Community participation model in attempt to preserve mangrove ecosystems (Study: Pariaman Utara Sub-District, Pariaman City, West Sumatera)

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Abstract. This research is located in a mangrove forest covering 18 Ha, which is still far from ideal conditions. The problem of this research is the decreasing mangrove forest due to rapid development activities in coastal areas. This research aims to analyze the structure of mangrove vegetation, the relevance between internal and external factors with the level of community participation in mangrove ecosystem management, and make models of community participation and its correlation with the structure of mangrove vegetation in North Pariaman District, Pariaman City. Plot sampling and purposive sampling were used to collect vegetation data, while accidental sampling was used to collect community participation data. A total of 98 participants were collected as samples. This number was calculated based on Slovin Formula. Community participation models were made using ordinal regression. The results showed that the density of mangrove vegetation structure is 841 Ind / Ha. In conclusion, the mangroves are categorized as damaged, and all of the participation stages are categorized as low. There is a formula to increase participation level, and it varies at each stage, consisting of several variables such as occupation, age, and period of stay.

1. Introduction
Mangrove is a plant community that lives between sea and land and is affected by tides, currents, fresh water, and sedimentation [1]. Mangrove is often found in estuary areas, namely the meeting place between river estuaries and seawater. Mangrove ecosystems in various regions and countries have undergone damage and decreased in an area over time. Pariaman City, West Sumatra, also experienced this condition. This is presumably because of the construction activities in the mangrove habitat. The percentage of mangrove cover was merely 25% of the 52 ha mangrove area [2]. Another source asserted [3] that mangroves in Kota Pariaman had only 18 ha, North Pariaman District had the largest mangrove forest, which was 16.5 ha.

The mangroves were scattered in Apar Village (6 ha), Ampalu Village (3.5 ha), and Manggung Village (7 ha). The decline of the mangrove forest area is due to increased development activities, especially in coastal areas [4]. Mangroves in Pariaman City have an area of 18 ha, which is still far from ideal conditions. Ideal conditions, according to Permenhut No. 53 of 2010, is an area with a width of 130 x the mean value of the difference in annual highest and lowest tide measured from the lowest tide line towards the land. The average difference between the highest and lowest tides in...
Pariaman City is 1.1 meters [5]. This calculation indicates that the ideal condition for the mangrove area in Pariaman is 143 ha.

In this regard, participation can be carried out in several stages. Classify participation into several stages as follows [6]:

1. Decision-making: The stages of decision making are those manifested by community participation in meeting activities.
2. Implementation: The implementation stage is the most critical in development because the essence of development is its implementation. There are three concrete forms of participation at this stage: participation in thought contributions, material contributions, and forms of involvement as project members.
3. Benefit: The enjoyment stage can be used as an indicator of community participation's success in the project's planning and implementation stages. Besides, by looking at the community's position as the subject of development, the greater the project's benefits are felt, meaning that the project is successful on target.
4. Evaluation: The evaluation stage is considered necessary because community participation is considered feedback that can provide input for improving the implementation of further projects.

Various factors influence the community in their participation in mangrove management, including the following:

1. Level of education: The right level of education will influence community participation in managing mangrove forest areas, shown by the community's high desire to protect and preserve the area [7].
2. Age: Age is the life span that a person goes through. Productive age is in the age range of 15-64 years [8]. Based on the task of human development, [9] classifies adulthood into three groups, namely early adulthood (18-29 years), middle adulthood (30-50 years), and old adulthood or old age (> 50 years). Being in the productive age provides potential opportunities for participatory mangrove forest management. This is based on absorbing and carrying out participatory activities more likely to succeed at a productive age [10].
3. Income level: Income can affect community participation in managing the environment [11].
4. Length of stay: The length of stay is the person's domicile to live in the area or the length of time the people inhabiting an area. The longer the community lives in an area, the sense of belonging to the environment will be increasingly visible in its massive environmental activity [12]. The length of stay of a person in a specific environment and the experience of interacting with that environment will affect one's participation.

