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Mangrove Rehabilitation Program in North Coast, Central Java-Indonesia (Case Study in Regency of Brebes, Pemalang and Demak)

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ABSTRACT

This research aims to evaluate mangrove rehabilitation program and compose environmental management strategy in the area of sustainable mangrove along the North Coast region of Java Island (Regency of Brebes, Pemalang, and Demak). This long-term research generally holds the purpose of mitigating and minimizing the rate of destruction of mangrove every year in the North Coast of Java Island. Research results are the process of perception data, participation, and the area condition of mangrove damage in Regency of Brebes, Pemalang, and Demak which uses SEM program (Structural Equation Modelling) Lisrel 8,0. Factor loading value above 0,4 shows that item is a fit indicator to be used as forming constructs. The calculated t values of -4,09 and -3,47, which are greater than 1,96, indicate that there are significant negative impacts between perception and participation on mangrove destruction. Generally, the physical condition of coastline in Pantura, Central Java has been going through some alterations caused by abrasion/erosion and accretion due to buildings jutting into the sea, rise of sea level, shifting function of coastal border, and also global warming effect. In order to rehabilitate ecosystem, several principles need to be considered, which are; prioritization of ecological rehabilitation, proper rehabilitation, accompaniment sustainability, taking into consideration should physical rehabilitation is implemented, and harmoniously living together with the ecosystem.
KEYWORDS: Evaluation, mangrove, rehabilitation, SEM program.

INTRODUCTION

This research aims to evaluate mangrove rehabilitation program and compose environmental management strategy in the area of sustainable mangrove along the North Coast region of Java Island (Regency of Brebes, Pemalang, and Demak). This long-term research generally holds the purpose of mitigating and minimizing the rate of destruction of mangrove every year in the North Coast of Java Island.

Mangroves have many functions, whether in biological cycles, physical function, as well as sociological function. Few roles of mangroves as an ecosystem are; as coastline border, waste material assimilation treatment, sludge coagulator and land-forming medium, as land used by humans for activities such as fishponds and salt ponds, mining activities, and even as landfills [1, 2, 5].

Mangroves are also known to have the capability to thrive in a very extreme environment which naturally shows that there are successions and dominant species of plant. However, mangroves are highly sensitive towards environmental changes which may spoil them and eventually leads to their demise [9, 12, 19] in 1982, Department of Forestry mentioned that Indonesia had 4,25 million hectare of mangroves and those numbers went down to 3,9 million hectare in 2003. Meanwhile, in 2009 the existing mangroves in Indonesia was approximately 3,3 million hectare [13, 22, 23]

There are numerous factors affecting the very existence of mangrove forests area; climate change and global warming, which affect the quality and the carrying capacity of the water; the presence of coastal abrasions and accretions which causes alteration in coastlines; Predation of mangrove seeds by the biota (vinegar crabs, *episesarma)* due to the constriction of density and extent of mangroves area; also the increasing economic activity of mangrove conversion into ponds, and logging for either buildings or firewood.

The diminishing of mangrove forest can cause coastal abrasion as it plays a rather important role in diminishing the extent of mangrove área [15, 16, 21, 30]. Until the year of 2000, the coastal abrasion of Brebes Regency had reached 789 hectare, while bearing 310 hectare of accretion. The area of mangrove forest in Regency of Demak in 2002 was established at 395,5 hectare with abrasion area of 681,9 hectare [3].

Ecologically, mangrove plant has integrated life cycle and recruitment, so that expansion can occur. A statement from [24, 26, 27] stipulates that mangroves will continually grow and yield seeds around them, so that it will keep expanding and eventually form a mangrove forest. The aforementioned expanding capabilities is shown by the growth rate of mangrove around 0-7,2% from the flower it produces. However, this growth rate only occurs virtually on mangrove forest with little to

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no predator. In the after-conversion area of mangrove, the predation is done by predator such as vinegar crabs, thus rendering the expansion and recruitment of mangrove seeds ineffective [10, 11].

