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## Assessment of one-year mangrove reforestation using *Rhizophora apiculata* seedlings in Lubuk Kertang village, North Sumatra

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**Abstract.** Mangrove forests in North Sumatra existed in the east coast of Sumatera Island and are rapidly degraded due to anthropogenic activities such as mangrove conversion to other land-uses. The present study describes one-year assessment on mangrove rehabilitation in Lubuk Kertang village, Langkat, North Sumatra, Indonesia. The restoration was carried on May 2016 using indirect planting of 6,000 *Rhizophora apiculata* seedlings. *R. apiculata* belongs to Rhizophoraceae family with hardwoods, have good stilt roots that can survive in mud substrate. The assessment was carried out in 4 plots with each plot consist of 100 plants. The evaluation parameters of mangrove reforestation comprise of seedling growth rate, diameter and height, leaf thickness and some leaves. Results show that the growth rate for first-year assessment was 92.3 % considered successful because of the average percent growth of plants  $\geq 70$  %. By contrast, the height, diameter, and a number of leaves seedlings planting were shown variation performance of among the plots observed. Our present study suggested that success factors in the rehabilitation of mangrove affected by salinity, substrate conditions, pests and diseases and human activities on the rehabilitation site.

### 1. Introduction

Mangrove forests in Indonesia together with North Sumatra are quickly pressured attributable to direct and indirect causes [1-2]. More than 1.1 million ha from 1980 to 2011, mangrove forests in Indonesia have been reduced [3]. Likewise, the mangroves lost in North Sumatra from 1990 to 2015 was shown as 22,513.2 ha; approximating to the mangrove reduction 2000-2012 inclusive Indonesia [1][4]. The mangroves conversion to aquaculture, swamp shrub, barren land, and oil palm estate has been the primary responsibility of mangrove degradation in North Sumatra [2-4]. Consequently, mangrove



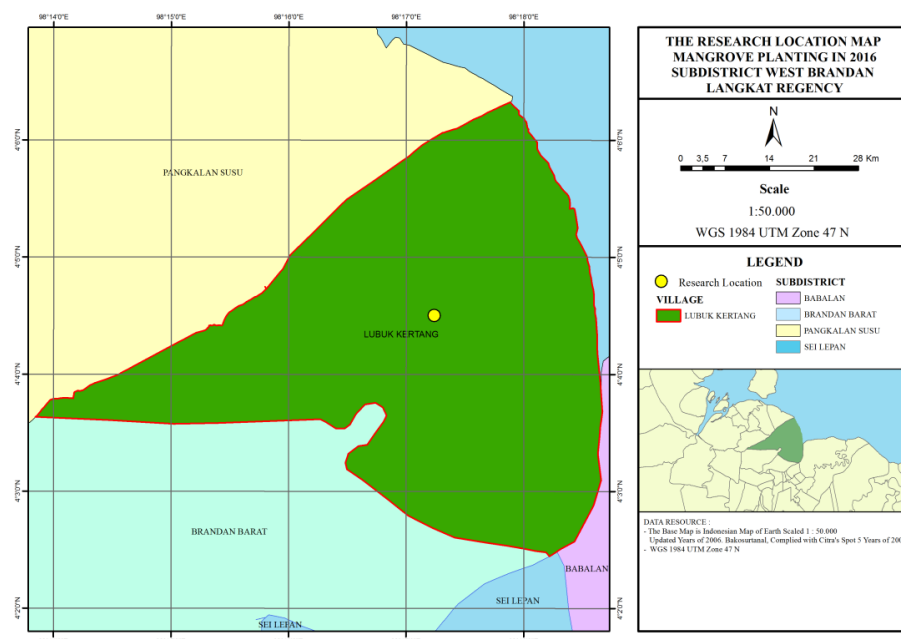
rehabilitation of disgraced mangroves is needed to conserve the presence of mangrove forests and disputes to altering surroundings.

Despite mangrove rehabilitation internationally or provincially has been flourishing documented [5-7], evaluation on mangrove reforestation are hardly explicitly described specifically at nationally or regency stage in Indonesia. The current work pointed to investigate one-year assessment on mangrove rehabilitation using *Rhizophora stylosa* seedlings in Lubuk Kertang village, Langkat, North Sumatra, Indonesia.