Several studies have been conducted on the structure of mangrove vegetation with different density results and important index values, such as in the Riau Islands Province [13], in East Lombok Regency, West Nusa Tenggara Province [14], and in Balusu, Barru Regency, South Sulawesi Province [15]. Research on community participation has also been carried out a lot, such as in Sayung District, Demak Regency [16], in Tarumajaya District, Bekasi Regency [17], and a Case Study in Indramayu Regency, West Java [18] with different results. However, research is still scarce, linking the data on mangrove vegetation structure with the community participation model. Usually, the structure results are only associated with natural factors, which in this study, both aspects will be examined. This research is located in a mangrove forest that is still far from ideal conditions. The problem of this research is the decreasing mangrove forest due to rapid development activities in coastal areas. This research aims to analyze the structure of mangrove vegetation, the relevance between internal and external factors with the level of community participation in mangrove ecosystem management, and make models of community participation and its correlation with the structure of mangrove vegetation in North Pariaman District, Pariaman City.

2. Method
The method used in this research is a combination of quantitative and qualitative methods (mix method/mixture). Quantitative methods are used to analyze vegetation data processing, while
qualitative methods are used to analyze the results of questionnaires from the community and interviews with informants. The method used in determining the location of mangrove vegetation was the *purposive sampling* method. At each location, transects were laid out measuring 10 m x 10 m for the tree category, 5 m x 5 m for the *sapling* category, and a 1 m x 1 m plot for *seedling* [19]. The data was then analyzed to determine the Importance Value Index (IVI). However, if a species is found for the stem diameter cannot be measured, it can use percentage cover, such as calculating the *seedling* plot. The sample of coastal communities was obtained representing the entire population based on accidental sampling techniques.

The society participation questionnaire consisted of two questionnaires: the Guttman scale and short essay. The sample of community participation amounted to 98 people obtained from the calculation of Slovin. The Guttman scale questionnaire aims to obtain information about how much society's participation is in four different stages, namely decision-making, implementation, enjoying the result, and evaluation. Research using the Guttman scale is carried out to get a firm answer to a problem being asked [20]. The measured variables scoring has two intervals: Yes, with a score of 1, not with a score 0. The scoring results are then calculated and percentage in three levels: low, medium, and high, according to the number of respondents and the number of questions. The result of community knowledge about mangroves is a short questionnaire that is summarized and classified according to the type of question. These results were analyzed by presenting each answer given by the respondent.

This research used two research tests: the Spearman Rank test and the statistical test of non-parametric Chi-Square. The Spearman Rank test is used to see the correlation between the level of social participation variables, including age, last education level, income, length of stay, methods of implementing activities from society, and service implementation of society's activities. To gain a low, moderate, or high probability of an individual for participating, it can be calculated by using an ordinal regression model. Ordinal regression models in general:

$$Logit(Y = y_i) = \text{Constant} + \text{Estimate}_1 x_1 + \text{Estimate}_2 x_2 + \cdots + \text{Estimate}_j x_j$$

(1)

Note:

$y_i$: Society Participant (Low, Moderate, High)

$x_1, x_2, \ldots, x_j$: Independent variable 1 to $j$ ($j =$ the last variable that has a significant effect)

Constant: Logit value if the respondent is on the reference variable in each independent variable

Probability can be calculated by:

$$P(Y = y_i) = \frac{1}{1 + e^{-\text{Logit}(Y = y_i)}}$$

(2)

Note:

$P(Y = y_i)$: The probability of individual participating in the I.

The probability can be described as follows:

$$P(Y = low) = \frac{1}{1 + e^{-\text{Logit}(Y = \text{low})}}$$

$$P(Y = moderate) = \frac{1}{1 + e^{-\text{Logit}(Y = \text{moderate})}}$$

$$P(Y = high) = 1 - P(Y = low) - P(Y = moderate)$$

(3)
Table 1. Variable Operational Definition

| No | Variable                                     | Definition                                                                 |
|----|---------------------------------------------|---------------------------------------------------------------------------|
| 1. | The structure of the mangrove vegetation   | Description of the Basal Area, Density, Domination, Diversity, Zoning, Diameter, and Vegetation Height |
|    | a. The density                             | The number of individuals per unit area                                    |
|    | b. The Diversity Index                     | Characteristics of a community that describes the level of species diversity of organisms that are primary in the community |
|    | c. The uniformity index                    | Comparison between the diversity value and Ln of the number of species     |
|    | d. The index of significance               | The value obtained is to determine the species that dominate a mangrove area |
| 2. | Internal factors                           | The factors contained in individual respondents that can be an encouragement to participate in mangrove conservation efforts |
|    | a. Age                                     | The age of the respondent when the data was collected                     |
|    | b. Income                                  | The average income in the form of money the respondent earns every month   |
|    | c. Length of stay                          | The length of time the respondent lived in the research location until the time the data was collected. |
|    | d. Last Education                          | The respondent's type of school education                                 |
| 3. | External factors                           | Factors from outside the individual that can influence or are suspected of having a relationship with the level of participation in mangrove conservation efforts |
|    | a. The method of implementing              | The score activity was obtained from a questionnaire to assess the respondents’ views on delivery in mangrove conservation activities. |
|    | b. Service implementation                  | Scores obtained from questionnaires to assess respondents' views on the quality of mentoring, training, and facilities in mangrove conservation activities |
| 4. | Community participation                    | The participation of respondents in all stages of group activities        |
|    | a. Decision making                         | Scores obtained from questionnaires to assess the participation of respondents in attending meetings / planning an activity and respondent activeness in the meeting |
|    | b. Implementation                          | Scores obtained from questionnaires to assess participation in the implementation of mangrove conservation activities |
|    | c. Enjoy the results                       | The scores obtained from the questionnaire to assess the impact on respondents in experiencing the benefits of mangrove conservation activities |
|    | d. Evaluation                              | Scores obtained from questionnaires to assess respondents' participation in assessing an activity |

3. Results and discussion

Based on the results obtained, it can be concluded that on the whole, the dominant species in the mangrove ecosystem of North Pariaman District was *Nypa fruticans* with an average Importance Value Index (IVI) of 200. This was due to only one species was found in both. When it was viewed from its density, the species that had the highest density was *Sonneratia caseolaris*. 
The density value of mangrove species in the tree category shows that each village's density has a value ranging from 867 ind/ha to 967 ind/ha with an average density of 841 ind/ha. This result is lower than the coastal border of Balusu District [15], which has an average density of 1027 ind/ha. This is because the species in the data collection plots at the research location tend to be dominated by the juvenile to mature mangroves with large trunk diameters, which implies a sizeable Relative Dominance (DR) value, thus affecting the mangrove density value. According to the Minister of Environment Decree [21], with this density condition (841 Ind/ha), the mangroves in North Pariaman District were categorized as damaged. However, other considerations dealing with mangrove area cover can be affected by dominance and the Importance Value Index.

Table 2. Value of Density (K), Basal Area (BA), Relative Density (KR), Relative Dominance (DR), and Importance Value Index (IVI) for Each Species in the Research Location.

| No  | Location/Species           | K (ind/ha) | BA (m²/ha) (%: Nf) | KR (%) | DR (%) | IVI (%) |
|-----|---------------------------|------------|--------------------|--------|--------|---------|
| 1.  | Desa Apar                 | 967        | 0,14               | 52,72  | 36,8   | 89,6    |
|     | *Rhizophora apiculata*    |            |                    |        |        |         |
|     | *Sonneratia caseolaris*   | 867        | 0,24               | 47,27  | 63,2   | 110,4   |
| 2.  | Desa Manggung             | 800        | 53,4               | 100    | 100    | 200     |
|     | *Nypa fruticans*          |            |                    |        |        |         |
| 3.  | Desa Ampalu               | 733        | 50                 | 100    | 100    | 200     |
|     | *Nypa fruticans*          |            |                    |        |        |         |

