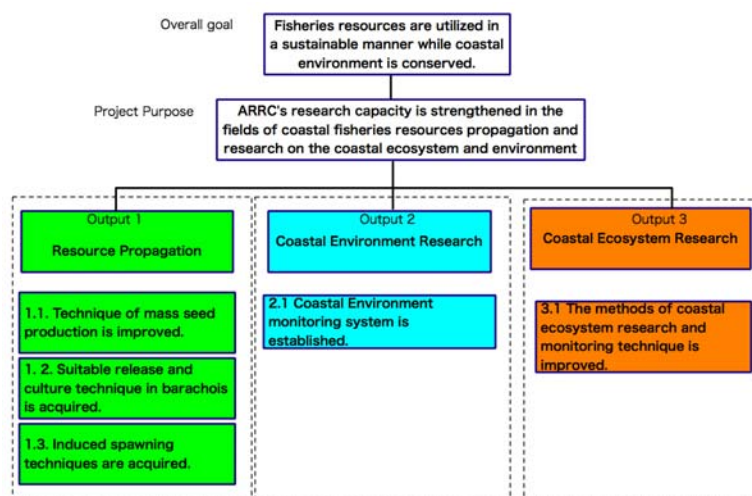
1-1. Background of the Project

In its 6th National Development Plan (1992-1994), Mauritius regarded the improvement of fishery research as an essential task for making the best use of ocean resources on a sustainable basis. The AFRC was then the only institute in Mauritius, conducting studies on fishery and marine resources. A technical cooperation project was requested with the objective of enhancing the capacity of the center with regard to the conservation of coastal resources and the environment. In response to the request, the Japanese Government agreed to implement “The Coastal Resources and Environment Conservation Project”. The project was implemented for 5 years.

The project helped AFRC build research infrastructure in AFRC and develop the capacity of the researchers in resource propagation, coastal environment research and coastal ecosystem research. Through the project activities, several scientific papers and articles were published. The counterpart personnel had significantly enhanced their capabilities. Yet, some of the important activities planned at the beginning of the project were not complete. The Mauritius and Japanese sides agreed to extend the project for two years as the follow-up of the project.

1-2. Project Overview

(1) Framework of the project



The follow-up of the project focused on the following fields:

1. Resource propagation of seed production of Mangrove Crab and Sea Bream.

2. Improvements of techniques in marking, release and recapture (Sea Bream)

Improvements of the methods of coastal ecosystem research and monitoring techniques relating to corals.

(2) Inputs

Inputs	Technical cooperation project (1995-2000)	Follow-up (2000-2002)
Japanese side:		
Long-term experts	5 (300 M/M in total)	3 (72 M/M in total)
Short-term experts	14 (13 M/M in total)	3 (4 M/M in total)
Training in Japan	14 researchers	4 researchers
Equipment	137 Million Japanese yen (30.8 Million rupees)	17.7 Million Japanese yen (3.98 Million rupees)
Operation cost	25.6 Million Japanese yen (5.8 Million rupees)	4.9 Million Japanese yen (1.1 Million rupees)
Mauritius side:		
Counterpart personnel	12 researchers	8 researchers
Recurrent budget	45.4 Million Japanese yen (10.2 Million rupees)	22.5 Million Japanese yen (5 Million rupees)
Other inputs	Land, buildings, utilities, etc.	Land, buildings, utilities, etc.

(1 Japanese yen = 4.45 rupee)

2. Evaluation Team

Members of Evaluation Team	Mr. Rajaobelina Haja (Programme officer, JICA Madagascar Office) Mr. Rasoanarivo Hariliva (Consultant) Mr. Kaneyasu Ida (IC Net Limited)	
Period of evaluation	October 1 – October 28, 2005	Type of Evaluation : Ex-Post Evaluation

3. Results of Evaluation

3-1. Summary of Evaluation Results

(1) Impact

The project aimed at enhancing the research capacity of AFRC in the fields of aquaculture, coastal environment and ecosystem. The impacts of coastal environment and ecosystem components of the project have been strong and those of the aquaculture component is yet limited. The following are the impacts of the project identified by the evaluation team.

