Affecting Factors on Community Based Mangrove Replantation Programs in Semarang Coastal Area

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Abstract

The climate change phenomenon is no longer seen as a natural process when it has been correlated with human behavior, especially from increasingly rapid development activities. In Semarang, the impact of climate change has been affecting people activity especially in the coastal area. Coastal communities that depend on coastal resources feel the effects of climate change. Fishermen, mangrove farmers, and fishpond farmers are vulnerable groups to the impacts of climate change because of the coastal resources which is in quality and quantity decreases and affecting their lives. Efforts are made by stakeholders through mangroves rehabilitation programs all over the coastal line including the community approach to increase the mangrove growth rate. However, mangrove seeds that were planted in Semarang coastal area has different levels of life and growth rate in each planting location. Based on Environmental Agency of Central Java Province data in 2013, 8,594.89 ha of 11,732 ha mangrove vegetation in the North Coast of Central Java Province are in damaged condition. Hence, this paper aims to elaborate the key factors of community-based mangrove replantation that affecting the mangrove growth in Semarang coastal area. Five mangroves rehabilitation areas in Semarang namely in Kelurahan Mangkang Kulon, Mangkang Wetan, Mangunharjo, Tugurejo and Kelurahan Trimulyo are observed throughout 2015-2016. The results shows that suitability between mangrove species and the location is very influential on mangrove growth rates in Semarang Coastal. The community effort in each location is also become the external factors that are affecting the growth of mangrove in Semarang Coastal Area. By understanding the factors of mangrove growth rate on the community-based mangrove replantation, hence better result of mangrove replantation programs can be acquired in the future.

Keywords: mangrove; Semarang; coastal area; climate change

1. Introduction

The north coast of Central Java is one of the most vulnerable region to climate change in Indonesia (Marfai 2011). One of the impacts caused by climate change is an increase of sea level, so that it affects changes in ocean currents in coastal areas and results in damage to the mangrove ecosystem. (Suhelmi and Prihatno 2014). The degraded mangrove belts less effectively protect the coast (Luom et al. 2021). Mangroves can become one of solutions for climate change adaptation and mitigation (Gilani et al. 2021) as they can absorbs pollutant (Duan et al. 2020), create ecosystem in the coastal area (Gilani et al. 2021) and maintain estuarine water quality as a habitat for many commercially important species of fish and prawns (Kusmana 2011).

In order to reduce the risk of coastal erosion in Semarang, in one hand the government has implemented structural measures, i.e. constructing walls, Poulder (flood pond) and wave breakers along the coast. However, this measure takes time to finally solve the entire problem of coastal erosion in Semarang. Those efforts are mostly done with a conventional approach that tends to be top-down and not fully appropriate to the local resources. Therefore, some conflict occurs in the development of the hard structure like in the land acquisition problem in the process of Banger Pond development.

Semarang City is the capital city of Central Java Province located in the north coast of Java Island. This coastal city is the major city of Metropolitan Semarang (Handayani et al. 2020) which has a coastal line length of ± 13.6 kilometres (if it is pulled straight from east to west ends). If the coastline is measured from the outer part of it, it changes each year due to coastal abrasion, accretion, or reclamation. Based on the data that has been processed by the Office of Marine and Fisheries of the City of Semarang, in 2008 there was an increase in sea level which caused economic losses due to mangrove damage of 729 million per year, as many as 2,889 ha of damaged pond area and caused economic losses of 110 million (Fauziah 2014).

The area of mangrove vegetation in the coastal area of Semarang City based on data from the Department of Marine and Fisheries (2013) are 94,39 ha. Based on the administration area, the largest mangrove vegetation is in Tugu Sub-district 46,19 ha (48,93%); the second widest is Genuk Sub-district of 22,72 ha (24,47%), the third is Semarang Barat Sub-district with an area of 13,40 ha (14,20%) and the least is in Semarang Utara Sub-district with an area of 12,07 ha (12,79%). The condition of the mangrove vegetation is uneven and tends to decrease due to the insistence on the needs of coastal land use, still

lack of law enforcement, and insistence on various interests in the use of residential land, industrial estates, basic facilities and infrastructure in coastal areas.

