

Evaluation of mangrove reforestation and the impact to socio-economic-cultural of community in Lubuk Kertang village, North Sumatra

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Abstract. Mangrove forests in North Sumatera existed in the east coast of Sumatera Island and are rapidly threatened due to anthropogenic activities such as conversion for aquaculture, oil palm plantation, filling and use of mangrove for urban development. The present study describes the current and first-year evaluation on mangrove restoration and its impact to socio economic-cultural of community in Lubuk Kertang village, Langkat, North Sumatra, Indonesia. The rehabilitation was carried on December 2015 using direct planting of 6,000 *Rhizophora apiculata* propagules and May 2016 using 5,000 *R. apiculata* seedlings. The evaluation parameters of mangrove reforestation consist of seedling diameter and height, leaf thickness and number, and seedling growth rate. Ninety-two of 1,124 households were surveyed using Slovin formula to obtain community perspective on the socio-economic-cultural impact of reforestation. Results show that the growth rate for current and first-year evaluation was 93 and 86 %, respectively. By contrast, the height, diameter, and some leaves seedlings planting were shown better than the performance of propagules planting. No change in the green foliage plant thickness between both farming methods. The reforestation affected 71.74, 55.43 and 39.13% of economic, social, and cultural of Lubuk Kertang community, respectively. The data is likely to provide valuable information for mangrove reforestation in North Sumatra.

1. Introduction

Mangrove forests in Indonesia including North Sumatera are rapidly threatened due to anthropogenic activities and climate change [1-2]. Indonesian mangrove forests have been degraded from 4.2 million in 1980 to only 3.1 million in 2011 [3]. Furthermore, the mangrove deforestation rate in North Sumatra from 1990 to 2015 was reported as 1.51 %/year, similar to percentage mangrove lost 2000-2012 overall Indonesia (1.72%) [2,4]. The replacement of mangroves to aquaculture and oil palm plantation has been principal drivers of mangrove loss in Indonesia [2-4]. Therefore mangrove conservation, as well as



reforestation of degraded mangroves, is required to maintain the existence of mangrove forests and challenges to changing environments.

In spite of mangrove reforestation globally or regionally as well as the socio-economic significance of essential mangrove service was well documented [5-6], reforestation and its impact to socio economic-cultural of surrounding mangrove forests are rarely reported especially at nationally or regency level in Indonesia. The present study aimed to examine the comparative evaluation using direct planting (the current year) and indirect planting (first year) of mangrove reforestation and its impact to socio economic-cultural of community in Lubuk Kertang village, Langkat, North Sumatra, Indonesia.

2. Materials and Method

2.1. Study area

The study was carried out in Lubuk Kertang mangrove forest, North Sumatra, Indonesia, covering an area about 1200 ha. The Lubuk Kertang village is sited at 04° 07' 39.71" North latitudes, and at 98° 30' 97.87" East longitudes (Figure 1). Lubuk Kertang is regionally at Langkat Regency and district of Brandan Barat. The reforestation in Lubuk Kertang village was carried on 5 December 2015 using 6000 direct planting (propagules) of *Rhizophora apiculata* and indirect planting of 5000 *R. apiculata* seedlings. Two times of assessments, on 20 September and 20 December 2016 were carried out to monitor and evaluate 400 rehabilitated seedlings, respectively.

2.2. Growth measurement and rate

The growth determination of *R. apiculata* seedlings from direct and indirect plantations was by the stem height and diameter of the plants. Ruler with 1 cm accuracy was used to measure stem heights from the base of the propagule to highest plant tip where the stem shoots grow. Plant diameter was measured using a digital caliper. Thus, the stem heights and diameters *R. apiculata* were the indices of growth in this study. The percentage of plant growth calculated by comparing the number of plants present in a plot with the number of plants that should be present in the measuring plot grid as previously reported [2]. The calculation of growth rate refers to the regulation of Ministry of Forestry, Government of Indonesia number P.70/Menhut-II/2008.

2.3. Analysis of community perspective on socio-cultural impact of mangrove rehabilitation

Analysis of view of Lubuk Kertang community knowledge on mangrove forest, Community's attention for the changing of mangrove conditions, and Perspective of community knowledge on mangrove rehabilitation were performed using questionnaires. Nine-two head of household from a total of 1124 households was surveyed using Slovin formula to obtain community perspective on the socio-cultural impact of mangrove rehabilitation.

These respondents were collected to answer closed-ended questions [7]. The respondents are given a list of fixed items from which to choose their response, including multiple available answers and the meaning [7].

