RESTORATION OF MANGROVE FOREST AND IMPROVING THE AWARENESS OF THE LOCAL COMMUNITIES ON THE PROTECTION OF MANGROVE ECOSYSTEMS

Nguyen Thi Thanh Thuy, Ha Le Thi Loc
Institute of Oceanography

ABSTRACT

The project was supported by Rufford Small Grant (British), carried out based on co-management principles with participation of the local community. Sustainable Project Management Unit (PMU) was formulated including members of Institute of Oceanography, Van Ninh and Van Tho People's Committees. Based on field trip surveys and the local planning till 2020 and with agreement of the local authorities, the project sites were selected at Tuan Le Village, Van Tho commune. The selected site was marked by wooden poles and panels to prevent it from damage by other human activities. The local community was propagandized purposes of the project, long term benefit of mangrove eco-system and necessity of mangrove protection. The participators were selected based on criterion such as volunteer and enthusiasm. Sources of *Rhizophora apiculata* Bl. propagules from Can Gio mangrove forest. The new mangrove replanted area with size of 05ha was designed by Van Ninh Economic Department. Besides, shrimp pond banks affected by wave impact and mangrove incompletely destroyed areas with size of 0.5 ha, approximatively, were also selected for supplementing mangroves. The mangroves were taken care regularly by the participators and the sustainable PMU. The growth rate and survival of the mangroves were recorded monthly. The results showed that, after seven months of replanting, the diameters of the mangroves increased from 1.501 ± 0.102 cm to 1.670 ± 0.100 cm and 1.620 ± 0.700 cm at the new mangrove replanted area and shrimp pond banks, respectively. The height of mangroves increased from 20.825 ± 3.564cm to 53.630 ± 6.550 cm and 45.850 ± 11.850 cm at the new mangrove replanted area and shrimp pond banks, respectively. The survival of the mangroves was 70.000 ± 2.880 % and 68.467 ± 1.230% at the new mangrove replanted area and shrimp pond banks, respectively. The success of the project thanks mainly to high agreement and support of the local community. Through the project's activities, awareness of the local communities on long term benefit of mangrove ecosystem was significantly improved. The new mangrove replanted area has been handed over to Van Ninh and Van Tho People's Committees and Tuan Le community for management.

I. INTRODUCTION

Mangrove forest is considered a natural valuable common property resource supporting livelihoods of coastal communities both directly and indirectly. In 1975, Khanh Hoa had 3000 ha of mangrove forest. However, as ineffectively implemented local authority conservation principles combined with limited awareness of local communities on the long term benefits of the mangrove ecosystem, many such areas in Khanh Hoa province have been destroyed for agriculture, urbanization and frequently shrimp aquaculture.

According to Khanh Hoa Agriculture and Rural Development Department, in 2000, the total area of mangrove forest in Khanh Hoa remained about 100 ha. In fact, mangrove destroyed areas are not ideally suited to shrimp farming because of acid sulfate soils. On the other hand, the spontaneous development of intensive shrimp culture has produced large amounts of waste water and solids which cause water pollution and outbreaks of disease. The biggest lost in Khanh Hoa, at 2 million USD, was in 2001. Many local farmers are now in debt and have to cease culture. Consequently, hundreds of shrimp farming ponds in the mangrove destroyed areas are now fallow. The local authorities are aware the negative impacts on environment and the long term benefits of mangrove ecosystem management. In 2004, the local authorities invested in the replanting of 2ha of mangroves belonging to Van Tho commune, Van Ninh, Khanh Hoa.

The overall aim of the project is to replant 10 ha of mangroves in the specific mangrove destroyed areas unusable for other purposes. Concurrently, it is to improve awareness of the local communities on protection, sustainable use and long term benefits under the ‘code of conduct for responsible mangrove management’.

II. MATERIALS AND METHODS

1. Duration and organization principles of the project

The project was carried out from August 2006 to July 2007 based on co-management principles and community participatory.

Sustainable Project Management Unit (PMU) was formulated including members of institute of Oceanography, Van Ninh and Van Tho People’s Committees and the head of Tuan le Village.

Workshops and meetings were organized (Photo1-Appendix1) to propagandize purposes of

the project and improve awareness on “Protection of natural mangrove ecosystem and its long term benefits” with target beneficiaries focusing on local staffs and communities through participating project activities. The participators were selected by the PMU, based on criterion such as volunteer and enthusiasm.