Table 3. Stages of Society Participation in Mangrove Ecosystem Management

| No  | Stage                    | Category | Total (People) | Percentage (%) |
|-----|--------------------------|----------|----------------|----------------|
| 1.  | The Stage of Making a    | Low      | 67             | 68,37          |
|     | Decision                 | Moderate | 21             | 21,43          |
|     |                          | High     | 10             | 10,20          |
| 2.  | The Implementation       | Low      | 75             | 76,53          |
The results of the Regression Modeling Equation for the Decision-Making Stage are as follows:

Logit (Y = Low) = -2.543755 + 0.675 Housewife + 0.095 Parking Attendants + 0.626 College Students + 0.284 Fishermen - 0.544 Traders + 0.058 Students + 0.094 Farmers - 3.149 Volunteers - 0.403 Entrepreneurs - 0.921 Academics (Q7 2) + 1.521 Government (Q7 3) - 0.472 None (Q7 4).

Logit (Y = Moderate) = 1.790493 + 0.675 Housewife + 0.095 Parking Attendants + 0.626 College Students + 0.284 Fishermen - 0.544 Traders + 0.058 Students + 0.094 Farmers - 3.149 Volunteers - 0.403 Entrepreneurs - 0.921 Academics (Q7 2) + 1.521 Government (Q7 3) - 0.472 None (Q7 4).

Based on the results of the regression model above and with the existing calculations in the method, it is found that at the Decision Making Stage, the order of the types of work from the most influential is Housewife, College Students, Fishermen, Parking Attendants, Farmers, Students, Laborers, Entrepreneurs, Traders, and Volunteers. However, only the Housewife and students are under the moderate influence at this stage, while the rest have only minor influence. The results of the Regression Modeling Equation for the Implementation Stage are as follows:

Logit (Y = Low) = 18,73376 - 5,313 Age 26-35 - 4,491 Age 36-45 - 62,068 Age> 45 - 29,441 Junior High School - 2,919 Senior High School - 1,995 D3 / S1 + 22,685 Housewife + 20,199 Parking Attendants + 21,340 College Students + 19,781 Fishermen + 2,555 Traders + 19,095 Students + 51,954 Farmers + 23,135 Volunteers + 21,649 Entrepreneurs.

Logit (Y = moderate) = 54.68241 - 5,313 Age 26-35 - 4,491 Age 36-45 - 62,068 Age> 45 - 29,441 Junior High school - 2,919 Senior high school - 1,995 D3 / S1 + 22,685 Housewife + 20,199 Parking attendants + 21,340 College Students + 19,781 Fishermen + 2,555 Traders + 19,095 Students + 51,954 Farmers + 23,135 Volunteers + 21,649 Entrepreneurs.

Based on the results of the regression model above, it is found that at the Implementation Stage, the order of age categories from the most influential was 15-25 years, 36-45 years, 26-35 years, up to> 45 years. But all categories fall under little influence. For the latest education characteristics data, the most influential ones are SD, D3 / S1, SMA, SMP. However, all categories are of little effect. The order of Job type from the most influential is Farmer, Volunteer, Housewives, Entrepreneurs, College Students, Parking Attendants, Fishermen, Students, Traders, and Workers. All types of work at this stage are of significant influence. The results of the Regression Modeling Equation for the Enjoying Stage are as follows:

Logit (Y = Low) = -2.543755 + 0.675 Housewife + 0.095 Parking Attendants + 0.626 College Students + 0.284 Fishermen - 0.544 Traders + 0.058 Students + 0.094 Farmers - 3.149 Volunteers - 0.403 Entrepreneurs - 0.921 Academics (Q7 2) + 1.521 Government (Q7 3) - 0.472 None (Q7 4).

Logit (Y = Moderate) = 1.790493 + 0.675 Housewife + 0.095 Parking Attendants + 0.626 College Students + 0.284 Fishermen - 0.544 Traders + 0.058 Students + 0.094 Farmers - 3.149 Volunteers - 0.403 Entrepreneurs - 0.921 Academics (Q7 2) + 1.521 Government (Q7 3) - 0.472 None (Q7 4).

