

Studies on conservation and management of coastal resources through the integration of social, physical and biological approach: case study in Paojepe, Wajo, South Sulawesi¹

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ABSTRACT

This research is based upon an interdisciplinaty field study encompassing anthropology, biology, and oceanography, conducted within a period of May 1999 to May 2001 at Paojepe coast, Wajo regency in South Sulawesi. The study has three main objectives : firstly, to identify social, cultural, ecological/biological and econo-demographic problems that concerned mangrove-forest conversion phenomenon into brackish water milkfish pond areas, as one of the main economic activities of the local people. Secondly, to identify achievements as well as failures in the efforts to rehabilitate mangrove forest by using of analyzing social, ecological and demographic symptoms and conditions at the coast of Paojepe. Thirdly, to identify the potentials of social institutions the people of Paojepe maintain, which was believed to be able to contribute as the means and medium in the efforts to apply the most suitable intervention strategies in coastal management, particularly intervention strategies in rehabilitation of the mangrove forests.

The study on biological aspect has identified the biological diversity of Paojepe coast and also identified on the on-going ecosystem changes as consequences of mangrove depletion, coastal abrasion, and coral reef mining. The results of the oceanographic observation on Paojepe coast showed that, the sea currents that parallel the shore can move at speed of 62.64 cm/second and many transport suspended sediment and/or other materials from the coats heading offshore at a depth of 19 to 20 m, approximately 1333.4 m from the shore. The effect of rising and falling tide on coastal abrasion is followed by the presence of huge waves, especially at high tide.

Coral reef has still been mined by the community. At a contour depth of about 4 meters, the reef could actually be a natural protector from the sea wave attacks on the eastern coast of Paojepe. The coral reef mining has resulted in their disappearance, sea waves hit the shore directly and frontally. The result of social study have tapped in aspirations of most of the local people, who have begun to be aware of the danger of abrasion on their locations. These people have begun to realize that abrasion can in fact pose serious threats to their economy, as more and more ponds located on the beach have been eroded. This means potential reduction on their milkfish and shrimp commodities. As have been empirically observed, owners of such ponds have strong

¹ This paper presented on the *International symposium on land management and biodiversity in Southeast Asia* ». Kuta, Bali, 18-20 September 2002. Organized by Hokkaido University, Sapporo, Japan and Research Center for Biology, Indonesian Institute of Sciences (LIPI).

motivation in mangrove re-plantation. They have even more considered to plantation of *Rhizophora* spp. on their ponds. The multidiciplinary approaches in the conservation and management will be discussed later in this paper.

Key words : *Coastal management and conservation, interdisciplinaty study, coastal degradation, Paojepe coast, Wajo, South Sulawesi.*

INTRODUCTION

A. Background

Along with increasing national and international markets for brackish water fish pond and shrimps, there has been an increase in population in the coastal areas, in turn adding to the pressure to convert the mangrove forests into residential areas. However, phenomena relating to the exploitation and conversion of mangrove forests has not been at all clear. Previous studies reveal that in such situations, people do not have clear ideas and information of the zoning and boundaries of the mangrove areas. Since there is no effort by regional or local government to provide this information nor to take appropriate action, the zoning of mangrove areas for forest conservation and the coastal lands outside these areas is perceived by the local people as permitted areas (open access resources) to be utilized and converted. The local people themselves have developed the allocation and management of these areas for their own needs. On the people's perception that anyone having ponds behind the mangroves have the right to expand their ponds toward the seashore. Hence, it is difficult to uphold the government's regulation to sustain the 200 meters of mangrove forests as green belt areas.

The ability of the local people to convert and utilize the coastal zones might also relate to the mechanism by which they have been able to form local institutions and/or arrangements among themselves. Local people have developed their capacity to gain access to the forests and to depend on the mangrove area for their main source of income. How this capacity developed and was put into operation by the local people needs further study.

Statement of Problems

The condition of the Paojepe coast has reached such a critical level and it needs to be addressed urgently, considering the ever-increasing sea abrasion there. On the other hand, the abrasion has been due to the poor conditions of and/or the absented coastal atoll, which is a natural habitat for a number of sea fauna as well as a great barrier against sea abrasion. The destruction of the underwater ridge was not natural; it was due to the TNT explosion and chemical, people used when catching certain types of fish.

The deforestation process in the Paojepe coasts was started as early as 1968 by the GOA paper mill, when it began operating by utilizing stems of mangrove trees as its raw material for pulp. To support the activity, hundreds of hectares of the mangrove forests in Paojepe had to be cleared approximately for one year. The local government did not

prohibit the felling of the mangrove trees. On the contrary, it supported the development, as the Goa Paper mill contributed economically, both to the district and to the government of South Sulawesi Province.

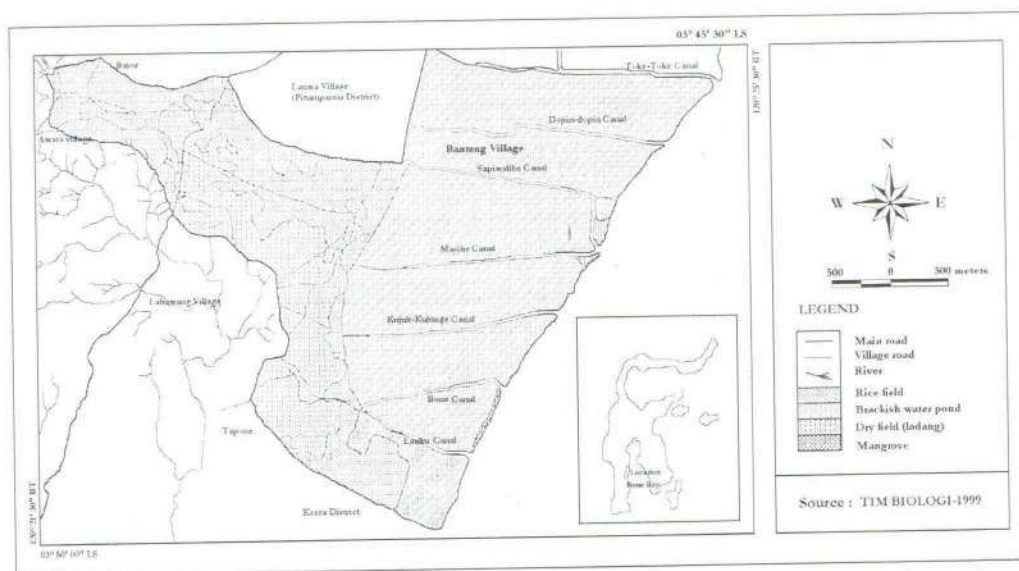


Figure 1. Paojepe coast and landuse

Figure 1. Paojepe coast and landuse

Besides all this, the depletion of the mangrove forest in Paojepe was also brought about by the local people's economic activities in raising milkfish, a popular type of fish for the Bugis and Makasar, in embankment ponds. The conversion of mangrove forests into brackish water ponds in Paojepe was generally done by the people coming from Pangkep and Bulukumba who, due to limitations in their own area, had to expand by clearing mangrove forest and creating new ponds in other areas, among which were in the mangrove forest of Paojepe. The clearing process started in 1968, when the local government supported it as the area had not been economically productive. Discourses on nature preservation were not an effective means of development back in the 1970s and early 1980s. The end results of development program were merely targeted at economic gains, paying know attention to its social and cultural, let alone environmental impacts. This disturbing fact was actually still going on in the 1990s when shrimp culture activities boomed in many coastal areas in Indonesia including the Paojepe and other coasts in South Sulawesi. The economic gains from the shrimp enterprise were indeed significant as an export commodity. Therefore, a great many investors rushed in to convert the coastal areas in Indonesia exploitatively without concerns on nature preservation. Demands from Japan, Hongkong, and Singapore did increase sharply at the particular time.