Nowadays, the increasing number of population is directly proportional to the increase of the construction building activities, which subjects the exploited mangrove forests to be potential target [6, 7]explained that the reasons for mangrove disappearance and its degradation are; the rising pressure caused by inhabitants, extraction of timber, field conversion for agricultural purpose and mineral salt production, lead mining, industrialization in coastal area and urbanization as well as field conversion for aquaculture development. Those ever increasing utilizations of coastal region not only give positive effects through the enhancement of standard of living and provision of employment to coastal residents, but also negative effects if the utilizations are not environmentally friendly and uncontrollable [17, 20].

MATERIAL AND METHOD

This research uses cases studies, where observation was undertaken in three particular regencies, without considering time and/or seasons, and the data collected was analyzed descriptively. The case studies method was carried out profoundly which is limited to the area of Brebes, Pemalang, and Demak within limited amount of time (rainy season). As for the investigated case, it was ecological phenomenon which affects the destruction of mangroves and coastal region, as well as the countermeasures through socio-ecological approach. Quantitative method is performed for the parameter which will be presented in form of numbers, whereas the qualitative method is used to interpret the qualitative data as well as the policies, potentials, and hindrances which are described qualitatively. This research was performed in the coastal area of Brebes regency, Central Java in 2014. According to [3] had 882 hectare of mangrove areas which spread across District of Losari, Tanjung, Bulakamba, Wanasari, and Brebes. The Village of Kaliwlingi alone is located inside the District of Brebes which is adjacent to Margadana District, Jatibarang District in the south, Wanasari District in the west, Java Sea in the north. Village of Kaliwlingi is located at coordinates of Latitude 060 48' 19,68" S and Longitude 1090 02' 26,01" E.

Mojo Village, District Ulujami, Pemalang Regency is located at coordinates of South 6049'43" and East 109032'45", and adjacent to Siwalan District. The geographic condition resembling that of Semarang Coast, jutting into the sea, is hugely beneficial to the fishermen, since it can be used to raise milkfish and Soka crab.

Meanwhile, the mangrove area in Demak Regency in 2009 was recorded to have been around 2.370 hectare [8]which spread across Districts of Sayung, Karang Tengah, Bonang and Wedung. Bedono Village is located in Sayung District which is adjacent to Karang Tengah District in the east, Mranggen District in the south, Semarang City in the west, and Java Sea in the north. Bedono Village is located at coordinates of Latitude 060 44' 28" S and Longitude 1100 29' 58" E.

Lines of Inquiry

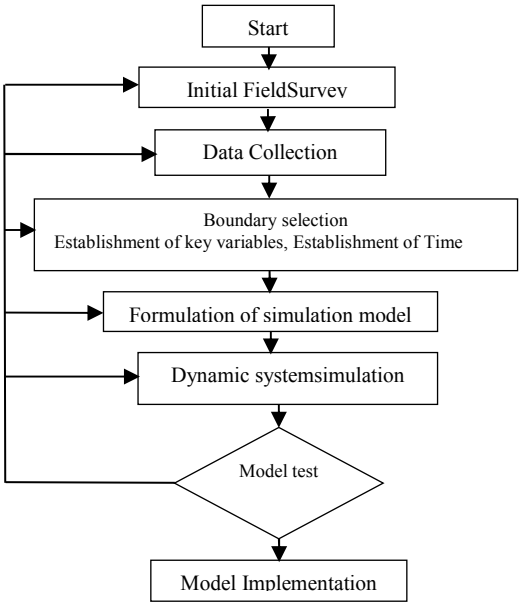

Fig.1 Chart flow of dynamic system analysis

Analysis of Anthropogenic factor

Modeling of Structural Equation Modeling (SEM)

In order to ascertain the linkage between Independent Variables (exogenous) of anthropogenic factor and dependent variables (endogenous), which are the perception and participation of society, respectively, towards the rate of mangrove destruction, the modeling of SEM will be performed by using Program LISREL 8.0 [14, 18, 25, 28, 29]. The stages of SEM modeling in this research will be as follows:

Conceptual Model

Conceptual model is a drafting stage of the basic framework of model which shows the connection between the perception, participation, and the destruction of mangroves along the coastline of Brebes, Pemalang, and Demak Regency. Model conceptualization established as the development of hypothesis according to the related theory is used as a foundation to linking the perception of latent variables and people's participation on the damage/decrease of the mangroves area along the coastline of Brebes, Pemalang, and Demak regency together with its indicators.