Base on this fact, stakeholders have carried out mangrove rehabilitation starting from nurseries to mangrove planting since 2009. This program is not only carried out by the government, but also collaboration with the private sector, academics and involves the community. One of the collaborative programs carried out by these stakeholders is Asian Cities Climate Change Resilience Network (ACCCRN): Enhancing Coastal Community Resilience by Strengthening Mangrove Ecosystem Services and Developing Sustainable Livelihoods in Semarang City. This program is funded by Rockefeller Foundation.

Non-structural approaches like mangrove replantation (Kongkeaw et al. 2019) and community-based measure in coastal area (Septiarani and Handayani 2020) has become one of promising ways to conserve the coastal area. Also, the fact that permanent migration has not yet been an option for adaptation in dealing with environmental hazard in Java (Handayani and Kumalasari 2015) and adaptation are still the preferred option for community (Buchori et al. 2018) has lead the vulnerable people to the one and only option which is to adapt with the condition.

Conducting mangrove rehabilitation efforts is not an easy task in Semarang coastal area. The mangrove seedlings planted have different life success and growth rates in each planting location. Therefore, the involvement of stakeholder has become one option in increasing mangrove growth rate. Involvement of community in replantation effort has significantly increase the chance of their success (Kongkeaw et al. 2019). Not only the replantation, Kongkeaw et al. (2019) demonstrates the successful mangrove management through community-based approach in Thailand. Hence, efforts need to be made to improve the success of those efforts in all planting locations through monitoring of mangrove growth and identifying the causes of differences in the growth rates in each planting location. This paper aims to elaborate the key factors of community-based mangrove replantation that affecting the mangrove growth in Semarang coastal area so the results can give inputs to the next planting effort in Semarang coastal area. By identifying the key factors that affecting the growth of mangrove in Semarang Coastal area, mangrove reforestation effort in the future can be more effective and the halting factors can be avoided to increase the success rate of mangrove plantation.

2. Methods

This research was conducted in two sub-districts, namely Tugu Sub-district (Mangkang Kulon Village, Mangkang Wetan Village, Mangunharjo Village, Tugurejo Village) and Genuk Sub-district (Trimulyo Village) which directly bordered with the Java Sea. The research location was determined based on the results of planting carried out by local community groups that had been involved in the ACCCRN program. The calculated mangrove life level is the result of planting stages 1-3. The list of community group that involves can be seen on table 1.

Table 1: Community Group and Their Mangrove Rehabilitation Location

Community Group	Location
Kyai Wakak II	Mangkang Kulon
Tunas Harapan, Kali Santren	Mangkang Wetan
Sumber Rejeki Makmur	Mangunharjo
Prenjak	Tapak
Sringin	Trimulyo

Method that used in this study is quantitative method. In order to understand the affecting factors in community-based replantation process there are two steps that are explained:

1. Identifying the mangrove growth rate

   This conducted by doing census to the mangrove on plantation area which is counting one by one mangrove seedlings that live with the help of community groups as the verification to find out the number of successes planted mangrove seeds. The classification of seeds that live in this activity are seeds that still have green or chlorophyll color, and showing no symptoms of wilting. To find out the measurement of seedling fragility using the transect measuring 1 m x 1 m. In each plot data collection was carried out in the form of seedlings, number of seedlings, stem diameter (0 – 0,9 cm) height of less than 1 meter. These seeds are seeds planted through the Asian Cities Climate Change Resilient Network (ACCCRN) program in 2016. The starting point and end point of the transect are marked by using the Global Positioning System (GPS) for mapping.

   Seeds that are categorized as good are seeds that have intact leaves, while seeds that are categorized as damaged include seeds whose leaf ends are missing or the absence of leaves, but the propagule (growing seeds) conditions and stems are still green. Mangrove seeds that have damaged conditions still have the possibility to grow.