The limitation of areas for brackish water ponds in Pangkep, South Sulawesi, occurred since fish culture was one of the main economic sources and clearing new areas was done from time to time in their effort to increase productivity and to create more jobs for the ever increasing local population. The coastal parts of Pangkep were then converted into fishponds, and after a while they found it hard to get more forests to clear. Hence, the main motivation of the people of Pangkep in exploring new places outside their territory.

A part from the phenomenon, in the Paojepe coast, there occurred another type of atoll destruction, mainly caused by the scarcity of natural resources: coral stones, which are raw materials for building houses.

By and large, the problems stated above have created conflicting government regulations in its efforts to regulate the natural resources in Bone Bay, South Sulawesi. On the other hand, the government has supported the conversion of mangrove forests into shrimp ponds to address the economic demands from regional, national and international levels. The government has also started reforestation and replantation of mangrove trees in the destroyed areas. In this respect, responses from the local and other stakeholder over the phenomena above vary to include the following : (1) the continuous massive conversion of mangrove forests into shrimp and brackish water ponds as well as exploitation of mangrove for fuel wood, despite increased land degradation and the government's program to rehabilitate the coastal areas ; (2) the replanting of mangrove trees by local people to protect their residences and ponds without any government support and involvement.

The research activities in this matter are addressed to the problems of :

1. Why has the conversion of mangrove forests into shrimp and brackish water ponds persisted despite local government regulations and programs to rehabilitate the coastal areas ? What are the people's strategies and their implications on the coastal ecosystem and the local people's consumption pattern and prosperity, including those who have traditionally use the mangrove forests and have been marginalized since then ? Why, on the other hand, are there cases of people's own efforts to alleviate and support ? How and why could these activities take form and become established ? What are their future implications on the people's prosperity and the condition of the coastal ecosystem and resources ?
2. How can a community based management program, developed by empowering local people, be carried out in a situation where people and other stakeholders utilize those "*common pool resources*" in unsustainable manner ? To be able to carry out such program, information of the intelligible factors which may contribute to the attainment of the program is necessary. The information may include those as expressed by the local people themselves, which is perceived as significant to assist in modifying their strategies in the utilization of coastal resources, as well as that which is perceived as necessary to be supplied by the researcher. Information would also include those covered in the case of local people's own effort to replant mangroves, so as to serve as comparative knowledge for the researchers.

B. Objective

The three main objectives in this study are as follows :

1. To identify social, cultural, ecological/biological, economic and demographic problems that concerned mangrove-forest conversion phenomenon into brackish water milkfish pond areas, as one of the main economic activities of the local people.
2. To identify achievements as well as failures in the efforts to rehabilitate mangrove forest by using of analyzing social, ecological and demographic symptoms and conditions at the coast of Paojepe.
3. To determine the potentials of social institutions the people of Paojepe maintain, which was believed to be able to contribute as the means and medium in the efforts to apply the most suitable intervention strategies in coastal management, particularly intervention strategies in rehabilitation of the mangrove forests.

C. Mechanism of the study

The first step of this study consists of three sites : Paojepe (Wajo regency), Bonepute (Bone regency) and Tongke-Tongke (Sinjai regency). Every location has a specific character on ecosystem and social culture. This step is comparative study that aims to identify the social, culture, biology, ecology and oceanography aspect.

1. *Paojepe* : this site location is a case of abrasion, the damage of the coastal environment has reach such a critical stage that it urgently calls for measure to address and overcome the problems.
2. *Bonepute* : a case of green-belt zone. The role of local leaders in the management of green-belt.
3. *Tongke-Tongke* : this site has a case of preventing abrasion by replanting *Rhizophora* sp.

We observe the same variable for the three sites study in social, biological, and oceanography aspect. The study aims to understand the existing phenomena and the contextual factors. The result of the comparative study and the identification of those variables are used as base on the facilitating action research.

Seconds step is to realize the facilitating action research that focusing at Paojepe coast. This facilitating action research was undertaken by adaptive management of coastal of Paojepe. Result of the facilitating action research used as « *trial and error* » to rehabilitate the mangrove ecosystem. What kinds of strategy for rehabilitate the mangrove ecosystem ? And how to manage this coastal area for the economic and ecology advantage ?

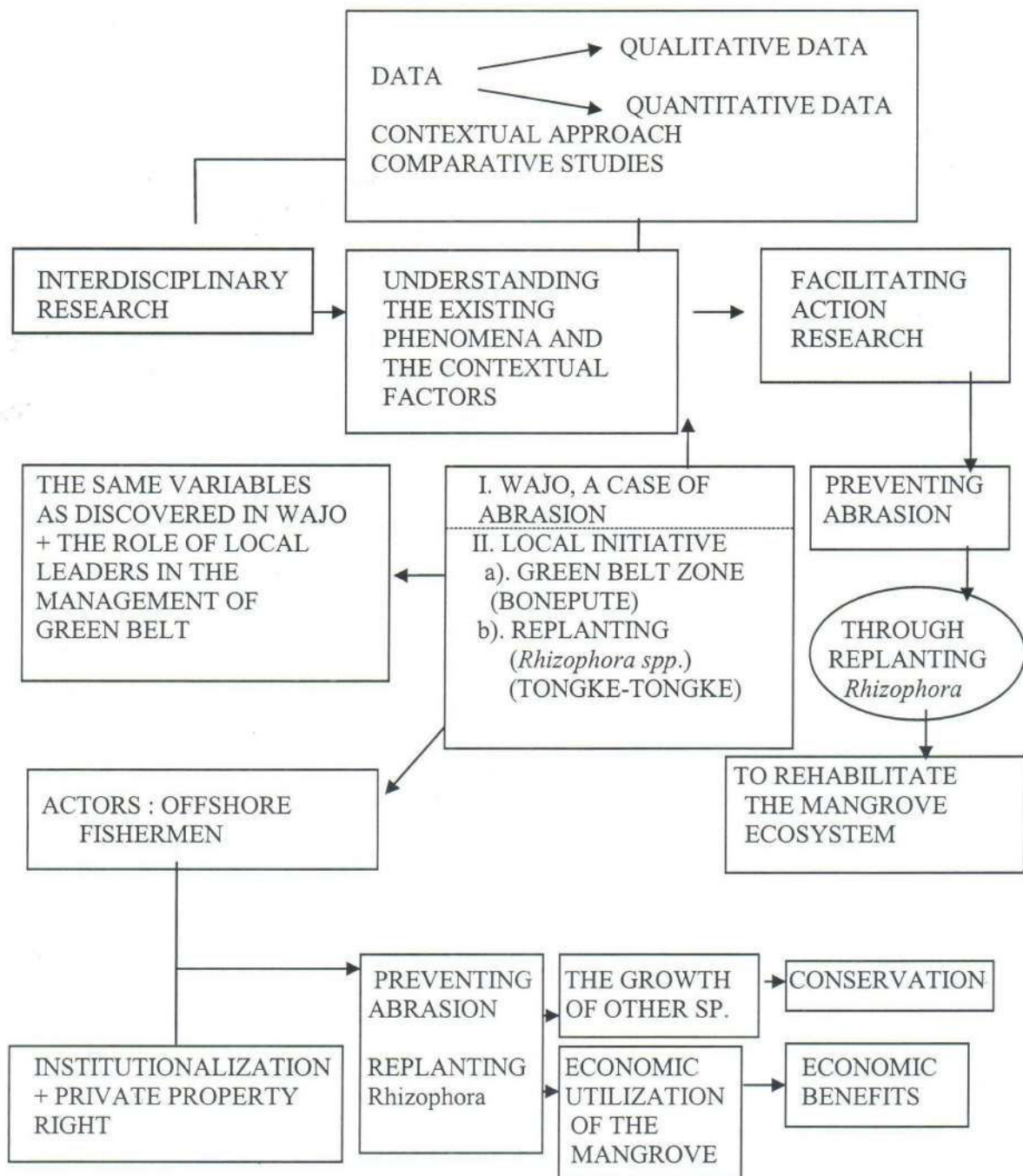


Figure 2. Mechanism of the studies (Winarto and Purwanto, 1999)

Abrasion history at Paojepe

In fact, the reason of the utilization of the mangrove forest resources in Paojepe is on economic interest (see figure).

