

Rufford Small Grant

(for Nature Conservation)

In association with the Whitley Laing Foundation

REPORT

1. Title of Application

Cost-Effective Mangrove Rehabilitation Focusing on Restoration of Hydrology

2. Name of Applicant and/or Organization

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4. Executive summary

Many mangrove rehabilitation projects in Indonesia have experienced technical failure due to the incorrect assumption that degraded coastal lands that were once inhabited by mangroves can be re-established by simply replanting mangrove seedlings. In order to provide an alternative mangrove rehabilitation technique, we have initiated the project of cost-effective mangrove rehabilitation focusing on the hydrological restoration at Tiwoho, Bunaken National Park, Indonesia. The rehabilitation technique applied in this project follows the five important steps suggested by Lewis and Marshall (1997).

With the support of Rufford Small Grant the first step of the project of mangrove rehabilitation has been completed on October 2005, with some fundamental achievements. The hydrological condition of about 12 hectares of disused shrimp ponds located in the mangrove near the *Daseng Lolaro*- Coastal Community Resource Centre at Tiwoho had been restored. The restoration is to support natural secondary succession of mangroves on the site. Small-scale artificial plantation also conducted at some eroded locations within the site where natural establishment of mangrove has not been successful for many years.

New establishment of mangrove is expected to take place after the hydrology condition of the site was restored. To ensure the successful of natural mangrove establishment, the site has to be secured from any disturbances mainly from human activities and mangrove logs moving freely within the site during spring and neap tides. The successful of mangrove establishment has to be monitored and evaluated periodically. Species of new mangrove seedlings, their abundances and survival are of importance in explaining the natural secondary succession process of the mangrove ecosystem.

The second stage of the restoration project at Tiwoho was started in June 2006 with the support of Rufford Small Grant. The project activities include five major activities: (1) monitoring and evaluation of mangrove establishment, (2) site maintenance, (3) mangrove training, (4) mangrove education, and (5) legal drafting of mangrove management at Tiwoho in form of village ordinance. The completion of the project results in the comprehensive understanding of mangrove restoration program and its better management.

5. Objectives

The project objectives are, as follows:

1. To understand comprehensively the procedure of hydrological mangrove restoration;
2. To work together with local communities and any other concerning stakeholders in the practice of cost-effective and mangrove rehabilitation program and its better management;
3. To provide scientific information in the context of mangrove rehabilitation process.

6. The project site

The project is undertaken in the mangrove forest of Tiwoho, Bunaken National Park, which is located on the Coast of North Sulawesi, Indonesia (between $01^{\circ}35'00'' - 01^{\circ}36'2.00''$ N; $124^{\circ}50'.21.06'' - 124^{\circ}50'47.10''$). In 1991 some 12 hectares of mangrove area was converted to shrimp ponds at this location. Figure 1 depicts the map of the project site.



Figure 1. Map of the project site

7. The project team

The following are core team of the project:

- a. Helda Rapar (KELOLA staff, community organizer),
- b. Decky Tiwow (KELOLA staff, outreach and education),
- c. Edmundus Serin (KELOLA staff, community organizer and senior researcher)
- d. Ahmad Bason (KELOLA staff, community organizer and senior researcher)
- e. Local community at Tiwoho Village (mangrove group)
- f. Staffs at *Daseng Lokaw*– the Coastal Community Resource Centre

8. Method

To monitor mangrove establishment, seven quadrates of 20 x 20 m are set. The presence of mangrove seedlings are identified and counted up. Observation is made at three months interval. During the observation, notes are made to dying seedlings and possible causes of death. General observation is also conducted to specific locations where new mangrove seedlings are observable.

Twice in a month the restoration site is checked for the presence of free moving mangrove logs. These logs are made motionless by tying up them to standing trees or stakes. Relative small logs are leaning on standing trees. The site is also controlled regularly from man made disturbances.

Available draft of mangrove management is discussed with the Village Government and Village Representatives. Two focus group discussions are conducted to revise the Draft of Mangrove Management Tiwoho Village Ordinance.

Mangrove training is conducted at the Coastal Community Resource Centre, *Daseng Lokaw*. This training covers topics of bio-ecology of mangrove, mangrove observation methods, rehabilitation techniques, and sustainable use of mangroves.

Mangrove education is introduced in the local subject of coastal environment curriculum. A lecturing book of mangrove and syllabus are provided to support the implementation of mangrove education. Two primary schools at Tiwoho are involved in this process of mangrove education development.