2. Project sites

Based on the field trip surveys and the local planning till 2020, the project sites were selected at Tuan Le Village, Van Tho commune, Van Ninh District, Khanh Hoa province where the level of local commitment allowed the sustainable replanting new mangroves. The first selected area with size of 0.5ha (Figure 1) was in mid-tidal zone, which was designed by Van Ninh Economic Department. The select site was marked by wooden poles and panels (Photo 2-Appendix 1) to prevent it from damage by other human activities. The second selected area was in high tidal zone, including shrimp pond banks affected by wave impacts, and mangrove incompletely destroyed areas (so called mangrove supplemented area) with size of 0.5 ha, approximatively. Both of the shrimp pond banks and the mangrove supplemented areas belong to the local volunteer participators.

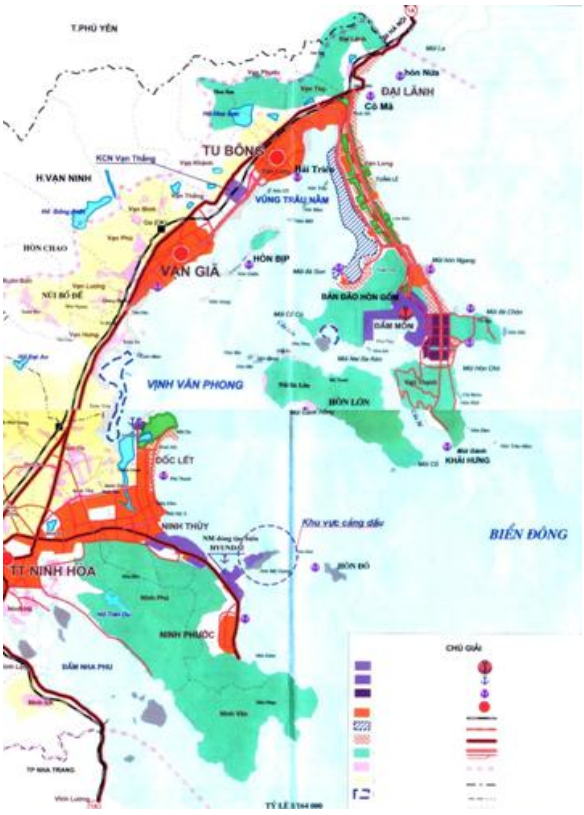

Figure1. Map of overall planning till 2020 of Van Phong Bay; project sites:

3. Source of propagules and pretreatment for replanting

Rhizophora apiculata Bl. propagules, with sizes from 20 – 27cm in long and 14 – 16.5cm in diameter, originally from Can Gio mangrove forest were transported by aircon's van to the project sites for replanting (Photo 3 – Appendix 1).

The propagules were watered and kept under moisture condition until planted. Before planting, the propagules were pre-treated with the commercial pesticides and root growth promoting solution (Photo 4 – Appendix 1).

4. Planting techniques

Time for replanting the *Rhizophora apiculata* Bl. propagules was at low tide so that the bottom could be seen for making holes to fix mangrove propagules.

The density of *Rhizophora apiculata* Bl. propagules for replanting was 10,000 propagules/ha. The participators were trained theoretically in the workshop and practically on the field about techniques of planting and taking care of the propagules: two people were along together; one used a one meter wooden stick with one side pointed to make holes on the sea bottom and the other put the propagule in the hole and fixed it at 1/3 of the propagule. The gap between holes was 1 x 1 m (Photos 5 and 6- Appendix1).

5. Management and taking care of the mangroves

The participators regularly took care and guarded the mangroves at the project sites with management of the PMU.

After planting, the growth rate and survival rate of *Rhizophora apiculata* Bl. propagules were monthly recorded by the working team and the local participators (Photo 7- Appendix 1).

Sites for estimating growth rate and survival rate of the mangroves in the new mangrove replanted area were shown in Figure 2. Each site, 30 propagules were measured for estimating average diameter and height. Survival rate of the propagules was estimated by counting 100 propagules/site (10 x 10m), in which missing or dead propagules were estimated based on the gap between propagules (1x 1m).

As the shrimp pond banks and the mangrove supplemented area were in the same high tidal zone, growth rate of the mangroves in the shrimp pond banks was estimated and considered for both the areas. For estimating growth rate and survival rate of the mangroves in the shrimp pond banks: choosing 3 sites along the shrimp pond bank. Measuring 30

propagules/site. Regarding survival rate, counting 100 propagules in which missing or dead propagules were estimated based on gap between propagules (1x1m).