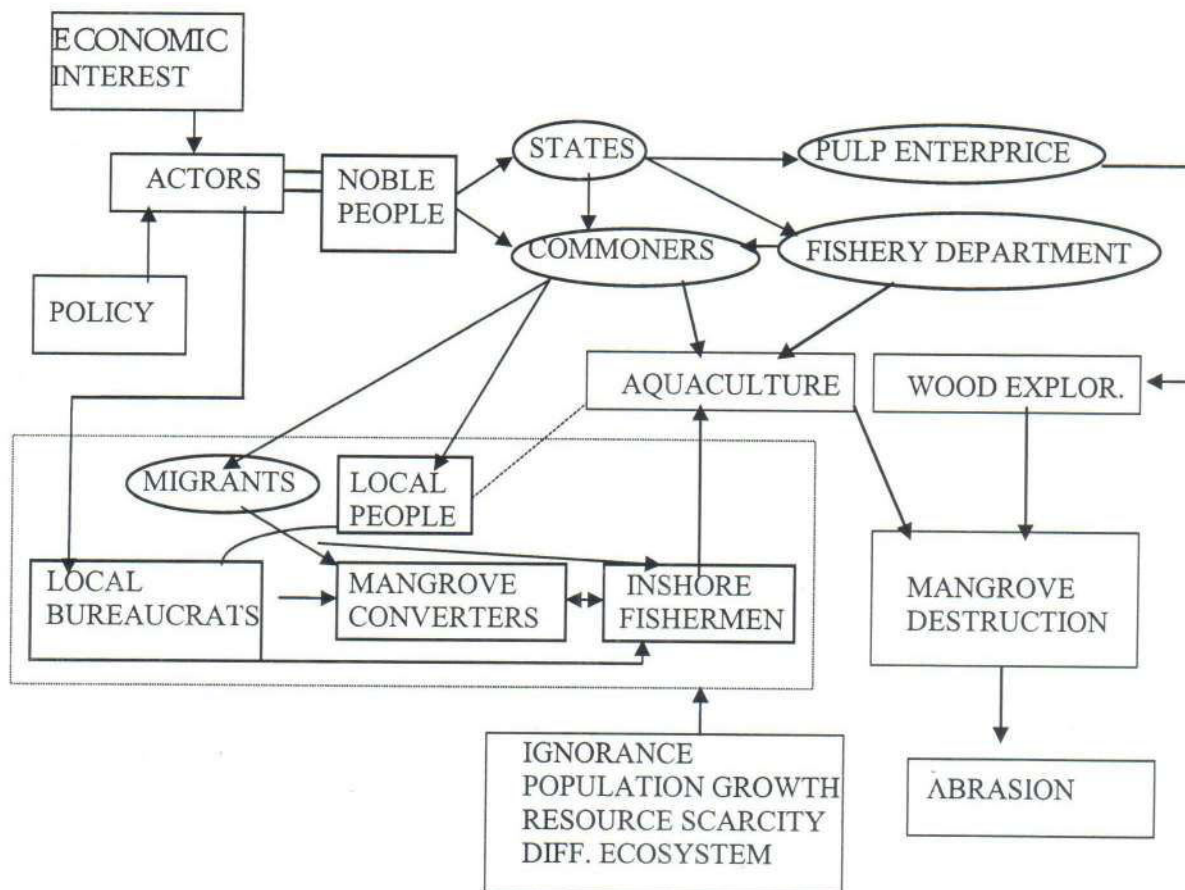


Figure 3. Abrasion process at Paojepe coast (Winarto and Purwanto, 1999)

The actors of the mangrove conversion at Paojepe coast

The actors who affect the mangrove destruction at the Paojepe coast are: (1) Noble people; (2) Government; (3) Pulp enterprise; (4) People (commoners): local people and migrants; (5) Department of Fisherman; and (6) Local bureaucrats.

Before the independence era, this area was under the control of the small kingdom «*Arung Pitumpanua*». During that era, mangrove areas had not been widely used by the people for economic purposes, utilization of mangrove forest was quite limited: fuel and fishing areas).

After the Indonesia declaration of independence, there occurred change in land ownership, this area became state owned, under the administrative government of district Pitumpanua. During that time, the population was still small so that the mangrove areas were not yet widely utilized by the local people.

The pulp enterprise Goa has a concession from local government to explore the wood resources at the mangrove areas of the Pitumpanua district in 1967. The wood was used by the mill as raw materials for making pulp and paper. The condition of the mangrove forests which were relatively open after exploitation by the Gowa paper mill had encouraged the local government to convert the mangrove forest into fishponds.

Since early 1970, in order to speed-up the development of this area, the local government made some effort to attract people to come to the area for the conversion of mangrove forest into fish pond (*Tambak*).

Conversion of mangrove forest into fish pond accelerated upon recommendation from Fishery Department (Dinas Perikanan) and the coming of migrant from Pangkep who have specialize to open/convert the mangrove forest into the fish pond.

It was not until the early 1990, that a reduction in mangrove occurred and abrasion of the coast started. The abrasion is occurring a long the coast of Paojepe has now become very seriously.

METHODOLOGY

This research is based upon an interdisciplinary field study encompassing anthropology, biology, and oceanography. It is evident from these cases of mangrove conversion and use that a set of intelligible factors comprising of cultural, social, economic, institutional, biological, ecological, oceanography and demographic elements have affected the problems of both damaging and restoring the mangrove forest at Paojepe coast. A comprehensive understanding of these problems requires an understanding of the context within which they become manifest. To examine these intelligible factors, then, a research approach of progressive contextualization is most appropriate. This method enables the researcher to move backward in time and outward in space in progressively contextualizing the data without a priori boundaries of the context (see Vayda, 1983). With the progressive search and understanding of the spatial and temporal contexts of the problem, intensive evaluation will be performed accordingly: collecting data to provide a context for the problem. The approach demands creativity and attention to detail on the part of the researcher and the requiring in it continuous evaluation of all information and data collected.

Evaluation of research finding will be continuous and will run simultaneously with facilitating research activities carried out *in-situ*. Participant observation, the research method of staying among the local people and participating in their daily activities, is the method that will best enable the researcher to understand the situation in detail, and to carry out facilitating research action by involving the local people. In effect, researchers and locals will be involved in participatory learning and action, allowing for the development of a bottom-up solution to the problems at hand. The method enables the researchers to

evaluate gathered information together with local people assisted by an interdisciplinary research team. The interdisciplinary approach will enable the search for data only insofar as they are significantly related to the problem, while avoiding the unnecessary collection of data pertinent only to each discipline. Thus the search for particular data will depend upon the already collected or existing body of the information, its relevance to the problem, and upon its import in efforts to assist the local people in developing sustainable resource use strategies. The approach is also advantageous in integrating the data for one comprehensive analysis of a problem.