Path diagram arrangement

Path Diagram arrangement is performed to facilitate the visualization of hypothesis which has been submitted to model conceptualization, that is to say that people's perception will affect people's participation and eventually people's participation will affect the dynamic change of total mangrove area along the coastline of Brebes, Pemalang, and Demak Regency. Path diagram arrangement is also meant to reduce the faulty rate of the model being built.

Model Specification

Model specification is meant to describe the trait or character as well as the amount of estimated parameter and represented in related mathematical model with the influence of perception and participation of the people towards the dynamic change of total mangrove area along the coastline of Brebes, Pemalang, and Demak Regency.

Model Identification

Information extracted from the data is tested to determine whether it is enough to estimate and obtain unique value from the parameter of the built model.

Parameter Estimation

Estimation of model-based parameter is obtained from the data to produce model-based covariance matrix, which is hoped to be consistent with observed covariance matrix.

Assessment of Model Fit

Assessment of model fit is done by comparing the similarity between model-based covariance matrix and data covariance matrix.

Model Modification

In case the model fit hasn't been able to be obtained yet, model modification will be performed based on the related theory that bolsters the model modification of the linkages between people's perception and participation towards the dynamic change/reduction of total mangrove area along the coastline of Brebes, Pemalang, and Demak Regency.

Cross-Validations Model

Cross-Validations model will be performed to test whether the model resulted towards new data is fit.

RESULTS

People's Socio-Economic and Cultural Condition

The number of population of Brebes, Pemalang, and Demak Regency that inhabit along the coastline according to the educational level in the end of year 2013-2014 will be served in **table** 1 below.

Table 1: Number of population of Brebes, Pemalang, and Demak regency according to their recent educational level.

Regency	College Graduate	High school Graduate	Middle school Graduate	Elementary School	Did not/yet to finish Elementary School	Total
Brebes	8.295	25.955	3.720	36.359	39.305	113.634
Pemalang	7.130	42.630	67.970	96.460	47.976	262.166
Demak	18.128	126.000	188.265	321.131	55.792	709.316
Jumlah	33.553	194.585	259.955	453.950	143.073	1.085.116

Source: Central Bureau of Statistics of Regency of Brebes, Pemalang, and Demak (2013-2014)

The Score of People's Perception and Participation

The result according to the questionnaire filling by respondents towards people's perception and participation in the Regency of Brebes, Pemalang, and Demak will be shown in table 2,3 and 4:

Table 2: The analysis of People's Perception in Regency of Brebes, Pemalang and Demak

Perception	The average score of questionnaire number					Total
	1	2	3	4	5	
Brebes	4,38	4,4	3,88	4,26	4,24	21,16 (4,23)
Pemalang	4,78	3,08	4,5	4,52	3,16	20,04(4,00)
Demak	4,18	1,98	3,96	4,5	4,56	19,18(3,83)
Rata-rata	4,44	3,15	4,11	4,42	3,98	20,01(4,02)

Information:
Score 1: Strongly disagree, very bad.
Score 2: Disagree, not good.
Score 3: Indecisive, intermediate.
Score 4: Agree, good.
Score 5: Strongly agree, very good.

Table 3: The analysis of People's participation in Regency of Brebes, Pemalang and Demak

Participation	The average score of questionnaire number				Total
	1	2	3	4	
Brebes	4,2	3,84	3,6	3,58	15,22(3,80)
Pemalang	4,38	4,04	3,94	4,32	16,68(4,17)
Demak	3,36	3	3,9	4,72	14,98(3,74)
Rata-rata	3,98	3,62	3,81	4,20	15,61(3,90)

Information:
Score 1: Very rarely, never, very bad.
Score 2: Rarely, 1-2 times a year, once every 5 activities, bad.
Score 3: Average, once in 3-6 months, once every 3-4 activities, intermediate.
Score 4: Often, Once in a month, once every two activities, good.
Score 5: Very often, more than once a month or at every activity, very good.

Table 4: The analysis of The Level of Mangrove Damage in Regency of Brebes, Pemalang, and Demak.