## 2. Materials and method

### 2.1. Study site

The work site was done in Lubuk Kertang village, Langkat, North Sumatra, Indonesia, consisting 1200 ha of mangrove area (Basyuni et al. 2018). The Lubuk Kertang village is situated at 04° 07' 39.71" North latitudes, and at 98° 30' 97.87" East longitudes as depicted in Figure 1. Lubuk Kertang is locally at Langkat Regency and district of Brandan Barat. The rehabilitation activity in Lubuk Kertang village was done in May 2016 using 6,000 *Rhizophora apiculata* seedlings (indirect plantings). Two times of evaluations on 29 September 2017 and 6 January 2018 were performed to observe and assess 400 reforested seedlings.



**Figure 1.** The study area (yellow circle) for the rehabilitation year 2016 at Lubuk Kertang.

### 2.2. Growth measurement and rate

The growth of *R. apiculata* seedlings (seedlings from nurseries) was determined by the stem height and diameter of the plants as previously reported [1]. One cm ruler precision was employed to quantify stem heights from the bottom of the propagule to highest plant tip where the stem shoots grew. A digital calliper estimated the seedling diameter. Therefore the growth indices in this work were derived from the stem heights and diameters of *R. apiculata*. The percentage of plant growth is estimated by paralleling the number of plants existing in a plot with the number of plants that should be existent in the quantifying plot framework as earlier depicted [5]. The estimation of growth level deals with the ruling as previously reported [5].

### 3. Results and discussion

Mangrove planting in 2016 had a salinity level of 25.2 ppt in the first observation (September 2017) and 24.5 ppt in the second observation (January 2018). The location of the research that became a rehabilitation program contained a type of mangrove *R. apicalata*. The assessment criteria of mangrove restoration comprise of seedling diameter, height, and growth level. Results depict that the growth level for indirect seedlings assessments was 92.3 % (Tables 1-2), this data including the confronted pests. The growth was comparatively minor with the including of infected pests 86.8 %.

The plant height and diameter, a leaf of thickness and a number of leaves seedlings were displayed variation performances among the plot observed (Figures 2). Numerous features that impact the achievement of mangrove restoration work within these sites are planted arrangement, planted seed circumstance, seed or propagule, plant preservation, pest and disease, and anthropological events [2, 6]. It has been indicated as specific concerns while reforesting degraded mangrove for example site collection for mangrove replanting, reforested mangroves that involve of natural redevelopment or artificial regeneration, and participation of local community [5]. In this perspective, the fruitful restoration of this works as a result of the suitable place and recommended mangrove species as well as the involvement of the home-grown people in Lubuk Kertang village.

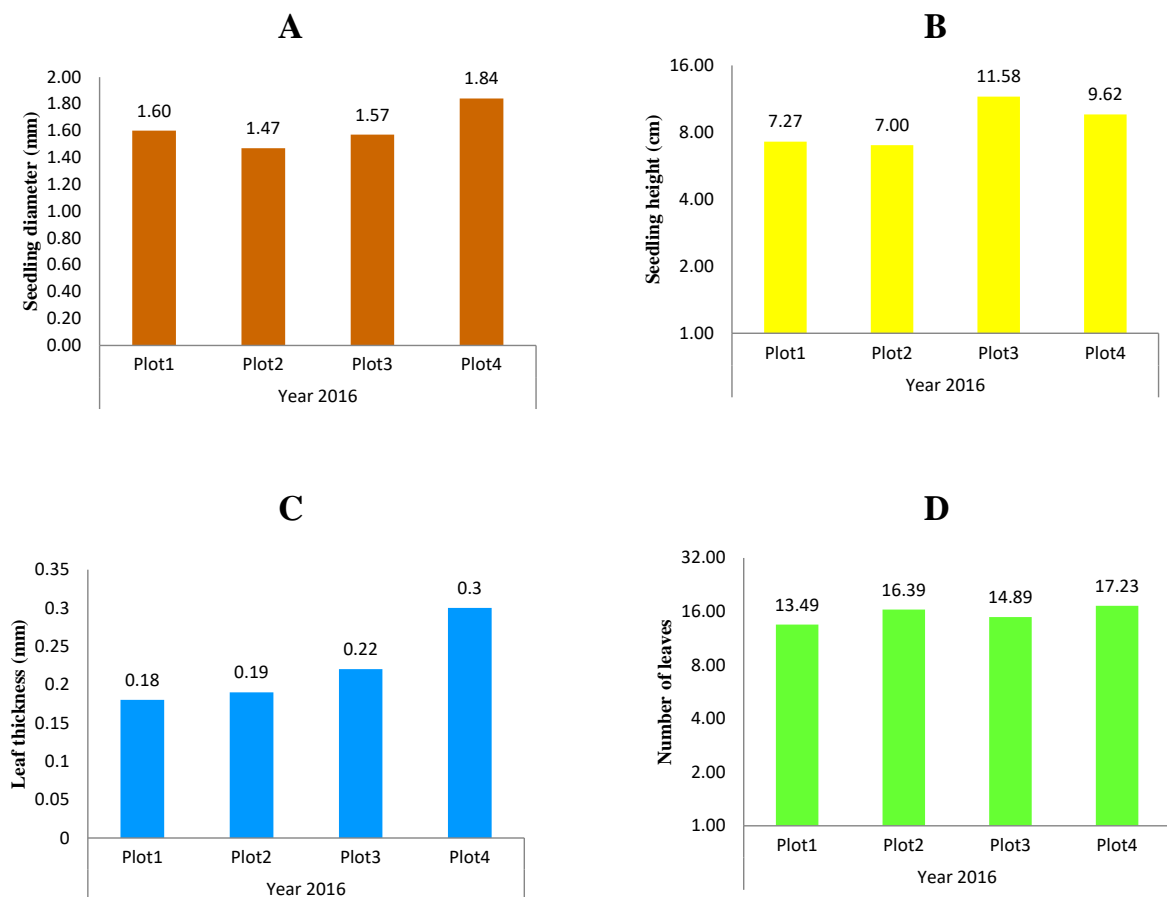
As depicted in Tables 1-2 the pest infected plants diverged including the plots investigated. Table 1 displays plot 4 of the plants influenced by 4.5% pests and the dead plants were 7.5%. Table 1 shows that the highest percentage of *R. apiculata* growth is in plot 1, plot 2, and plot 4, which is 94%, respectively then plants died was 6% and are attacked by pests and diseases in plot 1 by 4%, plot 2 by 6%, plot 2 was 2%. The lowest percentage of *R. apiculata* was found in plot 3, which was 88%, and then the plant died 12% and was attacked by pests and diseases at 6%. The leading cause of destruction to mangrove forests was a worm, the common pest. The occurrence indication is the leaves altered resonating, and the subsequent phase leaves to be yellow, dry and lastly collapsed [8].