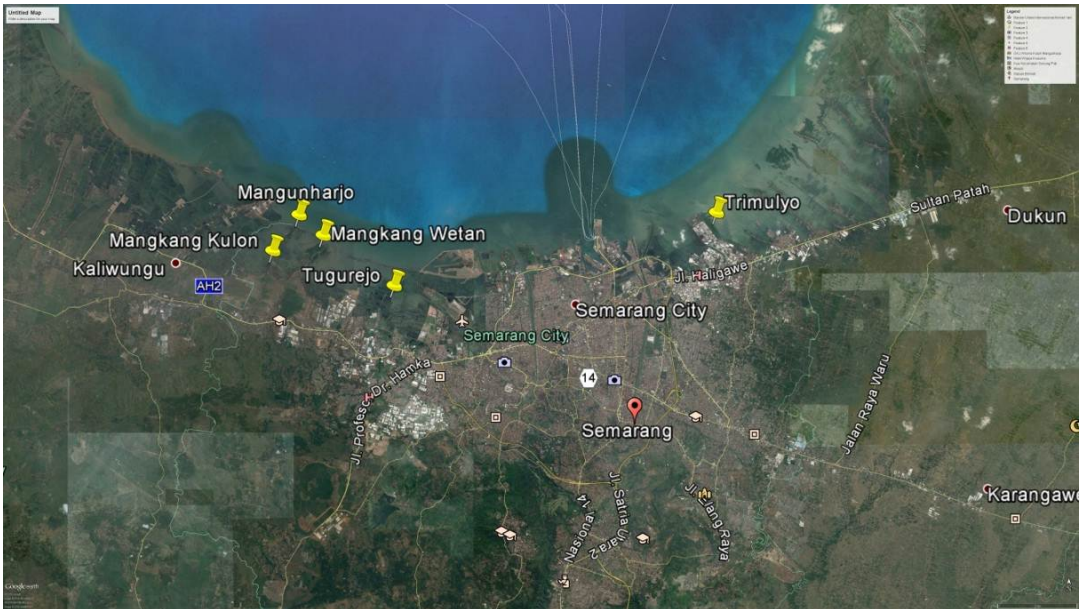

Figure 1. Sampling Location
(Google Earth, 2016)

Vegetation data taken from each location was analyzed using the Mueller-Dumbois and Ellenberg (1974) methods, including:

- Density (D)
  Density is the number of individuals per unit area (Mueller-Dumbois and Ellenberg, 1974). The density value shows with an ind/ha unit, using the formula:

$$D = \frac{ni}{A}$$

D = Density; ni = total number of species i; A = total area of data collection plot area

- Basal Area (BA)
  Basal area is the result of measurements of transverse tree stem (Mueller-Dumbois and Ellenberg, 1974). The larger the stem diameter of a tree it is assumed that the greater the area closure by the tree canopy determined in the calculation of Relative Domination (RDn). The stem diameter of each type is then converted into a basal area using the formula:

$$BA = \frac{\pi d^2}{4} cm^2$$

BA = Density
π = 3,14
d = Stem diameter

- Relative Density (RD)
  Relative density is the percentage density of each type in the transect (Mueller-Dumbois and Ellenberg, 1974). The relative density value is obtained using the formula:

$$RD = \frac{D_{ind}}{D_{tot}} \times 100\%$$

RD = Relative Density
D_{ind} = Density of individual species i
D_{tot} = Total density

- Relative Domination (RDn)
  Relative domination is the percentage of the closure of a species to a mangrove area obtained from the basal area for the tree category (Mueller-Dumbois and Ellenberg, 1974), using the formula:

$$RDn = \frac{BA_i}{\quad} \times 100\%$$

RDn = Relative Domination
BA_i = Total of basal area of species i
BA = Total of basal area of all species

- Important Value (IV)

Important values are obtained to determine the type that dominates a mangrove area. This important value is obtained by summing the value of Relative Density (RD) and Relative Domination (RDn) (Curtis, 1959 in Soerinaga and Indrawan, 1982).

$$IV = RD + RDn$$

IV = Important Value
RD = Relative Density
RDn = Relative Domination

2. Analysing the community participation in Mangrove Replantation Program

This analysis was conducted to see the performance of each community group based on some criteria that has been identified. There are six community groups that were assessed on this step. The assessment conducted in two steps which are through the scoring from replantation readiness criteria and the second through the scaling of community performance. The score were obtained through the interview with community facilitators during the ACCCRN program. There were three facilitators that were asked to score the community performance of each indicators. The indicators and scaling were explained on table 2.