Damage	The average score of questionnaire number				Total
	1	2	3	4	
Brebes	3,8	3,3	3,14	3,58	13,82(3,45)
Pemalang	3,72	3,9	3,7	3,08	14,4(3,6)
Demak	2,3	3,64	4,3	1,88	12,12(3,03)
Rata-rata	3,27	3.61	3,71	2,84	13,43(3,35)

Information:
Score 1: Really not serious, 0% damage, Rapid growth/increase rate of mangrove.
Score 2: Not serious, <10% damage, Mangroves grow normally. there is an increase (2 marks).
Score 3: Mild damage, 10-25% damage, there is a growth/increase rate of mangrove (3 marks).
Score 4: Serious, high damage rate ranging from 25 to 75%, relatively there is an absence of growth/increase of mangrove (4 marks).
Score 5: Very serious, Massive damage above 75%, no growth/increase of mangrove (5 marks).

Fig.2 Central Java-Indonesia

Fig.3 Research Sites

DISCUSSION

The people's perception in the Regency of Brebes, Pemalang, and Demak towards the importance of mangrove lies on the range of intermediate up to very good with average score of 4,02 (good). On the other hand, apparently those perceptions are not in a conjunction with real proportionate actions where the average score of people's participation in the Regency of Brebes, Pemalang, and Demak in conserving the very existence of mangrove's vegetation in their region is merely 3,90 (intermediate).

The analysis results of coastal people's perception in the Regency of Brebes, Pemalang, and Demak that lies on the range of good up to very good score is not automatically followed by the same score for its participation factor where the score of the participation merely lies on the range of intermediate up to good. Generally, the awareness and concern of coastal people in the Regency of Brebes, Pemalang and Demak to participate in conserving the mangrove ecosystem in their area held a significant role which is seen from whether the dominant socio-economic factoris relative (logging-incineration of mangroves) compared with the coastal-abrasion factor as an ecological factor. Nevertheless, the rate of reduction of the mangrove area in the coastal region in the Regency of Brebes, Pemalang, and Demak due to logging/incineration factor is 31,70 hectare/year (Brebes). Yielding a

contribution of more than 50% on the reduction of total mangrove area due to coastal-abrasion factor of 53,55 hectare/year with the same rate of coherency of 99,60% becomes a substantial matter that needs to be taken into consideration. Thus, the role of observation, prevention, and preservation of mangrove sustainabilty in the Regency of Brebes, Pemalang, and Demak towards the factor of logging/incineration needs to be improved.

Analysis of SEM (Structural Equation Modelling)

Process of perception data, participation, and the area condition of mangrove damage in Regency of Brebes, Pemalang, and Demak which uses SEM program (Structural Equation Modelling) Lisrel 8,0 resulting in linkage model of perception-participation-damage of mangrove in the Regency of Brebes, Pemalang, and Demak is shown in figure below:

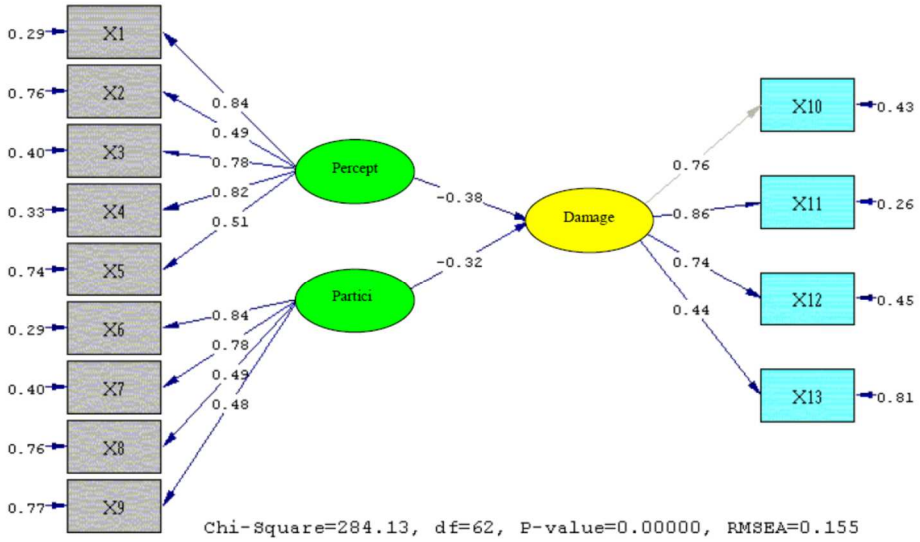

Fig. 4 Standardized output using LISREL software

Loading factor value above is 0,4, which shows that item is a fit indicator to be used as forming constructs.