9. Progress and achievement

Mangrove establishment and growth

It was reported in the first stage of the project that there was an establishment of natural mangrove seedlings of *Avicennia marina*, *Sonneratia alba*, and *Rhizophora apiculata* several months after the site's hydrology was restored. However, these mangrove seedlings established only on several locations mostly near their parent trees. At some locations subjected to erosion establishment of mangroves experienced problem. These locations had been replanted with several young mangroves (*Buguiera gymnorhiza* and *R. apiculata*).

Field observation indicates that secondary succession process on the restoration site has been initiated by three mangrove species of *A. marina*, *R. apiculata* and *S. alba*. Seedlings of *A. marina* are abundant near their parent trees particularly on landward margin. Figure 2 shows an abundant population of these seedlings near the landward channel in the restoration site. Distribution of *A. marina* seedlings is restricted to locations where mature trees of this species are currently present. It is also expected that the species

may not invade the middle and seaward margins of the restoration site. The most possible places of establishment of this species may be the site with relatively hard and sandy substrate on the landward margin. Seedlings of *S. alba* and *R. apiculata* are common within the restoration site. These two species are expected to dominate the future community structure of mangrove within the restoration site. Field observation indicates that seedlings of these species have started to invade the middle area and landward margin of the restoration site (Figure 3 a,b).



Figure 2. *A. marina* seedlings near their parents



Figure 3. (a) established seedlings of *R. apiculata*, (b) seedlings of *S. alba*

Figure 4 shows detail composition and number of mangrove species that have established during field observation. Data in this Figure are from seven sampling quadrates set up within the restoration site, and not included replanted seedlings of *C. tagal*. As can be seen in the Figure that seedlings of *R. apiculata* and *S. alba* have increased continuously and they have been present at almost all sampling locations. This pattern may indicate the future structure of mangrove on the restoration site that will be dominated by the two species. In comparing to seedlings of *R. apiculata* and *S. alba*, seedlings of *A. marina* are less abundant and they are present only at two sampling locations on landward margin. Meanwhile, seedlings of *B. gymnorhiza* are found only at one sampling location, and some of them are no longer to survive.

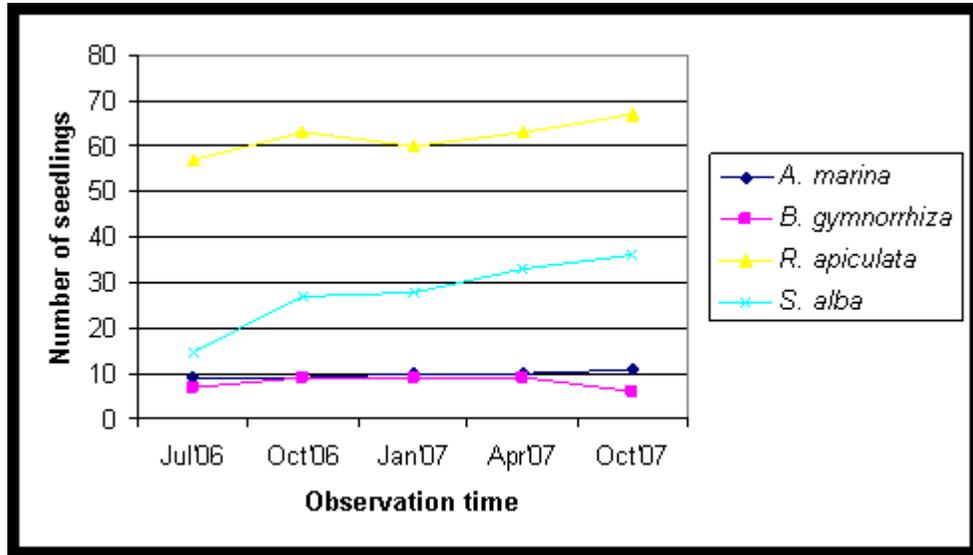


Figure 4. Mangrove seedlings composition and abundant observed on seven sampling quadrates of 20 x 20 m from July 2006 to October 2007.

Figure 5a,b shows different condition of establishment process on landward margin of the restoration site. The colony of *A. marina* seedling was firstly observed in three months after the hydrology of the site was restored (Figure 5a). Rapid growing of the colony can be seen in the Figure 5b. The colony remains dense and individual trees are healthy. It is expected that the colony may be successful in colonising this location.



Figure 5. (a) early stage establishment of *A. marina*, (b) current condition.