3. Results and Discussion

3.1. Evaluation of rehabilitated mangrove plant *R. apiculata*

The evaluation parameters of mangrove reforestation consist of seedling diameter and height and seedling growth rate. Results show that the growth rate for direct planting and seedling evaluations was 96 and 86 %, respectively (Tables 1-4), this increase excluded attacked pests. The growth was relatively lower with the accounting of attacked pests, in the current year, for first and second assessment the percentage growth was 90.75 and 85.25 %, respectively. In the case of performance of indirect planting, the survival growth rate with attacked pests was 90.75 and 79.50 % respectively.

By contrast, the plant height and diameter, and some leaves seedlings planting were shown better than performances of propagules planting (Figures 2-3). No change in the blade thickness between both

replanting methods (data not shown). Several factors that influence the success of mangrove rehabilitation activities within this location are plant spacing, planted seed condition, propagule, plant maintenance, pest and disease, and human activities [2,6]. It has been suggested as specific considerations when rehabilitating mangroves such as site selection for mangrove planting, planting mangroves that consist of natural regeneration artificial regeneration, and involvement of local people [8]. In this context the successful reforestation in this study due to the appropriate site and mangrove species and supporting the local community as well in Lubuk Kertang village.

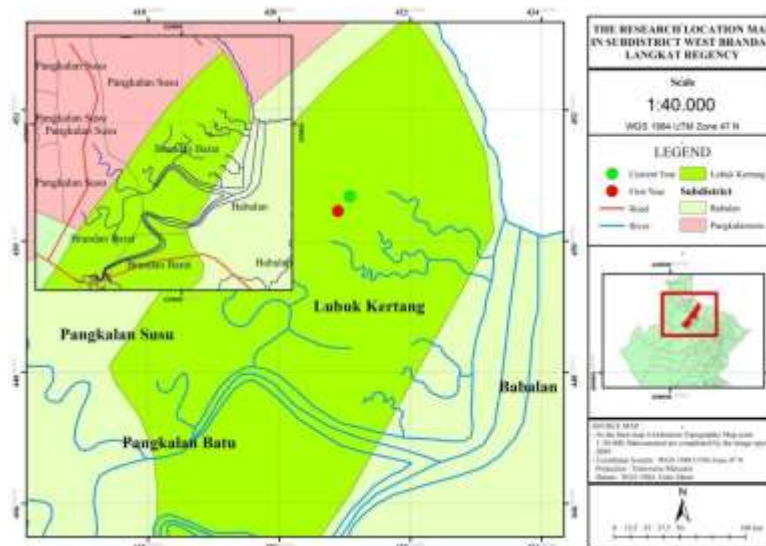


Figure 1. Study area at Lubuk Kertang

Table 1. Growth rate of rehabilitated mangrove using direct planting for first observation

No	Current year	Seedling plots			
		Plot 1	Plot 2	Plot 3	Plot 4
1	Survival seedlings	96	100	100	100
	– Healthy	91	95	89	92
	–Attacked pests	5	5	11	8
2	Dead seedlings	4	0	0	0
Total		100			

Table 2. Growth rate of rehabilitated mangrove using direct planting for second observation

No	Current year	Seedling plots			
		Plot 1	Plot 2	Plot 3	Plot 4
1	Survival seedlings	96	98	95	82
	– Healthy	90	92	84	75
	–Attacked pests	6	6	11	7
2	Dead seedlings	4	2	5	18
Total		100			

3.2. Analysis of community perspective on socio-cultural impact of mangrove rehabilitation

As shown in Tables 1-4 the pest-infected plants varied among the plots studied. Table 2 depicts plot 4 of the plants affected by 7% pests, and the dead plants were 18%. One of the causes of damage to mangrove ecosystems was a caterpillar, the dominant pest. Caterpillars usually attack mangroves by eating leaves on the lower surface of the leaves. The attack symptom is the leaves become hollow, and the next stage leaves become yellow, dry and finally fallen [9]. In the second observation of pests and diseases, not so much as in plot four pest and disease attacks decreased compared to the first view. This condition was probably at the second observation the seedlings might be able to adapt to the local environment resulted that plants look healthier than at the first remark.

The mortality rate at the second observation either in the direct and indirect plant is a significant increase that may be influenced by the local community activities that made the crab trap at the planting site. However, the rehabilitation program in this study is successfully categorized according to the forestry minister's regulation number 70 the year 2008, when the percentage of plant growth more than 70%.