In the scoring of readiness criteria, respondents were asked to give score based on criteria for each indicators. After that, they were asked to score the community performance based on scaling 1-10. Both readiness criteria and community performance indicators will then analysed using descriptive analysis to see the most affecting factors to community based replantation in Semarang coastal area.

Table 2: Readiness Criteria for Community Assessment

No.	Indicator	Criteria	Score
1	Mangrove life span from the community replantation	≥76%	4
		51-75	3
		26-50	2
		≤25%	1
2	Community response to the program activities	Fast response	3
		Response with offering	2
		Unresponsive with various reasons	1
3	Community commitment for mangrove maintenance	Every week	3
		Every month	2
		No maintenance	1
4	Transfer of knowledge process from the leader to community group member	Good (democratic, everyone could speak up through regular meeting)	3
		Fair (democratic or regular meeting)	2
		Poor (no transfer of knowledge mechanism)	1
5	Self-subsistent level	High (there is self-providing for additional seeds and self-initiative labor)	3
		Fair (there is self-providing for additional seeds or self-initiative labor)	2
		Low (paid labor)	1
6	Land availability to conduct mangrove seedling and replantation	Available without rent	3
		Available with rent	2
		Not available	1

Tabel 3: Indicator of Community Performance

No	Indicator
A	Response for Mangrove Planting and Nursery Activities
1	Fast response or action by each group to mangrove planting and nursery activities
2	the implementation of activities by each group when viewed from the punctuality of time
3	community initiatives in providing input to groups related to the implementation of activities
4	involvement of group members in the implementation of activities
5	cooperation in the implementation of activities
6	group management in carrying out activities
B	Group Commitment to Implement Activity Maintenance
1	the implementation of maintenance by each group viewed from the number of maintenance activities

2	the implementation of maintenance by each group viewed from their routine
3	group initiative in determining maintenance activities
C	Other
1	the knowledge transfer process from the leader to the group members
2	level of self-subsistent (they do not only rely on assistance, but also their willingness to volunteer)
3	ability to provide new planting sites
4	the level of willingness of the group to try and explore the lessons that can be obtained from the experience of doing nurseries and planting
5	their level of openness in receiving new information in the nursery and planting process

3. Result and Discussion

3.1 Mangrove Growth Rate for 2013-2016

This discussion is a recapitulation of the results of the mangrove growth rates of all groups during the period of 2013-2016. The following is a comparison of the results of mangrove growth grouped by planting period.

The total planting of mangroves from phase 1-3 counted 332,500 stems and those are still alive counted 132,437 stems or 40% from the total planted mangrove. The highest growth rate is the result of planting from Sringin Group on the Trimulyo Village. During the 3 periods of mangrove planting, the highest growth rate is in the first planting period. The second planting rate decreased by 20%. Besides the suitability of the planting location with the type of mangrove, the planting time is also one of the things that must be considered in planting. When planting, it should be done 6 months before the tide occurs. For example, in June high tide, the previous 6 months must have been planted, so that the roots are strong and not easily carried away.

Table 2: Recapitulation of the Mangrove Growth Rate from the Phase 1-3 of Planting Process

Community Group	Total Planting	Total Alive	Percentage
Prenjak	55.000	22.019	40%
Kyai Wakak II	63.000	16.107	26%
Kali Santren	48.500	14.015	29%
Tunas Harapan	54.000	15.616	29%
Sumber Rejeki Makmur	93.000	51.399	55%
Sringin	19.000	13.281	70%
Total Phase 1-3	**332.500**	**132.437**	**40%**

Source: Observation, 2015 & 2016

Planting also needs to pay attention to the slope of the substrate. Substrates that are too low cause mangrove seedlings to be submerged most of the day, due to high tides. Minimum requirements for the height of seeds planted should be at least 40cm and have 2-4 pairs of leaves. The fundamental principle that needs to be improved by the community is more on the openness of the community in receiving input / improvements related to the planting of mangroves. So far what has happened is that the community feels they can plant, so it is difficult to receive input related to improvements that must be made. The community is also less able to care for the mangroves that have been planted, this indicates that the community is more oriented to assistance than care.