1) Coastal environment and ecosystem

AFRC's coastal environment monitoring activities have a direct impact on the conservation of the coastal environment because a coordination mechanism has been established where the concerned authorities share monitoring results produced by AFRC and take measures when a negative impact on the coastal environment is recognized. AFRC is also actively involved in formulating and updating relevant regulations.

As for water quality monitoring, AFRC regularly submits the results of coastal environment monitoring to the inter-ministerial coordination committee. When the result of monitoring exceeds an accepted level on any parameter and the same situation persists for a certain period of time, the committee is authorized to order the authority concerned to take action. The monitoring activities also benefit tourists and the tourism industry. One obvious benefit is that tourists are ensured the safety of the beaches. Beach authorities also benefit. When the monitoring results prove positive, they can promote the safety of their beaches. When negative, they will know what measures should be taken to improve the sanitary condition of their beaches. So far, monitoring is conducted for 13 beaches. Currently, two out of three beaches in Port Louis are closed due to an excessive level of Coli forms.

Results of water quality and coastal ecosystem monitoring are used for Environmental Impact Assessment (EIA). In compliance with the Environment Protection Act of 2001, the Environment Coordination Committee was established in 2002, consisting of the relevant government agencies, NGOs, universities and research institutes. Since then, monitoring data produced by AFRC are widely used for EIA purposes. In fiscal year 2003, the Ministry of Agro-Industries and Fisheries examined 61 EIA applications for coastal development (e.g., construction of breakwaters, dredging of lagoons and upgrading of beaches) and forwarded recommendations to the Department of Environment. Monitoring data are also provided to various stakeholders of coastal development projects.

2) Resource propagation

The impact of the fish release program is not significant. The number of fish stocked in lagoons has not been great. Only 2% of fish released is recaptured. Also, marking, branding and tagging prior to release has been discontinued because the marking process increase the mortality rate of fish by 60%, and the tags came off easily and the tag numbers often faded away. Therefore, it is impossible to assess the impact of the program.

Distribution of fish, crab and shrimp

Species		Released during the project period (Dec. 1995 – Dec. 2000)	Released on 2001 to 2004
Sea Bream	Released to Lagoon:	50,780	1,167,700
	Released to Barachois	72,678	Stopped
Crab	Released to Lagoon:	2,217	Stopped
Shrimp	Released to Lagoon:	155,098	85,650
	Released to Barachois		10,000

(Source: AFRC)

The fiscal and economic impact of the aquaculture is also still quite limited. Fish production of aquaculture on the coastal areas has been less than 500 tones a year. Fish farming on the coastal areas has not attracted investors because of costly initial investment cost such as land price. Currently, investment in tourism seems to be regarded as a more feasible option for them. For the same reason, artisanal fishers have little capital for investment. The fishers that the evaluation team interviewed also stated that they would prefer to invest in fishing gears including boat and engine as there are still good opportunities for pelagic fish like yellow fin tuna.

(2) Sustainability

1) Inputs

The budget allocated to AFRC for research and operation is maintained at the same level as the time of the Project: approximately 3.0 Million rupees per year. The center has around 93 officers composed by 60 scientists and 33 administrators. Most of the researchers worked under the project have remained in the center.

2) Outputs

Coastal Environmental monitoring:

Coastal environment monitoring was initiated by AFRC in cooperation with the Canadian Government at eight sites prior to the project. During the project, two more sites and more parameters on chemical residues were added. To date, AFRC regularly monitors water quality on 17 parameters at 15 sites, and plans to set up three more sites where wastewater treatment plants are scheduled to be constructed. AFRC also monitors trace metal and residual pesticides at eight sites in Mauritius and five sites in Rodrigues in order to assess the impact of industrial activities and the impact of pesticides used for sugar cane cultivation.

Coastal ecosystem research:

During the project, data on 330 fish species were collected (This represents two-thirds of the reported fish species in Mauritius) and 50 coral species were identified. By the end of the follow-up period, 154 species were identified (From the bio-geographical point of view, it is assumed 282 species might exist in Mauritius.). COREMO (Coral monitoring software) was introduced for data analysis in ecosystem monitoring. "Field guide to Corals of Mauritius" was published. Through this activity, AFRC researchers have obtained important know-how in coral taxonomy. Regular monitoring on coastal ecosystem started in 1998.