It is also observed in the field that the current condition of the restoration site supports the healthy growth of natural young trees of mostly *R. apiculata* and *S. alba* as shown by their physical performances. These healthy young trees are producing many seeds that are of importance to support the successful of natural secondary succession. On some locations, the growth rate of replanted *C. taga* has increased since the hydrology of the site was restored as shown in Figure 6a, b. Long-term establishment of these fast growing of *C. taga* trees is questionable because the physical condition of the site may change by the time.



Figure 6. Fast growing of replanted young trees of *C. tagal*: (a) condition on October 2006, (b) condition on April 2007.

In the first stage of the project, a number of seedlings and young trees of *R. apiculata* and *B. gymnorhiza* was planted along the north tidal channel, on already ascended channel and on accreted mangrove area to the north. These replanted seedlings grow relatively slow along the tidal channel and on ascended channel (Figure 7a,b). But, about half of them died on accreted mangrove area. The hydrological change seems to have little effect on this specific area.



Figure 7. (a) replanted seedlings of *R. apiculata* and *B. gymnorhiza* on ascended tidal channel, (b) the same seedlings near the tidal channel.

On accreted area of mangrove to the south replanted young trees of *C. tagal* experience problem in growth. They tend to be stunted due to probably salt stress in the sediment. Rate of mortality of these trees is also significant. On the same area, young replanted trees of *R. apiculata* are also stunted, but their rate of mortality is not significant. The physical change pattern in this area is expected towards a relative normal mangrove condition, which is different from the direction of change in the accreted mangrove area to the north. Figure 8 shows the current condition of the growth of replanted mangroves on accreted mangrove area to the south.



Figure 8. Stunted growth of *C. tagal* and *R. apiculata* on accreted mangrove area to the south.

When mangrove logs are moving freely within the restoration site, they may kill seedlings and young trees. The process of new establishment in the site may be influenced by the presence of free moving mangrove logs. During the period of the project implementation, the project team has secured the restoration site from 48 free moving mangrove logs with diameters ranging from 20 to 80 cm. Figure 9 shows the project team tying up mangrove logs to steady stakes. To minimise the restoration site from being disturbed by local community, the site was controlled regularly and a board informing the conservation status of the mangrove was set.



Figure 9. Mangrove loges are tied up to steady stakes

Mangrove training and education

On August 3 to 5, 2007 a mangrove training was undertaken at the Coastal Community Centre Daseng Lolaro, Tiwoho. Participants of the training represents local community of Tiwoho, local community around the Tomini Bay, NGOs (local and national), University Staffs and Government Institutions (Fishery and Forestry Offices) from three Provinces in the North Peninsula of Sulawesi Island (North Sulawesi, Gorontalo and Centre Sulawesi). This training is also supported by the IUCN-Canada.

Several topics were included in the training. Participants learned the basic theory of mangrove bio-ecological aspect that comprises of adaptation strategies, regeneration process, growth and development. Simple and applicable mangrove observation techniques were also included in the training topic of discussion. Other topics of the training were mangrove rehabilitation procedure (artificial and hydrological restoration) and sustainable management concepts of mangrove. In the field most of the topics were practiced. Figure 10 shows the training participants in observing the mangrove condition at the restoration site.



Figure 10. Training participants were observing mangrove condition at the restoration site

As part of the project, mangrove knowledge is introduced to primary schools children through the development of Coastal and Sea Environment Curriculum. The project team worked intensively with primary teachers from the two schools in Tiwoho in providing teaching book and syllabus. It took almost three months for the project team to complete the teaching book and syllabus. Content of the teaching book is designed in a simple format with a lot of pictures to help teachers in understanding any information, concepts and ideas inside.

In the beginning of the curriculum implementation, the project team was working with involved teachers to integrate the subject in the school's timetable for two semesters. Serious discussion had also been focused on several aspects of teaching materials and supporting facilities. Because some teachers were not confident in lecturing several teaching materials, they were supervised by a team member of the project during in and out class activities (Figure 11a,b).



Figure 11. (a) The project team is lecturing mangrove, (b) in practicing mangrove plantation

In class activities are made interactive. Material presentations in form of texts, pictures, photos, and films are interesting for students. They respond actively to the lecture, making many questions and statements. Students seem to be familiar with any aspects in the subject.

Out class activities are more interesting. Students are enjoyable and participate actively in observing coastal environment and organisms they found. Their local knowledge and closed relationship to coastal environment in combination with knowledge they get in the class push them to know more detail of coastal environment and organisms within it. Two hours in the field seem to be not enough for students in observing marine organisms and practicing related research methods.