3.2 The Density of Mangroves in Tugu And Genuk Sub-Districts of Semarang City in 2016

The highest density of seedlings (stem diameter <1 cm) is in Trimulyo Village location with 28.889 ind/ha and the lowest is in Mangunharjo Village with a density of 11.111 ind/ha. This data collection of seedling mangroves shows the high availability of mangrove seedlings in certain locations, and shows the availability of land for rehabilitation activities.

The mangrove densities can shows how mangrove itself survive in certain environment condition. The total number of individuals (Ni), density (D), relative density (RD), relative domination (RDn) and important value index (IVI) of seedling categories in the coastal city of Semarang can be seen in Table 3 and Figure 2.

Table 3. Mangrove Distribution in Tugu and Genuk Sub-district, 2016

Sampling location	Species	Ni	D (Ind/Ha)	RD (%)	RDn (%)	IVI
Mangkang Kulon	Rhizophora mucronata Avicennia marina	4	15.555	100	100	200

Sampling location	Species	Ni	D (Ind/Ha)	RD (%)	RDn (%)	IVI
Mangkang Wetan	Rhizophora mucronata Avicennia marina Bruguiera gymnorriza	4	15.555	100	100	200
Mangunharjo	Rhizophora mucronata Avicennia marina	5	11.111	100	100	200
Tapak	Rhizophora mucronata Bruguiera gymnorriza	3	11.333	100	100	200
Trimulyo	Avicennia marina	9	28.889	100	100	200
Mean			16.489			

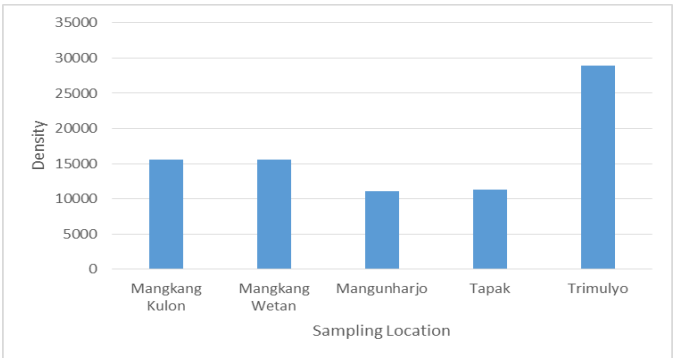

Figure 2. Distribution of Mangrove Density

3.2 Community Participation in Mangrove Replantation

The successful mangrove replantation has been the key to preserving the coastal area. To conduct the replantation, all the stakeholder should be in charge especially those who plays the role as main actor in coastal management. Coastal community has been seen as the most vulnerable people to climate change (Buchori et al. 2018), therefore, their existence is also importance in leveraging their own environment. The result from this analysis in community participation shows the performance and indicator for readiness criteria for each community group. Based on the results of scoring in assessment I and assessment II, the total score was obtained as shown in Table 4. Each group was ranked according to the order of the total value obtained and the value range was not used, because the number of groups was only a few (6 groups). Kali Santren group got the highest score in assessment I means that Kali Santren group has more score in readiness criteria and can be said that Kali Santren group is more ready in term of the local condition in receiving mangrove replantation program than the other groups. Meanwhile, the highest score in Assessment II is Prenjak means that Prenjak has the highest community performance among all of the community group.

Table 4. Community group score based on the assessment

No.	Community Group	Assessment I		Assessment II	
		Score	Rank	Score	Rank
1	Prenjak	12	II	291	I
2	Kyai Wakak II	9	IV	212	VI
3	Kali Santren	13	I	276	II
4	Tunas Harapan	11	III	251	IV
5	Sumber Rejeki Makmur	12	II	243	V
6	Sringin	11	III	271	III

The community performance is the key to successful community based mangrove replantation program (Kongkeaw et al. 2019). Among top three community group with the highest performance score (assessment II) are Prenjak, Kali Santren, and Sringin. Table 5 showing the readiness criteria indicator for each group in top three highest performance. It shows that the community with highest performance rank has the highest score for community response to program activities (indicator 2) which also in line with their performance. It also can be seen from the indicator number 6, that the availability of the land doesn't hamper community performance (they mostly don't own the land for seedling and replantation). It shows by the high score for their performance in assessment II despite the availability of the land to conduct the seedling and replantation.