After the project, AFRC has continued to conduct monitoring activity at all of the sites selected during the project, using the same methodology as the researchers learned from the experts. One site has been added since 2004. More sites are scheduled to be introduced. Data such as percentage cover of substrate (coral, algae and abiotic) and abundance of fish, sea urchins and sea cucumbers are collected. Monitoring results are added to the database and used by other agencies for decision making on the approval of various development projects such as sewage installation and hotel development projects that would affect the ecosystem in the coastal zone.

While AFRC monitors the impact of human activities that potentially threaten the coastal ecosystem, it also manages to protect coral reefs from natural processes such as the outbreak of crown of thorns starfish (*acanthaster planci*). To date, regular monitoring enables the researchers to identify abnormal increase of crown of thorns. In 2003 and 2004, an increase of crown of thorns on a small scale was identified at three sites and the infestation was controlled by injection of dry acid.

Resource propagation:

On shrimp culture, the sustainability of the project's output is rather low except for the production of giant freshwater prawn (*Machrobrachium resembergii*) that started in 2003 and continues to get good results as the table below shows. At the moment, the center tries in this way to maintain different and new species to ensure that the seed production is sustainable. But some species production and propagation have stopped, e.g., giant tiger prawn for seawater (*Panaeus monodon*) and red drum for fresh water because of high cost of investment. Concerning sea breams (*Rhabdosargus sarba*), 292,000 sea bream fry were produced in 2003, which is fewer than 338,000 in 2002. The number continued to decrease as the table below shows but sea bream production is one of the main activities of seed production with a good chance for sustainability because it is appreciated by consumers.

Seed production by AFRC for the last five years

Species/Year	2001	2002	2003	2004	2005
Giant tiger prawn for seawater (<i>Panaeus monodon</i>).	232,000	204,100	61,700		
Berri rouge for fresh water (<i>Oreochromis sp.</i>)	18,795	31,485	85,472	20,055	
Camaron for fresh water (<i>Machrobrachium resembergii</i>)			120,000	625,200	113,000
Sea breams (<i>Rhabdosargus sarba</i>)	182,000	338,200	292,000	255,000	275,000

(Source: AFRC)

3-2. Factors that have promoted project

(1) Impact

The overriding factor was the timely introduction of various legislative measures by the Government for environmental protection and conservation. Since the Environment Protection Act was enacted in 2001 (one year before the termination of the project), amendments have been made and regulations and their requirements under the Act strengthened (AFRC played important role in the preparation of standards and regulations.). Therefore, results of studies conducted by AFRC are effectively used by various stakeholders.

3-3. Factors that have inhibited project

(1) Impact

The progress of the aquaculture component has been slow due to the following reasons:

- The lack of the master plan on research and seed propagation activities to develop the exploitation of underutilized resources and diversify aquaculture is an inhibiting factor for the development of AFRC activities.
- The tagging and marking program was discontinued due to technical problems. Therefore, it is difficult to measure the effects of the stocking program.
- Some equipment items for the aquaculture department are out of order. This is a detrimental factor for AFRC because it caused the reduction of certain activities, particularly in broodstock and seed production.

(2) Sustainability

A factor inhibiting the sustainability of the project is the workload in the center because AFRC is the only division that provides technical support in fisheries and technicians and scientists have to do too much paper work and attend too many meetings. This factor sometimes disrupts their research activities. At the governmental level, the activities of the center cannot be much further developed because of the restriction on the budget of the Ministry of Agro Industry and Fisheries. The total budget for the technical department of the Ministry of Fisheries as AFRC is only around 3 million Rupees each year.

3-4. Conclusions

In summary, the project was largely successful. It produced different positive impacts on environmental protection level and improvement of its technical and scientific capacity in terms of environmental and ecosystem monitoring. The center is self-reliant particularly in these fields. For the aquaculture component, the center tries to do its best to identify and introduce new species through research, increase in seed production and sites of propagation in spite of the equipment problem. But this component has not yet fully developed to have a tangible impact on resource propagation or fish production.