Table 3. Growth rate of rehabilitated mangrove using indirect planting for first observation

No	First-year evaluation	Seedling plots (%)			
		Plot 1	Plot 2	Plot 3	Plot 4
1	Survival seedlings	99	92	99	97
	– Healthy	93	83	93	94
	–Attacked pests	6	9	6	3
2	Dead seedlings	1	8	1	3
Total		100			

Table 4. Growth rate of rehabilitated mangrove using indirect planting for second observation

No	First-year evaluation	Seedling plots (%)			
		Plot 1	Plot 2	Plot 3	Plot 4
1	Survival seedlings	80	88	96	81
	– Healthy	74	79	88	77
	–Attacked pests	6	9	8	4
2	Dead seedlings	20	12	4	19
Total		100			

3.3. Effect of rehabilitation on socio-economic culture

Table 5 shows the reforestation affected 71.74, 55.43 and 39.13% of economic, social, and cultural of Lubuk Kertang community, respectively. The relationship of mangrove forest rehabilitation to financial income is mangrove forest can increase the revenue of the community, especially the people who work as fishermen. Mangroves indirectly support fisheries through the mangrove function as nursery grounds for the early life stages of fish [5]. Mangroves and aquaculture are not necessarily mismatched, as suggested by [2,5], mangrove-friendly aquaculture is suitable in small-scale, may be applied in this location.

As displayed in Table 5 the relationship of mangrove rehabilitation program to the social community is that mangrove forest can be used as a place of association for society, and location of education and research. The relationship with the culture of the community is shallow. This reason was derived that forest products very rarely used in traditional events in Lubuk Kertang Village. From the observation of respondents within five years, the mangrove in Lubuk Kertang was more degraded. Conversion to aquaculture and oil palm plantations are in charge for deforestation in this study. Local people realized

that the mangrove condition is getting worse in the domination by the fishermen because they often interact directly with the mangrove forest.

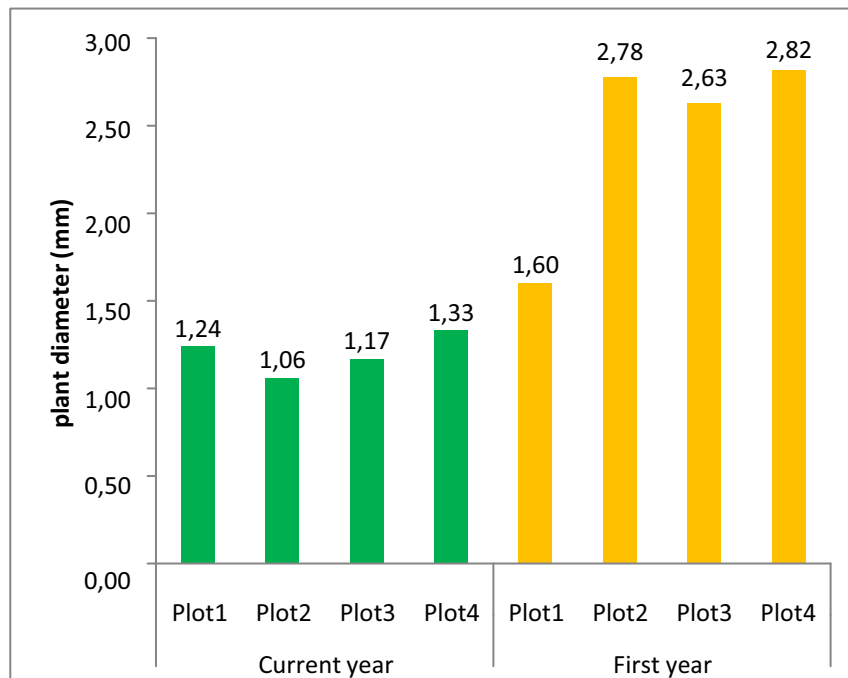


Figure 2. Average seedlings diameter of *R. apiculata* in the current and first year of assessment on September-December 2016

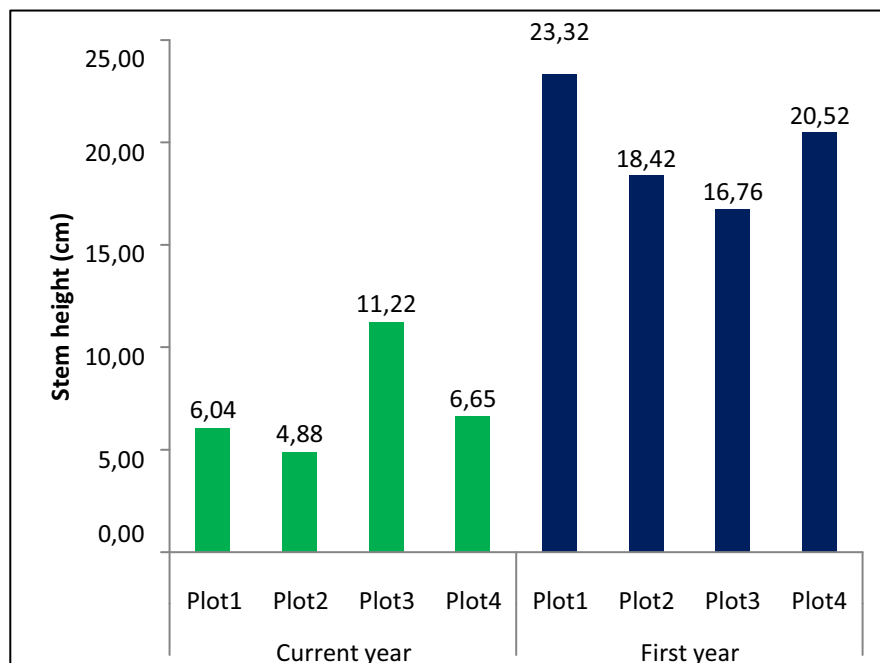


Figure 3. Average seedlings height of *R. apiculata* in the present and first year of evaluation on September-December 2016