6. Statistical Analysis

Validity was determined by the One Way ANOVA. P (probability) < 0.05 was considered statistically significant.

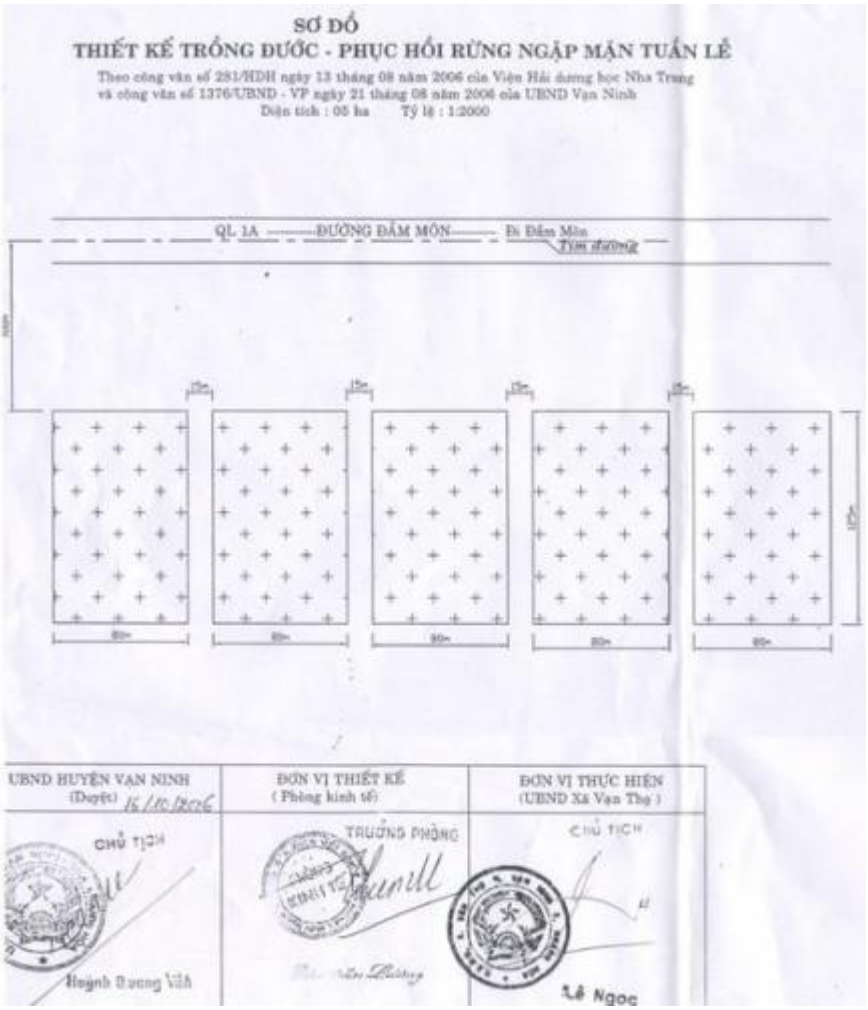

Figure 2. The project site was designed by Van Ninh Economic Department; Points for estimation of growth rate and survival rate of the mangroves:

III. RESULT AND DISCUSSION

1. Improving awareness of the local communities

Before implementation of the project, a workshop was organized with target beneficiaries focusing on local authority staffs and key persons in the communities to inform purpose of the project and complement them acknowledge in long term benefit of mangrove eco-system and necessity of mangrove protection. The most important and basic materials

related to mangrove restoration and forest protection were distributed to the local authority staffs and key persons. Then the key persons came to the local household by household to explain the purpose of the project and canvass them to participate and support actively project activities.

It has been reported that the standard of living and education of the local communities are rather low and their livelihood relies mainly on fishing and aquaculture, which limit their awareness on protection of natural resources and environment (Do Huu Hoang et al, 2007). However, thanks to enthusiasm of the PMU and local key persons, all 35 households including children in Tuan Le village attended in the meetings in which the purposes of the project and long term benefit of mangrove eco-system were propagandized to them by the simple way. On the other hand, through the project's activities, the local communities could understand the meaning of the project easier than they just attended in the meetings and listened theoretically.