3-5. Recommendations

To AFRC and the Ministry of Agro-industry and Fisheries

- Currently, the Ministry of Fisheries along with AFRC is planning to develop a master plan for aquaculture development. It is recommended that the Ministry will give this task a higher priority, provide necessary support to AFRC and complete the plan as soon as possible so that AFRC can concentrate its efforts and allocate its resources on prioritized activities. In the preparation of the master plan, a detailed feasibility study with focus on marketability should be conducted to identify the species to be promoted.
- AFRC should always ensure sufficient inputs and resources for regular monitoring activities. In 2001, administrative restructuring of AFRC and its subsequent delay in administrative procedures resulted in the interruption of coastal ecosystem monitoring. If there were any interruption in longitudinal monitoring as coastal ecosystem monitoring, the data's reliability would be significantly affected. In order to avoid such a risk, it is suggested, if regulations permit, that a minimum budget (and if possible, the sufficient number of staff) required for maintaining daily activities be secured at annual planning and reimbursable flexibly for designated expenditure items. This way, regular monitoring can be continued without being affected by change in external environment.
- Many of AFRC's activities directly benefit the private sector, particularly the tourism industry. AFRC's budget is limited to approximately three million rupees per year, rendering it very difficult to expand such programs as fish stocking in the lagoons. Therefore, it is recommended that AFRC pursue the possibility of raising fund by involving the users of the coastal resources in AFRC's program. One way of promoting the program is to make it a joint program between the public and private sectors where AFRC distributes juvenile fish at an affordable price to member companies or civil societies, and they stock fish for their events as an environmental conservation activity. In order to solicit support for the program from the public as well as the users of coastal resources, AFRC will need to launch a campaign to promote the program and publicize its achievements.
- The Ministry of Fisheries should ensure that the sufficient number of researchers is allocated for AFRC so that the researchers can concentrate their efforts on research activities.

To JICA

- Although the capacity of the researchers in regular and research activities has been well developed, they need to upgrade their techniques and skills. Yet since the end of the project, they have had limited opportunities to upgrade their technical know-how and skills as well as be exposed to new developments in fisheries technologies. Therefore, it is suggested that JICA will assist AFRC in two ways. First, JICA is to promote AFRC as the host for Japanese researchers and graduate students in order to facilitate an exchange between the two sides. Second, short-term experts will give advice to AFRC researchers when regional training courses are organized in Mauritius and experts are dispatched from Japan.

3-6. Lessons learnt

- Technical assistance to enhance research activity for resource conservation can be very effective when it comes with the introduction of a legislative framework and the strengthening of law enforcement. Therefore, it is recommended that, when the research component of a similar project is proposed, the planner will carefully examine the needs and readiness of the relevant legislative and administrative branches of the Government to utilize the enhanced research capacity.
- Main functions of the technical unit for aquaculture development are usually to improve and develop seed production techniques, ensure good brood stock and provide guidance and advice to the private sector. The technical unit may not have sufficient financial resources to expand its resource propagation programs but it has the technical and physical capacity to produce sufficient seeds. Therefore, effects of technical assistance for seed production techniques for resource propagation can be further enhanced if the planner examines and set strategies on how propagation programs should be expanded after seed production techniques have been transferred.
- During the project, many of the AFRC staff members were trained in Japan in the use and maintenance of the equipment that they would use for their research activities. Yet, no further relationship was established between them and the manufacturers and dealers in Japan. Once the guarantee period was terminated, it was very difficult for AFRC to get supplies and spare parts. In order to address this problem, it is suggested that JICA set up a system for supplied equipment where it will facilitate communication between the counterpart organizations and the distributors of equipment in Japan.