Table 5. Top Three Groups with highest performance seeing from the readiness criteria of mangrove plantation

No.	Community Group	Indicator						Total Score
		1	2	3	4	5	6	
1	Prenjak	2	3	2	2	2	1	12
2	Kali Santren	2	3	2	2	2	2	13
3	Sringin	3	2	2	2	1	1	11

The mangrove growth substance doesn't mainly affect the growth rate of the mangrove. It can be seen on table 6, the mangrove growth rate for location that has the high readiness criteria is most have higher mangrove growth rate percentage (> 40%). Meanwhile, the community performance doesn't seem to have affect on mangrove growth rate. It can be seen on table 6 that the high score in assessment II doesn't in line with the higher level of mangrove growth rate percentage. Means that although the performance is high, the mangrove growth level is not only affected by the performance. It can be also because of the low level of transfer knowledge among community group member that cause the growth rate is not optimize. The community group also seems best at doing the replantation for Avicennia Marina and Bruguiera gymnorriza. It can be seen from the high growth rate percentage of that species and with high performance of community group and readiness criteria level. This is also because community both of mangrove species has been introduced so many times in replantation program both by government or NGO because of its compatibility to Semarang coastal substrate condition.

Table 6. Community Level of Participation Compared with The Mangrove Growth Rate and Density

Sampling location	Community group	Assessment I (readiness criteria)	Assessment II (community performance)	Species	Mangrove Growth rate percentage	D (Ind/Ha)
Mangkang Kulon	Kyai Wakak II	IV	VI	Rhizophora mucronata Avicennia marina	26%	15.555
Mangkang Wetan	Tunas Harapan	III	IV	Rhizophora mucronata Avicennia marina	29%	15.555
	Kali Santren	I	II		29%	
Mangunharjo	Sumber Rejeki Makmur	II	V	Bruguiera gymnorriza Rhizophora mucronata Avicennia marina	55%	11.111
Tapak	Prenjak	II	I	Rhizophora mucronata Bruguiera gymnorriza	40%	11.333
Trimulyo	Sringin	III	III	Avicennia marina	70%	28.889

5. Conclusion

In general, mangrove vegetation in Semarang has been degraded due to natural and human factors. Mangrove planting activities in Semarang have many obstacles. To find out the constraints, it is necessary to monitor the results of planting, including monitoring the level of life and the density of mangroves. Based on the field survey there were several obstacles that caused the death of the planted mangrove seedlings, namely caterpillar pests, high tides, buried pond embankments, and carried by flood currents.

Monitoring the level of life of the mangroves is an improvement from the planting stage because through this monitoring, the number of mangrove seedlings planted is still alive, good, bad or dead so that the program that has been implemented is successful. The results of the monitoring survey (census) of a total of 332,500 seeds planted in phase 1, 2, and 3, the number of surviving seedlings planted was 132,437 (40%).

Monitoring the density level of mangrove species is a parameter to estimate the density of mangrove species in a community. Species density in an area can provide an overview of the availability and potential of mangrove plants. The results of the survey in the field obtained an average value of the density of mangroves planted in Mangkang Kulon, Mangunharjo, Mangkang Wetan, Tugurejo, and Trimulyo Villages of 16.333 ind/ha with diversity of mangrove species including Rhizophora mucronata, Avicennia marina and Bruguiera gymnorriza.

Of the five villages that have been monitored, the village that most needs planting and adding mangrove planting is the Mangkang Kulon Village because the level of mangrove damage there is higher

than other areas, besides the mangrove vegetation in the area is converted into ponds and the area is directly bordered with the sea which make it more vulnerable to abrasion. The results of the survey in the field, mud substrate which is located not far from the shoreline should be planted with Rhizophora sp., The location of sand substrates not far from the coastline should be planted with Avicennia sp., While Brugueira sp. preferably planted on mud substrates far from the shoreline.

Community group has been seen as the main actor when it comes to the mangrove replantation (Kongkeaw et al. 2019; Septiarani and Handayani 2020). From the readiness criteria of each community group, it is shows that the land availability doesn't affect the community will to perform mangrove replantation program. However, the community commitment and response in program has seen to be importance in affecting the mangrove growth rate. Also, community knowledge in planting the specific species of mangrove has been seen as affecting the mangrove growth rate in their area.

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