The accumulation of data will allow the building up of assumption and objectives of the study. However, this study began with a set of the objectives of the study to be realized and to serve as a starting point in collecting contextual information. The objectives and the methods for realizing them are as follow:

1. To identify social, cultural, ecological/biological and econo-demographic problems that concerned mangrove-forest conversion phenomenon into brackish water milk fish pond areas, as one of the main economic activities of the local people.
2. To identify achievements as well as failures in the efforts to rehabilitate mangrove forest by using of analyzing social, ecological and demographic symptoms and conditions at the coast of Paojepe.
3. To identify the potentials of social institutions the people of Paojepe maintain, which were believed to be able to contribute as the means and medium in the efforts to apply the most suitable intervention strategies in coastal management, particularly intervention strategies in rehabilitation of the mangrove forests.

The methods for data collection and analysis are as follows:

- A. Social study: the collection data and documents, specifically those pertaining to the following: demographic figures of the population in the selected case studies along the coastal zone since the 1980s, occupation and resource use strategies and annual income, government policies and regulations regarding fish-shrimp production and marketing. Observation and interviews were undertaken specifically with regard to data on occupation and resource use strategies and annual income, as well as to the collection of data on the people's reason for settling in the coastal areas and converting mangrove forests ; to obtain the perspective of local/regional government officials on mangrove's conversion and their implementation and control activities ; to obtain also data from local people and other stakeholders concerning their knowledge of government regulations on coastal areas as well as their implementation, such as the tree replanting programs. Based on the social realities within the local community, the methodology in this study includes survey, focus group discussions, in-depth interviews and observation. Surveys are to be done particularly for collecting data on the local knowledge concerning conservation of the mangrove forest and danger of abrasion? The local people's aspirations concerning conservation of mangrove forests in the coastal will be compiled through focus group discussions. By using such a method, the

field researchers in fact can collect valuable findings that comprise the local people's opinions, suggestions and criticisms.

- B. Biological, physical and chemical aspects study: these studies used to know and to answered the problem that deforestation and degradation of mangrove forest for industrial activities such as shrimp farming, brackish water fish ponds, and mining and agricultural had led to tremendous environmental impacts and a new constellation of the ecosystem. We used the standard methodology using in the research in human activities impacts in the environment. We analyze the natural resources richness especially biodiversity and bio-physical aspect of the coast environment.
- C. Oceanography study: The activities of the oceanologist include data collection on the sea current, sea level, wave, position measurement, bathymetric data, and meteorological data, in the effort of compiling comprehensive data on the coastal dynamics as well as factors that may influence them. The methods applied cover several aspects that receive individual elaboration : (a) sea current, measurement of sea currents was conducted using an Acoustic Doppler Current Profiler (ADCP), (b) relative sea level, sea level measurement was conducted using an SBE 26-03 tide/wave meter ; (c) sea waves, the same equipment for sea level measurement ; (d) bathymetric data, the bathymetric data were collected using a Bottom Track ADCP with DGPS Garmin SRVY 100 device for locating position ; (e) position measurement, the position was determined using a differential GPS and a bottom tracking from a ADCP measuring device ; and (f) meteorological data, supporting data on wind velocity, air pressure, rainfall, sunshine and temperature were gathered from the local meteorological station (BMG).

Together with the oceanology researcher involved in the team, the biology researchers in this study will focus on the impacts of mangrove depletion on the biodiversity (on the land, on the coast, as well as in the sea) and the quality of waters in Paojepe. For data collection, they will conduct a number of surveys and quantitative samplings in some locations on the coast of Paojepe.

Moreover, oceanologist will attempt data collection on the patterns of sea waves on Paojepe coast. These data are necessary for identification of coastal abrasion indications on certain points of location where wave-diverging devices are required in order to abate the abrasion speed. In this respect, abrasion-lessening measures through reducing the wave speed have been under discussion so that they may be treated in the next study, because these wave divergent gadgets are very useful for reducing the abrasion effects on the coast.

The results of this study and the findings made by the team of social experts, biologist and oceanologists will be scrutinized and analyzed by considering their systemic interconnection. The findings can be references in modification of models of approach that have been set early in this action research. Gradually and promisingly, this phase II study has made significant progress, one indication of which is the fact that more and more mangrove seedling are asked by pond farmers to be planted on their areas. This indication needs to be nurtured qualitatively and quantitatively.

RESULT AND DISCUSSION

A. Social aspects

The destruction of Paojepe coast has been influenced by physical, biological and social condition. Conversion of mangrove forests into brackish water ponds as done by the migrants in Paojepe has brought about such consequences as physical and land degradation and abrasion, the conditions of which have been exacerbated by the exploitation of coastal ridges of reefs for utilizations as house building raw materials.

The local people and government officials are not fully aware of the ecological impacts of the forest conversion, since there has never been a feasibility study nor an environmental analysis on the matter. Some policies have ignorantly embittered the process of mangrove destruction, i.e. the encouragement by the Fishery Department to clear open the forests. More complicates have thus been triggered, either ecological or socially.

The typical attitude of the migrants is that they regard Paojepe as a mere « *working place* » and not « *home* », that way, they do not really care about the destruction they have caused.

The non functioning social institution in the community has allowed the conversion process to be out of control. Only after a serious damage has been done will the people consider a belatedly curative action.

In managing the coasts, the local government's attention has been geared more toward maximum economic goals than on ecological costs, even though it is realized that an ecological loss eventually translates into an economic loss. Abrasion caused shrinkage of ponds areas and coastal sandy-sediment accumulation, for example, will decrease the quality and fertility of a given pond area, all of which in turn leads to lower productivity.

The local people spend a great amount of time on economic activities for survival. They only concern about maximum income out of the coastal area, without any thought whatsoever on natural conservation. As a result, drastic degradation has occurred, which has affected the quality of the coastal area (including their brackish water ponds).

Some government regulations and policies have not been put to use. A variety of coastal destruction (reef exploitation, use of explosives or chemical substances for fishing) are still on progress.

Mangrove forest destruction has also been influenced by the way the local people perceive the forests. To the indigenous Paojepe, mangrove forests only function as a source for fuel wood and housing needs. Understandably, mangrove wood has still been exploited for the reasons. To the immigrants, however, mangrove forests may be converted into a brackish water pond. Therefore, they must be cleared off to the point that the bigger the pond is, the more profitable it is.

The disappearance of mangrove forests and occurrence of a abrasion in Paojepe have not only meant economic and ecological losses, but also have been expensive lessons to learn, especially for the local people to understand and for the local government officials to rehabilitate the damaged forests and conserve the ones still existing. These phenomena

have served to inform the decision makers and local people how valuable mangrove forests actually are in protecting their areas. They have also warned how any exploitation of natural resources must carefully consider cost and profit analyses, feasibility studies, and sustainability.

B. Biological aspects

a. Plant species diversity

The area of Paojepe which have been coastal area is degraded. It still has quite high plant species diversity (of about 28 species), but the existence of various plant grow partially and not forming a mangrove forest community. Ecologically this is not advantageous, either as protection from wave or on other ecological function. The existing of the high plant diversity of mangrove species is an indication that this area is possible to do reforestation.

b. Diversity of fauna (fish, mollusk, Reptile, Crustacean)

The number of fish species that found at the Paojepe coast is 34 species belonging to 26 genera and 19 families.