事後評価調査結果要約表

評価実施部署：マダガスカル事務所

1. 案件の概要	
国名：モーリシャス	案件名：沿岸資源・環境保全計画
分野：水産	協力形態：プロジェクト方式技術協力
所轄部署：森林・自然環境協力部水産環境協力課	協力金額：1.62 億円 (機材費と現地業務費の合計)
協力期間	プロジェクト： 1995 年 12 月～2000 年 11 月
	フォローアップ： 2000 年 12 月～2002 年 11 月
先方関係機関：アルビオン水産研究所	日本側協力機関：なし
他の関連協力	本案件に先立ち以下の協力が実施された。 ① 無償資金協力によるアルビオン水産研究所の建設 (1982 年) ② 無償資金協力による養殖実験施設建設 (1986 年) ③ 長期専門家派遣 (1991 年)
1-1. 協力の背景と概要 モーリシャス政府は、第 6 次国家開発計画 (1992-1994) で、持続的な海洋資源の活用のために水産研究の改善が不可欠であるとした。アルビオン水産研究所は同国における水産海洋資源に関する唯一の研究機関だったため、同国政府は日本政府に対して、沿岸資源・環境保全に関する同センターの能力向上を目的とした技術協力プロジェクトを要請した。これに対して、日本政府は 5 年間の「沿岸資源・環境保全計画」の実施に合意した。 本プロジェクトは、資源増殖、沿岸環境、沿岸生態の 3 分野で、同センターの基礎的な研究基盤の確立と研究員の能力開発を支援した。プロジェクト活動の結果、研究員の研究調査能力は大幅に向上し、各分野で科学論文が執筆・出版された。しかし、当初計画された中に、技術移転が不十分な項目が残ったため、両国政府は、プロジェクトを 2 年間、延長 (フォローアップ) することに合意した。	
1-2. 協力内容 (1) プロジェクトの枠組み	
<pre> graph TD A[上位目標 沿岸水産資源の利用と沿岸環境の保全が 継続的に行われる] --> B[プロジェクト目標 沿岸水産資源の増養殖と生態系・環境調査について、アルビオン 水産研究所の研究能力が総合的に向上する] B --> C1[成果 1 資源増殖] B --> C2[成果 2 沿岸環境調査] B --> C3[成果 3 沿岸生態調査] C1 --> D1[1.1. 安定的な大量種苗生産手法が確立する] C1 --> D2[1.2. パラショアにおいて適正な放流と養殖手法を確立する] C1 --> D3[1.3. 適正な親養成手法を確立する] C2 --> E[2.1 沿岸環境モニタリングシステムを構築する] C3 --> F[3.1 沿岸生態研究とモニタリング技術の手法を確立する] </pre>	
フォローアップでは次の分野での技術移転が行われた。 1. ヘダイとアミメノユギリガザミの種苗生産技術 2. ヘダイの標識、放流、再捕技術 3. サンゴ礁に関する生態調査技術	

(2) 投入

投入	プロジェクト (1995-2000)	フォローアップ (2000-2002)
日本側		
長期専門家	5人 (合計 300ヶ月)	3人 (合計 72ヶ月)
短期専門家	14人 (合計 13ヶ月)	3人 (4ヶ月)
日本研修受入	14人	4人
機材	1億 3700万円 (3080万ルピー)	1770万円 (398万ルピー)
プロジェクト運営費	2560万円 (580万ルピー)	490万円 (110万ルピー)
モーリシャス側		
カウンターパート配置	12人	8人
プロジェクト運営費	4540万円 (1020万ルピー)	2250万円(500万ルピー)
その他の投入	土地、建物、電気水道費等	土地、建物、電気水道費等

(1円 = 4.45ルピー)

2. 評価調査団の概要

調査者	ラジャオベリナ・ハジャ (JICA マダガスカル事務所プログラムオフィサー) ラソナリボ・ハリリバ (コンサルタント) 井田光泰 (アイシーネット (株))	
調査期間	2005年10月1日～28日	評価種類：事後評価

3. 評価調査の概要

3-1. 評価調査の要約

(1) インパクト

本プロジェクトの主要コンポーネントは養殖と沿岸環境・生態調査の分野だった。評価調査の結果、沿岸環境・生態調査コンポーネントで大きなインパクトの発現が確認された。増養殖コンポーネントによるインパクトは限定的だった。

1) 沿岸環境・生態調査

アルピオン水産研究所による沿岸環境のモニタリング調査は、直接的に沿岸環境保全に貢献している。モーリシャスではプロジェクト期間中、関係機関の間に調整システムが確立され、モニタリング調査の結果が関係機関に共有されるようになった。このシステムでは、アルピオン水産研究所が水質モニタリングの結果を関連省庁の調整委員会に定期的に提出する。モニタリングの結果、調査項目の中で基準値を超えた値が検出され、その状態が一定期間続いた場合、同委員会は関連機関に対して改善措置をとるよう通告する。また、アルピオン水産研究所は、環境関連の法整備にも積極的に関与している。