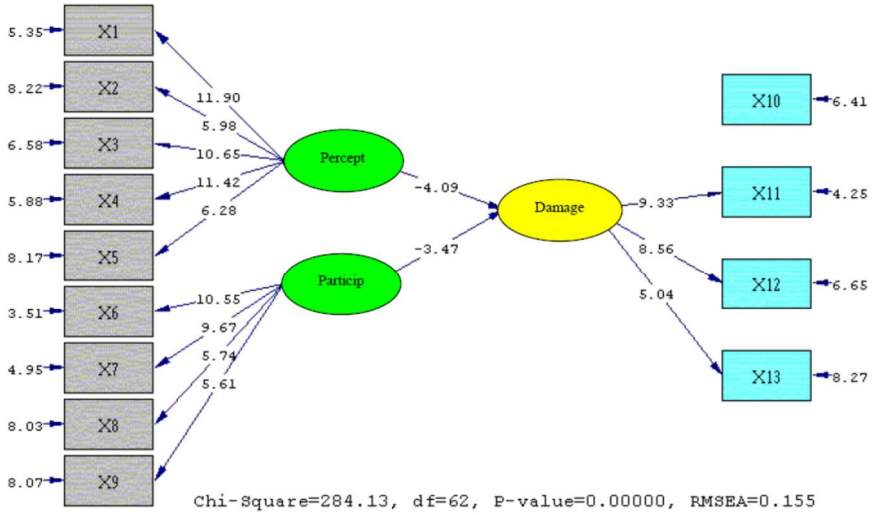

Fig. 5 Output of calculated t value using LISREL software

The calculated t values of -4,09 and -3,47, which are greater than 1,96, indicate that there are significant negative impacts between perception and participation on mangrove destruction (Structural Equation Modelling theory, concept, and application by LISREL 8,0 program, [18].

This matter attests that between perception, participation, and damage towards mangrove shows that there are significant negative impacts. Meaning, that the better the people's perception, the smaller the damage will occur. This could also mean the better the participation of people in continuing mangrove reforestation , the smaller the damage brought upon mangrove forest as well.

Table: 5 Correlation Matrix and Independent Variable

	Perception	Partisicipation
Perception	1.00	
Participation	0.03	1.00

	Damage	Perception	Participation
Damage	1.00		
Perception	-0.39	1.00	
Participation	-0.34	0.03	1.00

From the equations above, it appears that the impact of perception on participation is relatively small with regression coefficient of 0.03 and correlation proximity of 26%. Likewise, the impact of perception and participation on the dynamic reduction of total mangrove area in coastal region in the Regency of Brebes, Pemalang, and Demak is small as well. Both regression coefficient of perception and participation on the preservation of mangrove are 0.32 and 0.38 respectively with correlation proximity of 26%. In the said matrix, we can see the positive correlation between the perception and the participation occurring in the Regency of Brebes, Pemalang, and Demak. Whereas, Negative correlation is seemingly to occur between the damage of mangrove and either the perception or participation. That being said, if the people's perception gets stronger towards the existence of mangrove forest, the damage occurred will most likely to be at minimum. And if the participation by the people is getting more and more prevalent, then the damage of mangrove forest will be mitigated and thus it will retain at minimum.

CONCLUSION

Generally, the physical condition of coastline in Pantura, Central Java has been going through some alterations caused by abrasion/erosion and accretion due to buildings jutting into the sea, rise of sea level, shifting function of coastal border, and also global warming effect. In order to rehabilitate ecosystem, several principles need to be considered, which are; prioritization of ecological rehabilitation, proper rehabilitation, accompaniment sustainability, taking into consideration should physical rehabilitation is implemented, and harmoniously living together with the ecosystem.

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