Other aquatic fauna species found during research are mollusks (19 species, 16 genera, and 13 families), reptiles (4 species), crustacean (11 species, 3 groups, 5 families and 9 genera and 1 species of sea star.

c. Microorganism diversity (phytoplankton and zooplankton)

As shown by the analysis on phytoplankton population, they consist of four groups : cyanophyta, chlrophyta, chrysophyta and dinophyta, and every group has 18, 13, 29 and 1 species respectively. By looking the diversity of phytoplankton species, the coastal water of Paojepe is rich. However, if we see from the number of plankton per unit volume, the amount is relatively low, namely around 15-395 individuals per liter. The recorded number of phytoplankton in each observation is 2-20 species. The biggest plankton population is *Mycrocystis aeruginosa*, which is recorded to reach 245 individuals.

Copepod group is the primary subject in Zooplankton observation, because this group is very important in sea or coastal fishery. It is not only important as food for some commercial fishes and shrimp, but also it plays a role as an organic, biological indicator in the oceanic phenomenon. Calanoid copepod is the most important group of the sea zooplankton. Generally, this group consists of more than of the total zooplankton species. The copepod plays a role in connecting the food chain, from low to high levels.

From the observation yield at coastal water, there are 35 species of copepod dominated by the species of *Labidocera pado*, *Acaria erythraea*, *Centropages furcatus*, and *Potellopsis sp.* The observation at brackish water ponds shows only 6 species of Copepod (*Acaria erythraea*, *A. pacifica*, *Centropages furcatus*, *Potellopsis inflatodigitata*, *Pseudomacrochiron parvum*, and *Labidocera pavo*).

The difference in richness of plankton species found in brackish water and coastal water, in fact, the seashore water of the area is rich in plankton, but after being poured into brackish water ponds along with the tide and after a certain period, the total number of plankton decreases drastically. This decrease is not caused by the fact that the plankton is eaten by fish. In fact, various plankton species cannot stay longer in brackish water ponds due to «*poor nutrients*». Such a condition holds true in peat soil brackish water due to the physical and chemical conditions of the water, namely either low in pH, acidic, or poor in nutrients and other minerals.

C. Physical and chemical characteristic

a. The quality of water

The quality of waters is relatively good, especially brackish water salinity around 1.2 – 2.8 ‰. DO content is around 2.18-9.02 ppm. Fluctuation of DO content is relatively high relating to the shallow brackish pond depth (1.2 m), so that the movement atmospheric oxygen content and water are relatively fast, while the result of turbidity measurement is relatively small.

Table 1. Physical characteristic of water at Paojepe, Bonepute and Tongke-Tongke coast

No	Parameter	Site Study		
		Paojepe	Bonepute	Tongke-Tongke
1	PH	7-8.45	7.82-9.09	7.65-8.91
2	Turbidity (ntu)	40-931	8-68	8-177
3	Conductivity	0.15-250	0.22-73.4	0.22-45.3
4	DO (ppm)	2.33-8.63	2.18-11.89	2.91-10.10
5	Temperature (°C)	24.9-35.4	27.3-32.0	27.7-32.6
6	Salinity (‰)	0-2.81	0-3.02	0-3.06

Chemical analysis of water quality at Paojepe was presented in the Table as follows : water quality chemically in 3 locations seems clearly are not significant, except for N-total content seemed at Bonepute water is due to some brackish ponds are run more intensively especially for shrimp and milk fish brackish pond. This phenomenon has found also in the result of sediment analysis.

Table 2. Analysis of N-total, P-total, Nitrite and Ammonia concentration at water area

No	Analisis Parameters	Site Study		
		Paojepe	Bonepute	Tongke-Tongke
1	N-Total (ppm)	1.9-9.3	7.192-21.935	0.634-12.594
2	P-Total (ppm)	0.2-4.0	0.145-0.758	0.133-0.261
3	Nitrit, N-NO_3^- (ppm)	Ud	0.0104-0.0208	0.0035-0.0550
4	Amonia, N-NH_4^+ (ppm)	0.3-12.5	0.203-1.097	0.047-1.223
5	Kesadahan, CaCO_3 (mg/L)	-	1400-5800	150-5350

Table 3. Analysis of N-Total and P-total of water sediment

No	Site Study	N-Total (ppm)		P-Total (ppm)	
		Wet	Dry	Wet	Dry
1	Paojepe	3.80-14.0	12.6-46.9	15.1-282.5	37.6-899.2
2	Bonepute	6.423-21.523	24.525-57.385	11.375-53.380	33.885-140.363
3	Tongke-Tongke	2.979-15.815	4.428-29.495	70.344-112.215	105.285-188.453

b. Soil fertility level

Soil fertility level on 3 research locations seen from macro-nutrient can be categorized low to fair, especially for N and P nutrients. While K nutrient content is high enough, so as the C-organic content. This is due to the young age of brackish pond, especially the brackish ponds at Paojepe, so that decomposition process of organic matter from the wood cutting remnant still going on. That condition caused soil pH of Paojepe coastal area relatively lower, besides at this area is also found coastal peat soil area.

Table 4. Soil analysis

No	Parameters	Site		
		Paojepe	Bonepute	Tongke-Tongke
1	PH	4.0-7.3	6.5-7.30	6.10-7.50
2	C-organic (%)	2.98-24.12	1.77-4.33	0.10-9.53
3	N-total (%)	0.2-0.70	0.15-0.26	0.10-0.33
4	P-Bray1 Olsen (ppm)	1.5-19.7	7.0-18.5	7.9-14.7
5	K-HCL 25 % (ppm)	53.9-323.4	544.5-613.8	89.1-465.3
6	KTK	29.74-44.12	23.93-24.49	12.10-24.21
7	KB (%)	69.53-100	53.98-100	99.02-100

c. Oceanography aspect

The results of oceanographic observation on Paojepe coast are summarized as follows:

- The sea currents that parallel the shore can move at a speed of 62.64 cm/second and any transport suspended sediment and/or other materials from the coast heading offshore at a depth of 19-20 meters, south of the reefs, approximately 1333.44 meters from the shore ; at the contour depth of 1 to 4 meters the sediment will be transported north-eastward by the currents and will most probably be fully deposited by the Dopin-Dopin (see figure)
- The effect of rising and falling tides on coastal abrasion is followed by the presence of huge waves, especially at high tide. In the case when strong waves hit the shore, abrasion is in effect. At low tide, sediment will be carried farther offshore.
- Data on the sea salinity and temperature indicate that the influence of rivers is so significant. It may transport sediment offshore or otherwise deposit them by the estuaries.
- The wave altitude wave at the time of observation was not significant in terms of its abrasive contribution. Significant likelihood for coastal erosion to occur due to huge wave during the east monsoon.
- Coral reef has still been mined by the community. At a contour depth of about 4 meters, the reefs could actually be a natural protector from the sea wave attacks on the eastern coast of Paojepe. As reef mining has resulted in their disappearance, sea waves hit the shore directly and frontally. The presence of a 20 m deep basin on the east of Masihe and Sapiwalihe canals, about 1333.44 meters from the coast, has aggravated the coastal erosion.

If we assess deeper from various physical, chemical and biological aspects, the three areas are feasible for milkfish and shrimp brackish pond business. From the physical perspective, the area land has a plain topography. The waters biologically is rich of plankton and the area is chemically not yet polluted by industry waste. Furthermore, it has salinity appropriate for brackish pond culture, and good enough water quality, although brackish pond still need nutrient addition. However the main problem of this area is the shore degradation especially the phenomenon of abrasion due to mangrove land conversion into brackish pond.