Table 5. Perspective of community knowledge on mangrove forest

No	Aspect	Age Class (Year)					Total	%
		21-30	31-40	41-50	51-60	61-70		
1	Knowing/be familiar							
	a. Yes	10	27	29	7	5	78	84.78
	b. No	1	2	2	4	5	14	15.22
2	Understanding the benefits							
	a. Yes	8	20	16	8	4	56	60.87
	b. No	3	9	15	3	6	36	39.13
3	The effect of income							
	a. Affected	7	23	25	6	5	66	71.74
	b. Unaffected	4	6	6	5	5	26	28.26
4	The effect to social life							
	a. Affected	5	17	20	5	4	51	55.43
	b. Unaffected	6	12	11	6	6	41	44.56
5	The effect of culture and society							
	a. Affected	4	12	14	4	2	36	39.13
	b. Unaffected	7	17	17	7	8	56	60.87

Based on data from respondents, the decrease of fish caught in the sea was due to the reducing of mangrove forest in particularly in the coastal area. This land-use was largely in replacement to oil palm plantation. Meanwhile, the development of several companies of oil palm plantations in Lubuk Kertang became one of the factors of mangrove forest deforestation. Involvement all stakeholders (government, university, local non-governmental organization) including local community mainly rely on mangrove for their livelihoods are key for rehabilitation as shown in Table 6, more than 90% respondent agreed. The local people directly contributed in large part to the outcome of the reforestation program.

Table 6. Perspective of community knowledge on mangrove rehabilitation

No	Aspect	Age Class (Year)					Total	%
		21-30	31-40	41-50	51-60	61-70		
1	Understanding how to plant and to maintain mangrove rehabilitation							
	a. Understand	7	16	17	5	3	48	52.17
	b. Not understand	4	3	14	6	7	44	47.82
2	Necessary/not to rehabilitation							
	a. Yes	9	25	30	8	7	79	85.87
	b. No	2	4	1	3	3	13	14.13
3	Agree/not to mangroves rehabilitate							
	a. Agree	10	24	29	10	8	81	88.04
	b. Not agree	1	5	2	1	2	11	11.95
4	People who should be involved in rehabilitation							
	a. Government only	1	1	-	2	3	7	7.61
	b. Community only	-	-	-	-	-	-	-
	c. Institutions only	-	1	1	-	-	2	2.17
	d. All parties (a, b and c)	10	27	30	9	7	83	90.21
5	Response to students/agency							
	a. Very supported	10	28	29	8	8	83	90.21
	b. Unsupported	1	1	2	3	2	9	9.78
6	Community participation in mangrove forest rehabilitation							
	a. Interested to get involved	10	26	29	9	6	80	86.95
	b. Uninvolved	1	3	2	2	4	12	13.04

Table 7. Community's attention for the changing of mangrove conditions

No	Aspect	Age Class (Year)					Total	%
		21-30	31-40	41-50	51-60	61-70		
1	Understanding the changing within five years							
	a. There are changes	9	25	30	8	5	77	83.69
	b. No changes	2	4	1	3	5	15	16.30
2	Disagreement for mangrove conversion							
	a. Yes	3	2	3	6	6	20	21.73
	b. No	8	27	28	5	4	72	78.26
3	Mangrove forest condition							
	a. Good	4	12	7	3	2	28	30.43
	b. Bad	6	24	12	3	1	46	50.00
	c. No idea	2	6	8	1	1	18	19.57
4	The changing mangrove forest within five years							
	a. Better	5	11	6	4	2	28	30.43
	b. Getting worse	6	17	17	8	7	55	60.00
	c. No idea	1	4	3	1	-	9	9.78
5	Response to damaged mangrove forest conditions							
	a. Very concerned	8	24	29	8	5	74	80.00
	b. Unconcerned	2	7	3	4	2	18	20.00

4. Conclusions

The success and failure rate of mangrove reforestation in the current year was 93 and 7% and in the first year was 86 and 14% and, respectively. In this case rehabilitation activities are categorized successfully according to the regulation of the Minister of Forestry number P.70/Menhut-II/2008. The data is likely to provide valuable information for mangrove reforestation efforts in North Sumatra, Indonesia.

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