2. The growth rate of the mangroves at the project sites

The restoration of mangroves at the new mangrove replanted area, shrimp pond banks and mangrove incompletely destroyed areas (so called mangrove supplemented area) was depicted in Photos 8 to 17 (Appendix 2 and 3).

a. The average diameters of *Rhizophora apiculata* Bl. according to time

The growth rate of *Rhizophora apicula* Bl. in term of diameter at the new mangrove replanted area (mid tidal zone) and in the shrimp pond banks (high tidal zone) was shown in Table 1, Figure 3 and Figure 4. The result showed that, after seven months of replanting, the diameter of the mangroves increased from 1.501 ± 0.102 cm to 1.670 ± 0.100 cm and 1.620 ± 0.700 in the new mangrove replanted area and shrimp pond banks, respectively. Statistically, there was no significant difference in diameter (ANOVA, $P > 0.05$) of the mangroves between the new mangrove replanted area and the mangroves in the shrimp pond banks.

Table 1: The average diameters of *Rhizophora apiculata* Bl. according to time

Months after planting	Sites of planting mangroves	
	New mangrove replanted area	Shrimp pond banks
1	1.501 ± 0.102	1.501 ± 0.102
2	1.530 ± 0.118	1.537 ± 0.92
3	1.530 ± 0.961	1.535 ± 1.161
4	1.534 ± 0.05	1.533 ± 0.111
5	1.560 ± 0.06	1.565 ± 0.45
6	1.612 ± 0.166	1.573± 0.162
7	1.670 ± 0.100	1.620 ± 0.700

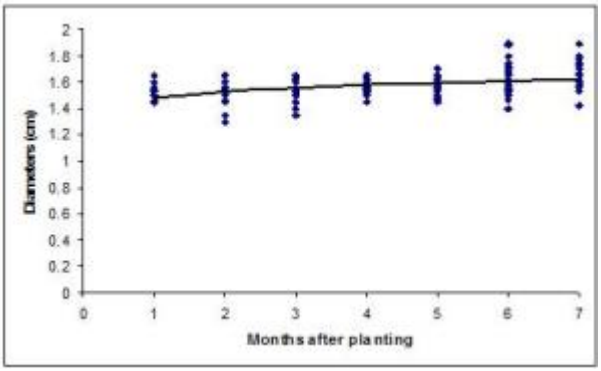

Figure 3. The average diameters of *Rhizophora apiculata* Bl. according to time at the new mangrove replanted area of Tuan Le village, Van Tho commune, Van Ninh - Khanh Hoa

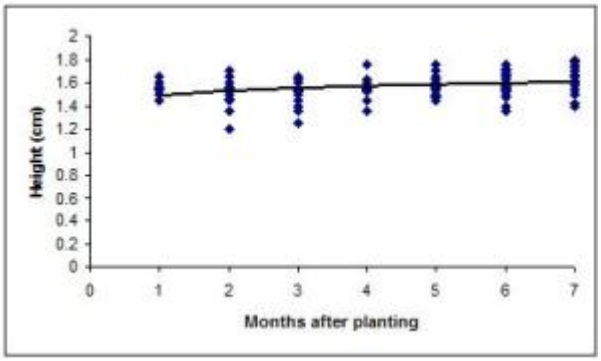

Figure 4. The average diameter of *Rhizophora apiculata* Bl. according to time at the shrimp pond banks of Tuan Le village, Van Tho commune, Van Ninh - Khanh Hoa

b. The average height of *Rhizophora apiculata* Bl. according to time

The growth rate of *Rhizophora apicula* Bl. in term of height at the new mangrove replanted area and shrimp pond banks was shown in Table 2, Figure 5 and Figure 6. The result showed that, after seven months of replanting, the average height of mangroves increased from 20.825 ± 3.564cm to 53.630 ± 6.550 and 45.850 ± 11.850 cm in the new mangrove replanted area and shrimp pond banks, respectively. Statistically, there was no significant difference (ANOVA, P> 0.05) in height of the mangroves between the new mangrove replanted area and the mangroves in the shrimp pond banks.

Table 2. The average height of the mangroves according to time

Months after planting	Sites of planting mangroves	
	New mangrove replanted area	shrimp pond banks
1	20.825 ± 3.564	20.825 ± 3.564
2	22.630 ± 2.214	22.870 ± 2.409
3	23.470 ± 2.100	23.100 ± 6.223
4	26.656 ± 7.334	26.400 ± 11.069
5	35.090 ± 9.300	35.170 ± 7.120
6	45.633 ± 12.44	38.493 ± 14.702
7	53.630 ± 6.550	45.850 ± 11.850