To overcome that problem, biologically it is needed to do effort on coastal area conservation especially area that has common border with shoreline, through replanting mangrove forest species like *Rhizophora*, in order to protect shore from abrasion. After comparing the 3 research locations, principally the area conservation of Tongke-Tongke and Bonepute as a matter of fact are able to keep the land from seawater abrasion. On the other hand, Paojepe area needs special treatment to keep that area from seawater abrasion. The observation results either physically, chemically or biologically of the area prove that it is possible to regrow mangrove plant species especially *Rhizophora* spp., which can withstand from wave. From this analysis, at Paojepe area, then it is need to arrange a

strategy to overcome abrasion integratedley, which relates to socio-economic problem of that area.

The results of this study and the findings made by the team of social experts, biologist and oceanologists will be scrutinized and analyzed by considering their systemic interconnection. The findings can be as references in modification of models of approach that have been set early in this action research. Gradually and promisingly, this study has made significant progress, one indication of which is the fact that more and more mangrove seedling are asked by pond farmers to be planted on their areas. This indication needs to be nurtured qualitatively and quantitatively.

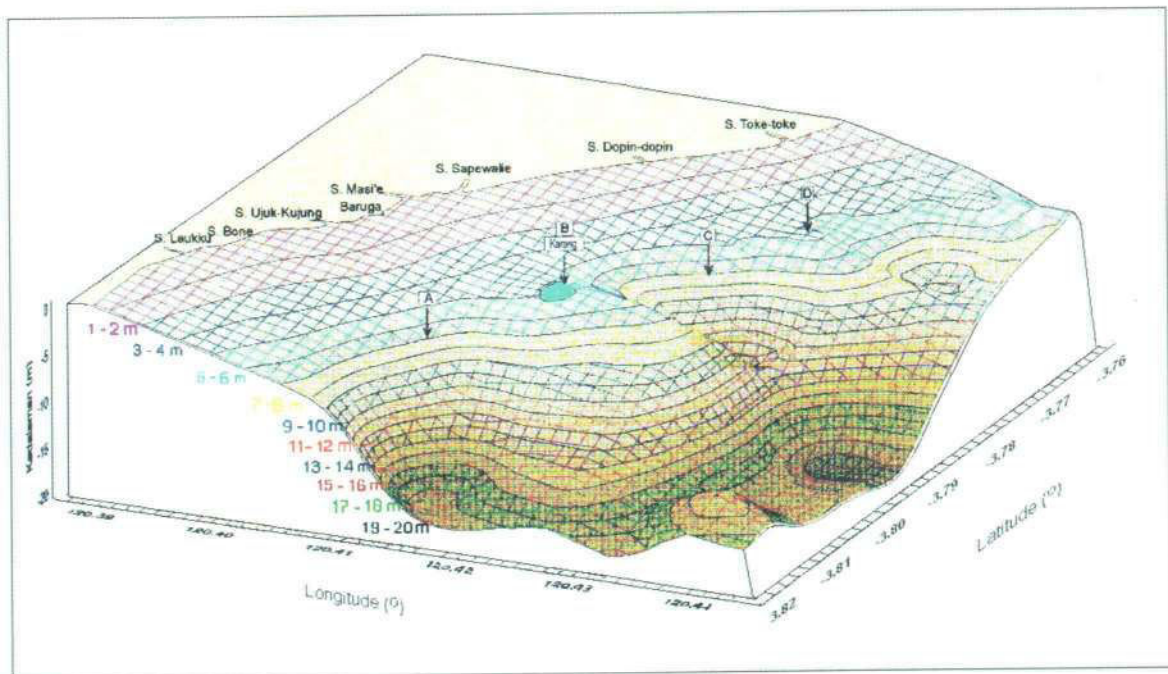


Figure 4. Bathymetric map of Paeje Coast (source : Kusmanto, 2000)

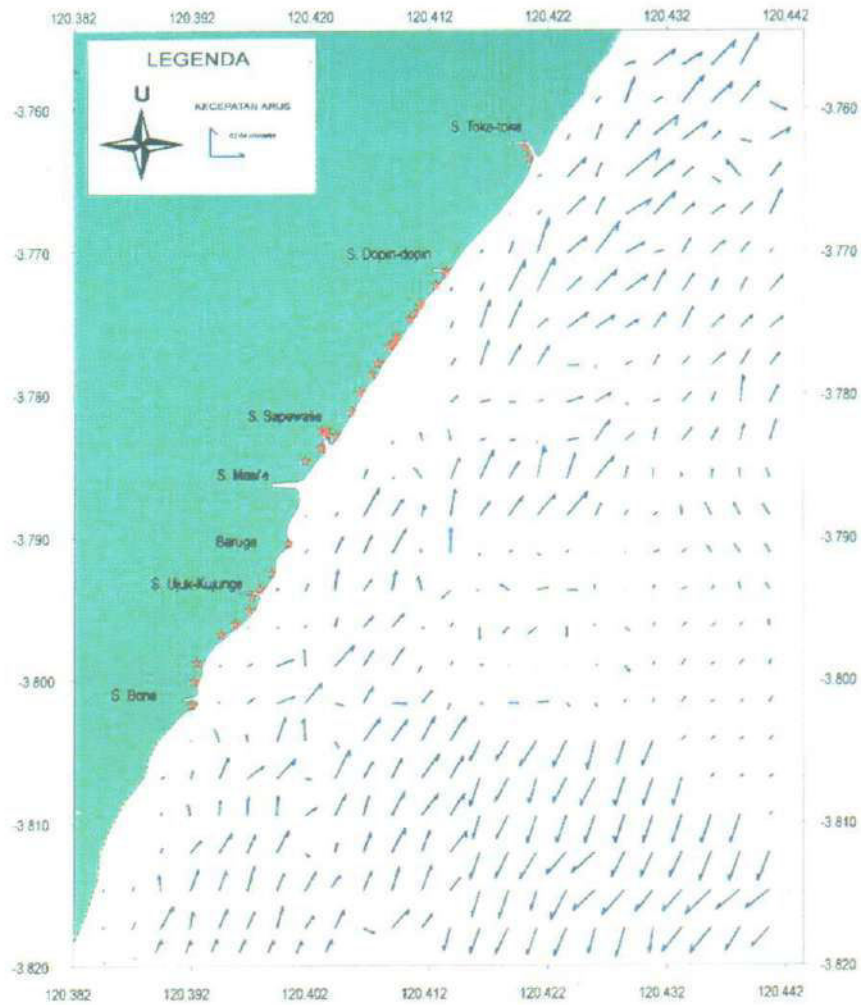


Figure 5. Patterns of the sea current on Paojepe (Kusmanto, 2000)