Change in local people perception and attitude

Local people perception to mangrove change very much. It is because they have learned much about the ecological value of the mangrove. It is believed that the mangrove can protect the village from big wave, habitats of specific coastal and marine organisms, spawning ground for certain species of fishes. During the bad weather, usually falls between November and January, the mangrove provides local people with protein through collected mollusks and crabs from it.

Wisely use of mangrove and its associated natural resources is the commitment of local people in Tiwoho. Cutting mangrove for fire wood and collecting mangrove leaves for food of goat is not practicing any more. Local people in collaboration with the Village Government take control on the resource from any detrimental activities. The practice of community-based mangrove management seems to work in this Village.

There is a significant upsurge in the local people awareness in relation to mangrove. Local people participate actively in any programs of mangrove rehabilitation. They are supporting the policy of the National Park of Bunaken in allocating some 60 hectares of mangrove in the Village to be rehabilitation mangrove zone. In the implementation of hydrological restoration many local people took part on it. Primary school children and teachers are enthusiastically replanting mangroves and making regular observation and evaluation to their mangrove rehabilitation program.

The draft of Mangrove Management Village Ordinance had been revised during the consultation process and in the Village Meeting. However, both responsible institutions in the Village (the Village Government and Village Representative) are not enthusiastic to establish it immediately due to the current change in the people perception and attitude to mangrove.

Networking

The project could not be implemented successfully without an active involvement of local villagers, primary schools and the Village Government of Tiwoho. These all elements in fact have been of important part of the project. They took part in the project design and field program implementation. A strong collaboration between these elements and the project team has contributed significantly to the existence of the *Daseng Lolaro*, Coastal Community Resource Centre at Tiwoho, as a community-based mangrove learning centre.

The Bunaken National Park Office supports the project implementation with recommendation and information board. Other participants in the project implementation are North Sulawesi Friends of the Earth in developing mangrove education, nature lover groups from various universities in observing mangrove on the restoration site and assisting mangrove training.

The Coastal Community Resource Centre at Tiwoho provides field laboratory and supervision to university students to learn mangrove and the practice of mangrove rehabilitation techniques and community-based mangrove management. The Centre is visited regularly by the students from various universities in the

North Sulawesi Province and other places. Several postgraduate and undergraduate researches had been conducted at the mangrove in Tiwoho during the last two years.

The development of mangrove education in the local subject of Coastal and Sea Environment Curriculum is supported by the Education Office in the Sub-District of North Minahasa. A number of primary schools in this Sub-district is now introducing the local subject. Implementation of the local subject in this Sub-district is supervised by the project team through the Coastal Community Resource Centre at Tiwoho. Four others primary schools within the Bunaken National Park also develop the same local subject.

The Coastal Community Resource Centre at Tiwoho is playing a significant role in linking various mangrove concerning groups and individuals. Mangrove trainings that had been undertaken at the Centre during the year 2006 and 2007 have been important events for these mangrove concerning groups and individuals to meet and learn together.

10. General conclusion and recommendation

Restoration to the hydrological condition of disused shrimp ponds has supported the natural secondary succession of mangrove. The succession initiates with the establishment of three mangrove species of *A. marina*, *R. apiculata* and *S. alba*. However, new establishment of mangroves seems to restrict to some locations. Mangrove seedlings experience problem to establish on particular locations such as on accreted mangrove area to the north and south.

The current hydrological condition of the site also supports the fast growth of young trees of two species (*R. apiculata* and *S. alba*). The future mangrove development is expected to be dominated by these two species. Growth rate of replanted young trees of *C. tagal* has accelerated after the site was restored. But, future development of trees of this species is questionable because the mangrove condition may change by the time.

There is much change in the local people perception and attitude regarding to mangrove. Although the Mangrove Management Village Ordinance is not formally established, local people are now practicing wise use of mangrove that is in line with the concept of community-based mangrove management. They participate actively in any mangrove rehabilitation programs.

The project has been beneficial for the Coastal Community Resource Centre in providing field object of mangrove study, mangrove training and education, as well as networking among concerning mangrove groups and individuals.

It is recommended that long-term observation of the mangrove establishment and the maintenance of the restoration site have to be undertaken. Mangrove training is of importance in disseminating the best practice of mangrove rehabilitation and community-based mangrove management. This training is recommended to be conducted regularly at the Centre. Integration of mangrove education in the primary schools' local subject needs to be developed.