沿岸環境モニタリングは観光産業にも貢献している。同研究所は13の海水浴場管理組合からの要請を受けて水質モニタリングを実施している。これにより、観光客は海水浴場の安全性を確認でき、管理組合も水質に問題があれば公衆衛生改善の措置をとることができるようになった。現在、モニタリング結果を受けて、ポートモリスの2ヶ所の海水浴場が大腸菌の基準値を超えたために閉鎖措置が取られている。

沿岸の水質と生態モニタリングの結果は、環境影響評価にも活用されている。2001年に制定された環境保護法に基づき、2002年には政府機関、NGO、大学・研究機関の代表者で構成される環境調整委員会が設置された。このため、2002年以降、同研究所のモニタリングデータは環境影響評価のために幅広く活用されるようになった。2003年度には、ラグーンの護岸・浚渫工事や海水浴場の開発など61件の沿岸開発プロジェクトの申請が提出され、水産省はモニタリングデータに基づき、環境保全の措置などを環境局に提案した。このように、アルピオン研究所のモニタリングデータは沿岸開発プロジェクトの事業者や研究者など広範な関係者に利用されている。

資源増殖

放流プログラムの影響力はそれほど大きくない。潟に放流された魚の数量はそれほど多くなく、その中でも再捕されるのはわずか2%である。また、マーキングを行うことによって魚の死亡率が60%増加し、タグ自体が外れやすい上にその番号も消えやすいことから、放流前のマーキングやタグ付けは現在行われていない。したがって、プログラムの影響を評価することは不可能である。

魚、カニ、エビの放流実績

種		プロジェクト期間中の放流数 (1995年12月～2000年12月)	2001年～2004年の放流量
鯛	潟に放流	50,780	1,167,700
	バラショア（沿岸の砂洲湖）に放流	72,678	中止
カニ	潟に放流	2,217	中止
エビ	潟に放流	155,098	85,650
	バラショア（沿岸の砂洲湖）に放流		10,000

(データ提供：アルビオン水産研究所)

養殖による財政的、経済的な影響もまだ非常に限られている。沿岸地域における養殖による漁獲高は年間500トン以下である。沿岸地域の養殖業は、土地購入などの初期投資費用がかさむため、投資家に魅力を感じさせるまでには至っていない。現在のところ、投資家にとっては観光事業への投資の方が収益性の高い選択肢となっている。地元漁民は投資できる資金をほとんど持っていないため、養殖業へ投資するとは考えづらい。評価チームがインタビューした漁民も、キハダマグロのような沖合漁業は今後も十分可能性があるため、むしろ船やエンジンを含む漁具に投資したいと語っていた。

(2) 自立発展性

1) 投入の継続性

アルビオン水産研究所の研究予算は約300万ルピーで、プロジェクト実施時とほぼ同額が配分されている。職員数は93人で、60人の研究員と33人の管理職員からなる。プロジェクトに参加したほとんどの研究員がプロジェクト終了後も継続して研究所に勤務している。

2) 成果の継続性

沿岸環境モニタリング

沿岸環境モニタリングはプロジェクト開始前に、カナダ政府の協力を得て着手された。プロジェクトを通して、2ヶ所のモニタリングサイトが追加され、化学分析のモニタリング項目も強化された。現在、研究所は15ヶ所のサイトを対象に17の検査項目について水質モニタリングを実施している。今後、汚水処理場の建設予定地などさらに2ヶ所を追加する予定である。また、研究所はモーリシャスの沿岸8ヶ所、ロドリゲス島沿岸5ヶ所で、重金属と残留農薬のモニタリングも実施し、サトウキビ生産など産業による沿岸環境へのインパクトを監視している。

沿岸生態調査

プロジェクトを通して330種の魚類標本（モーリシャスに生息する魚類の2/3にあたる）と50種類のサンゴが採取され、データベースに登録された。生態モニタリングのデータ解析のためにサンゴのモニタリング用ソフトウェアが導入された。また、「モーリシャスのサンゴ図鑑」が出版された。こうした一連の活動を通して、研究員はサンゴ・魚類の分類についてのノウハウを蓄積し、1998年からは沿岸生態モニタリングを開始した。