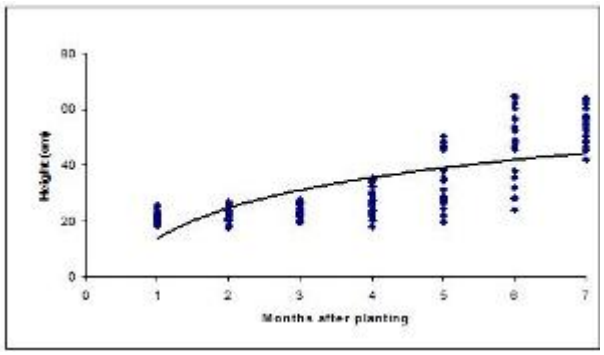

Figure 5. The average height of *Rhizophora apiculata* Bl. according to time at new mangrove replanted area

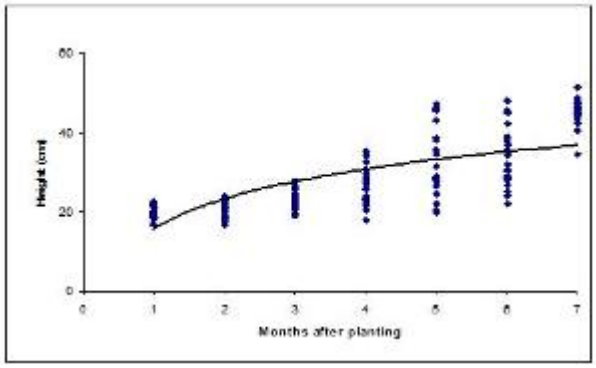

Figure 6. The average height of *Rhizophora apiculata* Bl. according to time at the shrimp pond banks (mangrove supplemented areas)

3. The survival rate of *Rhizophora apiculata* Bl. according to time

The survival rate of *Rhizophora apiculata* Bl. at the new mangrove replanted area and shrimp pond banks showed in Table 3. The result showed that, after seven month of planting, the survival rates of the mangroves were 70.000 ± 2.880 % and 68.467 ± 1.230 in the new mangrove replanted area and shrimp pond banks, respectively. There was no significant difference (P> 0.05, ANOVA) in the survival rate of the mangroves between the new mangrove replanted area and the shrimp pond banks.

Table 3: Survival rate of *Rhizophora apiculata* Bl. according to time

Months after planting	Sites of planting mangroves	
	New mangrove replanted area	Shrimp pond banks
0	100	100
1	95.680 ± 2.830	95.750 ± 5.460
2	76.600 ± 7.733	79.800 ± 3.194
3	75.800± 4.380	76.567 ± 1.789
4	71.600 ± 5.367	72.800 ± 1.789
5	70.800 ± 2.770	71.340 ± 8.921
6	70.400 ± 2.966	69.600 ±1.950
7	70.000 ± 2.880	68.467 ± 1.230

IV. COMMENTS

Generally, all the local shrimp ponds were built in high tidal mangrove destroyed zone. In fact, the mangrove destroyed areas were not ideally suited to shrimp farming because of acid sulfate soils. Meanwhile, the spontaneous development of the intensive shrimp farming, in which water inlet and outlet were the same channel, has produced large amounts of waste water and solids which was normally drained directly into the sea causing water pollution and outbreaks of disease. As results, hundreds of shrimp farming ponds in the mangrove destroyed areas have been fallow. Within the project's grant, it was impossible to support all the local shrimp culture farmers to replant mangroves at their areas. However, through project's activities, especially, success of the volunteer participators, the local shrimp culture farmers have now realized the negative consequence of destroying mangroves to environment and understood that no one but they themselves are who have suffered from the negative impacts.

It is not enough time and scientific basis to conclude about positive effects in term of environmental improvement through mangrove restoration at the project sites. However, visually it could be said that aquatic benthos, especially bivalves and gastropods could be seen more during the field trips in the project sites after 7 months of mangrove restoration. In fact, the new mangrove replanted area has been keeping away from other human activities which might damage the new mangroves. The local people, who normally catch the benthos for food or aquaculture in the area before, now have been participating to guard and take care of new replanted mangroves. Through the project's activities, awareness of the local communities on long term benefit of mangrove ecosystem was significantly improved.

V. CONCLUSION

The results showed that, after seven months of replanting, the diameters of the mangroves increased from 1.501 ± 0.102 cm to 1.670 ± 0.100 cm. The height of mangroves increased from 20.825 ± 3.564cm to 53.630 ± 6.550 cm. The survival of the mangroves after 7 months was 70.000 ± 2.880 %. The success of the project thanks mainly to high agreement and support of the local community. Through the project's activities, awareness of the local communities on long term benefit of mangrove ecosystem was significantly improved. The new replanted mangrove area has been handed over to Van Ninh and Van Tho People's

Committees and Tuan Le community for management. Obviously, the project could only succeed with high agreement and actively support of the local communities and authorities.