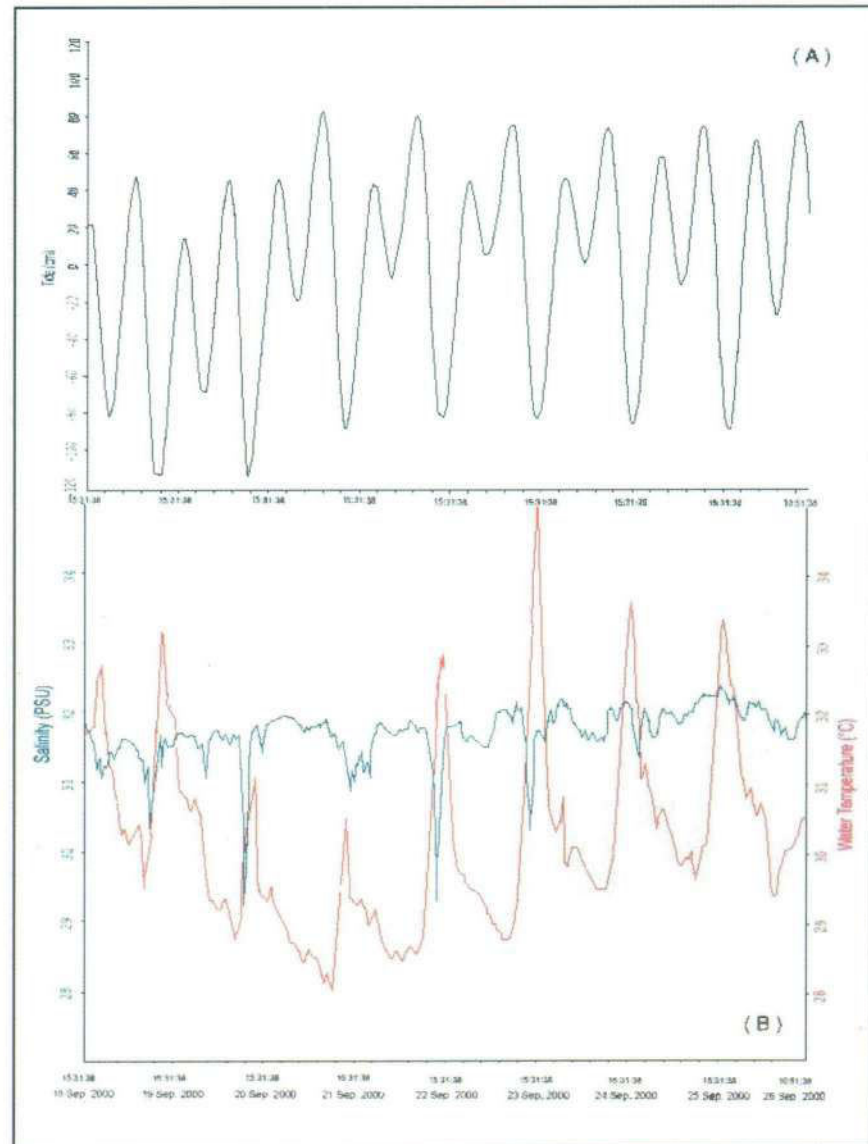


Figure 6. Bathymetric of Paojepe coast (Kusmanto, 2000)
 A. The tidal pattern ;
 B. The patterns of salinity and temperature

Strategy of coastal area rehabilitation

Based on the understanding of the existing phenomena of the mangrove forest destruction and abrasion at Paojepe coast, there are two principle condition factors to effort the mangrove forest rehabilitation, these factors are :

- (a) A strong institutional arrangement to deal with internal conflicts and external threads.
- (b) Technical devise : biological, physical, and geographical engineering, other success, and other government and NGO's programs.

Beside the two factors above, the other aspect important is financial support to realize the mangrove rehabilitation programs (see figure 4).

The arrangement of information and regulations which are needed and the application of tighter environment impact assessment (EIA) for the development prospects in the coastal area and sea. According to possible impact occurred very significantly, and there are 3 choices in response preparatory :

1. *Strategy of prevention* : This strategy is implemented by calculating the potency of increasing sea face and abrasion level and flooded area, then to be arranged a control plan with all prevention activities carried out behind the shore line. For example planting mangroves is implemented 50-100 m from shoreline, etc.
2. *Strategy of control* : After counting on abrasion level and increase in sea level, planning on procedures for overcoming to be implemented with strategy will be adapted with local environmental condition. As an example at Paojepe, besides planting mangrove species, also social and ecological approaches are conducted to overcome abrasion rate, such as prohibiting coral reef mining at the coastal region.
3. *Strategy of protection* : By constructing the protection building which functions not only to get protection but also to get benefit from probability of sea level. For example, with a building offshore which can fasten sedimentation process as an effort to broaden coastal land area.

The expose of various alternatives for overcoming strategy to the coastal condition at Paojepe. According to observation in the field, overcoming strategy for abrasion to be implemented is to plant mangrove (*Rhizophora* spp.), backward from shoreline around 50-100 m depending on land availability and willingness of brackish pond's owner, continued with strengthen embankment directly opposite to the sea. If condition is possible, the overcoming shore abrasion besides planting mangrove, also done development of wave break, either contemporarily, semi permanently or permanently.

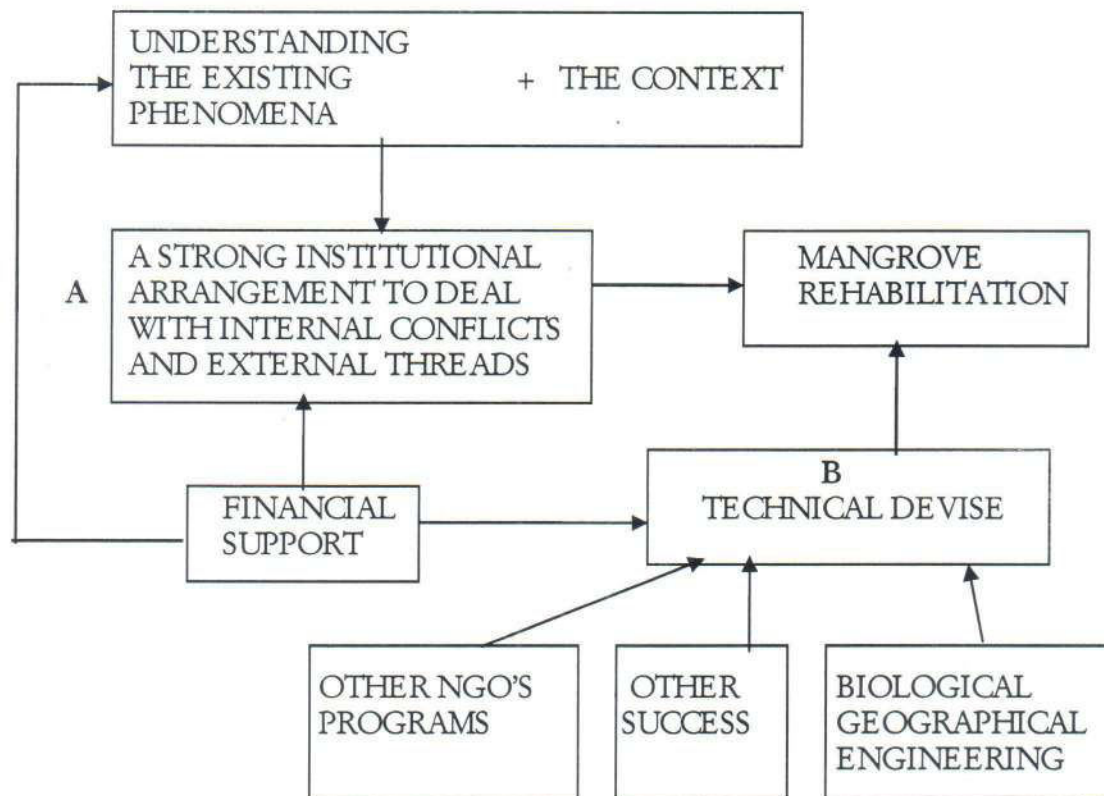


Figure 7. Mechanism of the mangrove rehabilitation (Winarto and Purwanto, 1999)

The implementations efforts in the field within the frame of looking for correct strategy to overcome the environmental destruction of coastal area of Paojepe is done with various alternatives of overcoming procedures, adapted to local ecological condition. The effort to overcome abrasion are :

1. *Overcoming biologically* : it is planting of mangrove forest plant species which are able to prevent abrasion : The steps to be implemented are follow :
 - (a) identification of plant species resistant to the raise of sea level and wave attack ;
 - (b) planting of *Rhizophora* spp. and *Avicennia* sp. ;
 - (c) developing mixed planting system of various mangrove plant species to speed-up the regeneration process of mangrove forest.
2. *Overcoming technically and physically* : this method is implemented by constructing outlet canal or water logged distribution at the shore area, wave breaking, and strengthening embankment that have direct boundary with the sea.