プロジェクト終了後もプロジェクトで採用された手法を活用して、選定された調査サイトでのモニタリングを継続している。2004年には新たに1サイトが追加され、さらにサイトを拡大する予定である。リーフ内のサンゴや藻類の分布状況、魚類、ナマコ、ウニの資源状況等のデータが収集されている。モニタリング結果はデータベースに入力されている。こうしたデータは下水処理やホテル建設など沿岸生態系に影響する開発行為の許認可の判断材料としても関連機関に活用されている。

また、同研究所では、経済活動による沿岸部の生態系へのインパクトをモニタリングすると同時に、オニヒトデ(*acanthaster planci*)などからサンゴを保護する活動も行っている。モニタリングにより、研究員はオニヒトデの異常繁殖を監視することが出来るようになり、2003年と2004年に3サイトで小規模なオニヒトデの高密度な繁殖を確認し、除去する等の活動を行った。

資源の繁殖

エビの養殖の場合、プロジェクト成果の持続可能性はやや低いと言わざるを得ない。ただ、2003年に始まったオニテナガエビ(*Machrobrachium resembergii*)の養殖は下記の表に示すとおり良好な結果を出し続けており、これは例外である。現時点で、センターは多くの新しい種をこのようにして維持し、種魚生産の持続可能性を保証したいと考えている。しかし、一部の種の生産と繁殖は中断している。たとえば、海水ウシエビ(*Panaeus monodon*)と淡水レッドドラムは、投資費用が高いため中断されている。ヘダイ(*Rhabdosargus sarba*)については、2003年には幼魚が29万2000トン養殖されたが、これは2002年の33万8000トンよりも減少している。下記の表に示すとおり、ヘダイの養殖は、その数量は減少し続けているものの種魚生産活動の主軸のひとつであり、消費者の支持を得ていることから、持続する可能性は十分ある。

最近5年間のアルビオン水産研究所による種魚生産

種/年	2001	2002	2003	2004	2005
海水ウシエビ(<i>Panaeus monodon</i>)	232,000	204,100	61,700		
淡水テラピア(<i>Oreochromis sp.</i>)	18,795	31,485	85,472	20,055	
淡水オニテナガエビ(<i>Machrobrachium resembergii</i>)			120,000	625,200	113,000
ヘダイ(<i>Rhabdosargus sarba</i>)	182,000	338,200	292,000	255,000	275,000

(データ提供：アルビオン水産研究所)

3-2. プロジェクトの促進要因

(1) インパクト

最も重要な促進要因は、モーリシャス政府が環境保護・保全のための法制度の整備をタイミングよく進めたことである。プロジェクト終了の1年前に環境保護法が制定され、その後も同法の改定と各種規則の整備が図られた（アルビオン水産研究所も積極的に規定や規準作りに参加した）。この結果、アルビオン水産研究所の研究・調査データが広範な関係者に利用されるようになった。

3-3. プロジェクトの阻害要因

(1) インパクト

養殖コンポーネントの自立発展性には次の要因が影響した。

- ・ 未活用の資源利用と養殖魚種の多様化のための明確な開発戦略プランがないため、研究所の増養殖の戦略も明確でないこと
- ・ 技術面の問題から放流魚の標識を中断したため、放流試験の効果測定が出来ないこと
- ・ 養殖用機材が老朽化したため、種苗生産量が低減したこと

(2) 自立発展性

研究活動上の制約要因としては次の点が挙げられる。

- ・ 同研究所は水産分野における唯一の技術支援部門であるため、事務作業や各種会議への出席など研究以外の業務の負担が大きく、時には研究活動の制約要因となる。
- ・ 水産分野の技術部門を担う研究所の年間調査研究予算が300万ルピーしかなく、研究所の活動規模は予算上の制約が大きい。