**Table 1.** The growth rate of reforested mangrove using *R. apiculata* seedlings for the first remark.

No	First-year evaluation	Seedling plots (%)			
		Plot 1	Plot 2	Plot 3	Plot 4
1	Survival seedlings	94	94	88	94
	– Healthy	90	88	82	92
	– Attacked pests and diseases	4	6	6	2
2	Dead seedlings	6	6	12	6
Total		400			

The first observation in the 2016 plantation area was carried out on 29 September 2017. In Figure 3 the condition of the 2016 first observation evaluation, this was the result of the 2016 planting activity using *R. apiculata* nursery in a polybag in place nursery. In the subsequent remark of pests and diseases, it was displayed to some extent increased (1%) linked to the first trial (Table 2). This state was possibly at the following inspection the seedlings might still to adjust to the limited location lead to plants have similar than at the first examination.

Table 2 shows that the highest percentage of *R. apiculata* growth is detected in plot 4, which is 94%, then the plant died 6% and attacked by pests and diseases by 4%. Figure 4 depicts the lowest percentage of *R. apiculata* was found in plot three which was only 88%, and then the plant died 12% and was attacked by pests and diseases 8%. It has been reported that pests that usually attack are worms (caterpillars) [9]. A typical attack on the leaves of plants that the larvae of this bagworm are always in the bag, this bagworm is very dangerous because it can cause mangroves to be bare until they cannot photosynthesize to form leaf tissue. Bag caterpillars eat mangrove leaves so that the leaves will be hollow, dry and fallen.