CONCLUSSION

1. The mangrove forest at Paojepe has suffered serious environmental degradation : the felling of mangrove trees by local inhabitants as well as immigrants has been done out of control. Conversion of mangrove forest into brackish water fish pond has been done by the local people as their main economic activity. This process of environmental destruction is exacerbated by exploitation of Paojepe coastal ridges of reefs to be used for housing raw materials and road construction. The explosives used in reef exploitation has killed a number of fish, devastating their natural habitat as well. This fact in turn have significantly expedited abrasion as well as threatened the existence of brackish water fish. With the absence of mangrove forests and reef ridges, tidal waves can severely hit the area any time.
2. The strategy for managing abrasion has been formulated in such a way that combines mangrove re-plantation, devising wave-breaking constructions, as well as creating special constructions to keep swept-away logs-that drift in from southeastern areas – from hitting the coast. The formulation has been based upon the actual conditions of the coast (e.g. abrasion level, number of the flora and fauna species, oceanography, etc.), trial and error effort done in 1999, as well as previous experience and knowledge of the local community.
3. After undertaken of facilitating action research, many members of the society have begun to see the importance of mangrove forests, so that they have started replanting mangrove trees, especially in abrasion hit areas. Such awakening is also reflected in the feedback they produced. They are willing to let go of pieces of their land by the coastline to be replanted. A few local government officials have begun to see the importance of analysis of environmental impacts in developing their areas.
4. In managing the coastal area of Paojepe, especially in combating abrasion, more through, interdisciplinary studies are required, encompassing such aspects as socio-cultural, biology, oceanography, environmental engineering, as well as field appropriacy study. This study is to give efforts to overcome abrasion and improve brackish water pond's productivity.

V. Acknowledgement

This study was funded by the MacArthur Foundation under the PCE programs. I would like to thank Dr. Yunita T. Winarto, Dr. dr. Boedhihartono, Drs. J. Emmed Priyoharyono MSc., Drs. Haryono MSc., Drs. Edi Kusmanto, Drs. Suharjono, Dr. Mulyadi, Drs. Tri Widiyanto MSi for their cooperation and encouragement. Thank is due Department of Anthropology-University of Indonesia, Research Center for Biology-LIPI, for permission and encouragement during my field work. And I would especially like to thank Abu Wena and his family, Amir and his family, and to all Paojepe society for their helps during is field work.

REFERENCES

- Boedhihartono, J. E. Prioharyono, Y. Purwanto dan E.M. Choesin (eds). 2001. *Management of Mangrove Forest : Conversion and Reforestration of Mangrove on the Coast of Paojepe, South Sulawesi*. Department of Anthropology, Faculty of Social and Political Sciences, University of Indonesia and The John and Catherine D. Mac Arthur Foundation. 2001. 177 p.
- Haryono dan Y. Purwanto 2001. Keanekaragaman Jenis Ikan dan Kaitannya dengan Sistem Pengelolaan Kawasan Pesisir Teluk Bone. *Prosiding Seminar Keanekaragaman Hayati Ikan*, Bogor 6 Juni 2000. Pusat Studi Ilmu Hayat IPB, JICA, dan Puslit Biologi-LIPI. Bogor. 2001 : 99-108 p.
- Kusmanto, E. 2000. *Laporan Penelitian Oceanografi di Paojepe*. Proyek Penelitian Coastal Management, Antropologi-UI dan MacArthur Foundation (tidak diterbitkan).
- Martosubroto, P. and Naamin. 1977. Relationship between tidal forest (mangroves) and commercial shrimp production in Indonesia. *Marine Research in Indonesia* 18: 81-86.
- Oldeman, L.R. and Sjarifuddin D. 1977. An agroclimatic map of Sulawesi. *Contr. Centr. Inst. Agric. Bogor. No. 33 (1977)* : 30 p.
- Prioharyono, J. E., Y. Purwanto dan E. M. Choesin (eds.). 2000. *Management of Mangrove Forests : Conversion and Reforestration of Mangrove on the Coast of Paojepe, Bonepute and Tongke-Tongke, South Sulawesi*. Annual Report of Firsh Phase Interdisciplinary Research. A joint Effort of Depart. of Anthropology, University of Indonesia and The John and Catherine D. Mac. Athur Foundation. 241 p.
- Purwanto, Y. 1999. *Kajian ekosistem kawasan pantai guna menunjang pengelolalan tambak dan rehabilitasi pantai di Paojepe, Siwa, Kabupaten Wajo, Sulawesi Selatan*. Workshop Penelitian Lintas Disiplin : Penanaman Bakau dan Pemisahan Terumbu Karang di Teluk Bone, Sulawesi Selatan. Antropologi, FISIP-UI, MacArthur Foundation, Pemda Tk II Wajo dan YTMI. Sengkang, 15 November 1999. 47 p.
- Purwanto, Y. 2000. *Pengelolaan Lokal Kawasan Pesisir : Studi Kasus Desa Tongke-Tongke, Bonepute dan Paojepe, Teluk Bone, Sulawesi Selatan*. Simposium dan Lokakarya International. Mengawali Abad ke 21 : Menyongsong Otonomi Daerah, Mengenali Budaya Lokal, Membangun Integrasi Bangsa. Research Center. UNHAS, Makasar, 1-5 Agustus 2000 : 19 p.
- Purwanto, Y. 2001. Pendekatan etnoekologi dalam pengelolaan kawasan pesisir di paojepe, Kabupaten Wajo, Sulawesi Selatan. *Seri Penelitian Fakultas Biologi UKSW* (4) 2 : Desember 2001 : 242-258 p.
- Suriamihardja, D., M. Sakka, A. Masinaedan M. Ramli. 1999. *Study of Siwa Oceanographic Condition*. Center for Environment Study. Hasanuddin University. Ujung Pandang 38 p + annexes.
- Weber, M and L. F. de Baeufort. 1911-1940. *The fishes of the Indo-Australian Archipelago* I-XI. Brill, Leiden.
- Whitten, A.J., M. Mustafa & G.S. Henderson. 1987. *Ekologi Sulawesi*. Gadjah Mada University Press. Yogyakarta. 845 pp.

- Winarto, Y.T., Arifin, H. Purwanto, Y., Prioharyono, J.E.M., Qosim, A., Gala, B. dan Lampe, M.. 1999. *Abrasion : Mangrove conservation, coral reef degradation, case from the coastal of South Sulawesi and the offshore of Pulau-Pulau Sembilan*. Department of Anthropology FISIP-UI and UNESCO. Jakarta. 86 p.
- Winarto, Y. T. and Y. Purwanto. 1999. *Research concept draft of coastal management in South Sulawesi*. Workshop of PCE program. McArthur Foundation. Palawan, Philippines, 1-5 march 1999 (not published).