3-4. 結論

本プロジェクトの沿岸環境・生態調査コンポーネントは、アルピオン水産研究所の技術面の能力を向上させ、環境保全上の様々なプラスのインパクトを与えている。また、これらの分野の自立発展性も高い。資源増殖分野では、研究所はプロジェクト終了後も機材の老朽化などの制約はあるが、種苗生産量を増加させ、新たな種苗生産技術の習得に努めている。しかし、養殖コンポーネントの経済的効果や資源増殖の具体的な効果は十分に発現していない。

3-5. 提言

アルピオン水産研究所と水産省

- 現在、アルピオン水産研究所と水産省は養殖開発のマスタープラン作りを計画している。研究所が優先度の高い活動に集中して成果を出せるように、水産省はこのマスタープラン作りを重要課題として位置づけることを提案する。また、このマスタープランの作成に際しては、市場性を重視した詳細なフィージビリティ調査を行い、推進する魚種を特定することを提案する。
- アルピオン水産研究所は、常にモニタリング活動に必要なインプットを確保するよう提案する。2001年に、同研究所の業務改善のための改革が実施されたが、新たに導入された事務手続きの遅れにより、生態モニタリングが一時的に中断される事態が生じた。長期的なモニタリング活動は継続することに意義があり、中断はデータの信頼性を著しく低下させる。こうしたリスクを回避するために、モニタリングに必要な最低限の予算を予算編成の段階で確保し、特定の支出項目については、研究員の裁量で支出できるような柔軟性を持たせることが必要である。
- アルピオン水産研究所の調査・研究活動は観光産業などの民間セクターに直接寄与するものが多い。一方、研究所の研究予算はわずか300万ルピーで、潟への放流事業などを拡大・普及することは出来ない。このため、研究所が沿岸資源の利用者をこうした活動に巻き込み、必要な資金を調達することを検討すべきである。研究所が稚魚を低価格で民間に提供し、民間の企業やNGOが彼らの資源保全活動として放流事業を行うなど、政府と民間の共同事業として取り組むのも一つの方法である。研究所は活動と実績をPRし、民間からの支援を獲得するよう努めることも必要である。
- 水産省は、アルピオン水産研究所の研究者が、研究活動に専念するに十分な職員数を配置できているか確認することを提案する。

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- プロジェクトによって研究所の研究・調査能力は向上したが、今後も継続的に技術レベルの向上に努めることは必要である。しかし、プロジェクト終了後、技術レベルの向上や新たな水産技術の知識を得る機会是非常に限られている。さらなる技術向上のために次のような支援が有効である。
 - ・ 日本の研究者や大学院生に対して、彼らの研究・調査の受入れ先としてアルピオン水産研究所を推奨することで、同研究所の職員の技術交流機会を提供する。
 - ・ 第三国研修などモーリシャスで水産分野の地域研修が企画された場合、講師として派遣される短期専門家の役割に研究員への研究助言を追加し、技術支援が受けられるようにする。

3-6. 教訓

- このプロジェクトは、資源保全のための法制度や行政機能の強化を伴った場合、研究プロジェクトは非常に効果的であることを示した。将来、研究コンポーネントを含んだ類似案件が要請された場合、当該政府の行政機関が研究結果をどのように活用するか、資源保全の諸制度をどの程度整備する意図があるのかといった点について、事前調査の段階で十分調査することが重要である。
- プロジェクト期間中、アルピオン水産研究所のスタッフの多くが日本で研修を受け、研究機材についても使用法やメンテナンスについて指導を受けた。しかし、機材のメーカーや代理店と研修員が直にコミュニケーションを取ることはなかった。このため、機材の保証期間が過ぎた機材については、日本からの備品やスペアパーツの入手が非常に困難となった。こうした事態を改善するためには、供与機材について日本の製造メーカーや代理店とCP機関とのコミュニケーションを仲介するようなシステムが有効であろう。

- 養殖振興における技術部門の主要な役割は、通常種苗生産技術の開発・向上、親養成、民間セクターへの技術支援能力の向上等である。こうした技術部門は種苗生産のインフラと技術は確立しても、種苗供給や資源増殖プログラムを拡大するための資金能力は望めないことが多いであろう。資源増殖の効果を高めるためには、強化された種苗生産能力をどのように活かすか計画段階で十分検討し、具体的な戦略を立てることが望まれる。