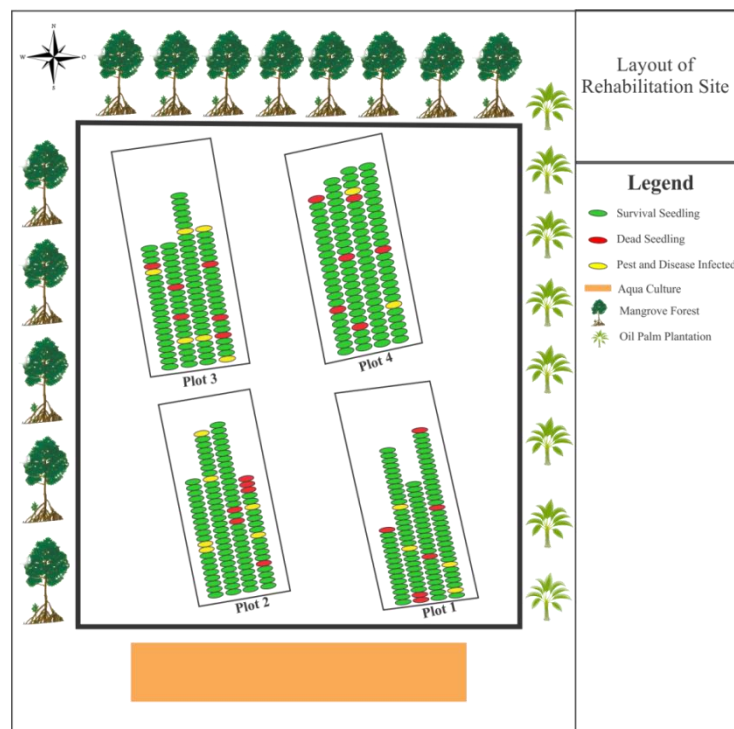


**Figure 2.** Growth parameters, diameter (A), height (B), leaf thickness (C), and the number of leaves (D) of *R. apiculata* in the first year of evaluation on September 2017-January 2018.

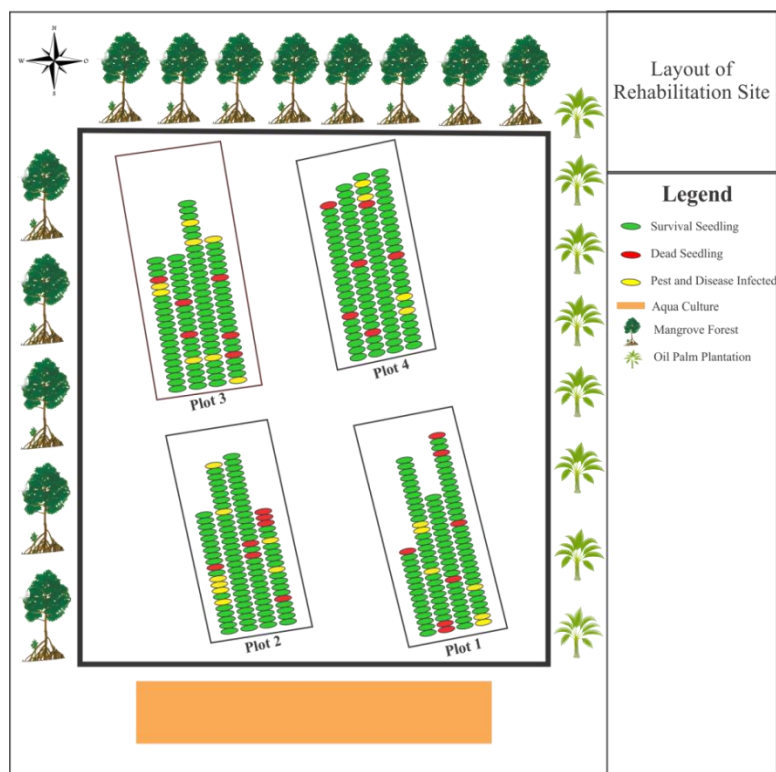
**Table 2.** The growth rate of reforested mangrove using *R. apiculata* seedlings for the second inspection.

No	First-year evaluation	Seedling plots (%)			
		Plot 1	Plot 2	Plot 3	Plot 4
1	Survival seedlings	93	93	88	94
	– Healthy	87	85	80	90
	–Attacked pests and diseases	6	8	8	4
2	Dead seedlings	7	7	12	6
Total		400			

The transience rate at the second examination from seedlings was a slight rise that could be prejudiced by the resident social activities that completed the crab trap at the rehabilitation site (Figure 4). Conversely, the restoration scheme in this work is positively considered in line with the forestry minister's ruling, once the growth rate of seedlings was above 70%.



**Figure 3.** Layout assessment rehabilitation year 2016 for the first observation.



**Figure 4.** Layout assessment rehabilitation year 2016 for the second observation.

To increase the success of mangrove rehabilitation, it is prerequisite to involved all local government, university, research institute, local group non-governmental organization as stakeholders as well as indigenous people by implementing local wisdom which applicable in that area [10]. Local communities largely depend on mangrove for their livelihoods as earlier reported [5], the majority of people agreed to conserve mangrove. The local societies in a straight line contributed in significant portion to the consequence of the restoration scheme in this work.

#### 4. Conclusions

The achievement and decline rate of mangrove rehabilitation in the first year assessment was 92.3 and 7.7%. In this case reforestation activity is considered positively consistent with the regulation of the Minister of Forestry number P.70/Menhut-II/2008. The data is expected to afford significant data for rehabilitation works of mangroves in North Sumatra, Indonesia.

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