VI. SUGGESTIONS FOR FUTURE WORK

There are still many fallow shrimp ponds located in Van Ninh district. The fallow areas belong to the local shrimp culture farmers who could not continue their job with high risk of lost cause. It has been known that shrimp culture in mangroves areas is a sustainable model which has been applied in some countries in the South East region. Therefore, replanting mangroves in the fallow shrimp ponds is feasible solution to improve environment and give the farmers chances to continue their job. On the other hand, as the fallow shrimp ponds belong to private property of the farmers, it is easier to take care of new mangroves replanted in the areas by the farmers.

ACKNOWLEDGEMENT

The project was funded by Rufford Small Grant. Special thanks to Van Ninh and Van Tho People's Committees and Tuan Le communities for high co-operation and active participation.

REFERENCES

1. Do Huu Hoang, Phan Minh Thu, Huynh Minh Sang. 2006. Evaluating the awareness of some coastal communities on natural marine living resources: basic for improving understanding

2. Nguyen Tac An, Bui Hong Long and Phan Minh Thu, 2004. Aquaculture in Van Phong Bay: Approaches for sustainable development. Conference on Approaches for developing economics in Van Phong Bay. Nha Trang. June 24, 2004.

3. Nguyen Tac An, 2005. Approaches to rehabilitation of coral reefs and seagrasses and restoration of marine environmental pollution. National Scientific Report. Institute of Oceanography, Vietnam. 200pp.

APPENDIX

Photo1. A meeting to propagandize purposes of the project and improve awareness of the local people on protection of mangrove ecosystem

Photo2. Marking the area for replanting mangroves at Tuan Le, Van Tho, Van Ninh - Khanh Hoa

Photo3. *Rhizophora apiculata* Bl. propagules were transported by aircon'van from Can Gio to Van Tho, Van Ninh-Khanh Hoa

Photo 4. *Rhizophora apiculata* Bl. propagules were treated with chemicals and measured before replanting

Photo 5. The local people participated replanting *Rhizophora apiculata* Bl. at new replanted area belonging to Tuan Le village, Van Tho commune, Van Ninh - Khanh Hoa

Photo 6. The local people participated replanting *Rhizophora apiculata* at shrimp pond banks belonging to Tuan Le village, Van Tho commune, Van Ninh - Khanh Hoa

Photo7. Measuring monthly diameter and height of *Rhizophora apiculata* Bl.

Photo 8.Two month old *Rhizophora apiculata* Bl. at new mangrove replanted area belonging to Tuan Le village, Van Tho commune, Van Ninh - Khanh Hoa

Photo 9.Two month old *Rhizophora apiculata* Bl. at shrimp pond banks mangrove belonging to Tuan Le village, Van Tho commune, Van Ninh - Khanh Hoa

Photo10.Two month old *Rhizophora apiculata* Bl. at mangrove supplemented area belonging to Tuan Le village, Van Tho commune, Van Ninh - Khanh Hoa

Photo11. Four month old *Rhizophora apiculata* Bl. at new mangrove replanted area belonging to Tuan Le village, Van Tho commune, Van Ninh - Khanh Hoa

Photo12. Four month old *Rhizophora apiculata* Bl. at shrimp pond banks belonging to Tuan Le village, Van Tho commune, Van Ninh - Khanh Hoa

Photo 13. Four month old *Rhizophora apiculata* Bl. at mangrove supplemented area belonging to Tuan Le village, Van Tho commune, Van Ninh - Khanh Hoa

Photo14. Six month old *Rhizophora apiculata* Bl. at Tuan Le village, Van Tho commune, Van Ninh - Khanh Hoa

Photo15. Seven month old *Rhizophora apiculata* Bl. at new mangrove replanted area belonging to Tuan Le village, Van Tho commune, Van Ninh - Khanh Hoa

Photo16. Seven month old *Rhizophora apiculata* Bl. at shrimp pond banks belonging to Tuan Le village, Van Tho commune, Van Ninh - Khanh Hoa

Photo17. Seven month old *Rhizophora apiculata* Bl. at mangrove supplemented area belonging to Tuan Le village, Van Tho commune, Van Ninh - Khanh Hoa