Based on the results of the regression model above, it is found that at the Enjoying Stage, the order of age categories from the most influential was 15-25 years, 36-45 years, 26-35 years, up to> 45 years. But all categories fall under little influence. For the latest education characteristics data, the most influential ones are SD, D3 / S1, SMA, SMP. However, all categories are of little effect. The order of Job type from the most influential is Farmer, Volunteer, Housewives, Entrepreneurs, College Students, Parking Attendants, Fishermen, Students, Traders, and Workers. All types of work at this stage are of significant influence. The results of the Regression Modeling Equation for the Enjoying Stage are as follows:
The regression model results above, and the calculation in the method found that, at the enjoyment stage, the ranking of the most influential age categories was 15-25 years, 36-45 years, 26-35 years, and > 45 years. But all categories fall under little influence. The length of stay category from the most influential was > 40 years, 15-25 years, 25-40 years. The length of stay > 40 years has a significant effect. The results of Regression Modeling Equation for The Evaluation Stage are as follows:

Logit (Y = Low) = -3.032717 - 18.671 Age 26-35 - 1.794 Age 36-45 - 20.082 Age > 45 - 0.565 Length of stay 15-25 years - 17.151 Length of stay 25-40 years + 1.991 Length of stay > 40 Year

Logit (Y = moderate) = 1.912161 - 18.671 Age 26-35 - 1.794 Age 36-45 - 20.082 Age > 45 - 0.565 Length of stay 15-25 years - 17.151 Length of stay 25-40 years + 1.991 Length of stay > 40 years

The regression model results above, and the calculation in the method found that, at the enjoyment stage, the ranking of the most influential age categories was 15-25 years, 36-45 years, 26-35 years, and > 45 years. But all categories fall under little influence. The length of stay category from the most influential was > 40 years, 15-25 years, 25-40 years. The length of stay > 40 years has a significant effect. The results of Regression Modeling Equation for The Evaluation Stage are as follows:

Logit (Y = Low) = 14.35263 - 39.110 Age 26-35 - 37.693 Age 36-45 - 58.511 Age > 45 - 57.466 Junior High School - 1.975 Senior High School - 1.355 D3 / S1 + 21.702 Housewife + 56.369 Parking Attendants - 13.937 College Students - 32.860 Fishermen + 22.803 Traders - 35.475 Students + 20.735 Farmers - 35.269 Volunteers + 4.212 Entrepreneurs.

Logit (Y = moderate) = 58.86824 - 39.110 Age 26-35 - 37.693 Age 36-45 - 58.511 Age > 45 - 57.466 Junior High School - 1.975 Senior High School - 1.355 D3 / S1 + 21.702 Housewife + 56.369 Parking attendants - 13.937 College Students - 32.860 Fishermen + 22.803 Traders - 35.475 Students + 20.735 Farmers - 35.269 Volunteers + 4.212 Entrepreneurs.

Based on the results of the regression model above, it is found that at the Evaluation Stage, the ranking of age categories most influential was 15-25 years, 36-45 years, 26-45 years, > 45 years. But all categories fall under little influence. The education category's order from the most influential is SD, D3 / S1, SMA, and SMP. However, all categories are of little effect. The order of job types from the most influential are Parking Attendants, Traders, Housewife, Farmers, Entrepreneurs, Laborers, Students, Fishermen, Volunteers, and Students. Types of work included in the significant influence are parking attendants, traders, domestic workers, farmers, and entrepreneurs.

The finding states that the level of social participation overall is in a low category. If it is linked to the data on individual characteristics and data on the implementation of mangrove ecosystem management, low participation in each is likely to happen. This is related to mangrove knowledge data, which indicates that most people do not know about and utilize mangroves. The nescience of some people in this regard, it causes a lack of social management of the mangrove ecosystem. The following statement argues that society has moderate and low participation because society realizes that their lives depend on existing mangrove forest resources. However, they do not understand that mangrove forests need to be appropriately managed benefits can be obtained sustainably [22].

Dealing with modeling at the evaluation stage, the influencing variables are age, education, and occupation. The impact of education level also occurs in research [16], which states in Surodadi Village, Sayung District, Demak Regency that the internal factors that significantly influence farmer group participation are the level of formal and non-formal education. All variables of age and education have a small effect. In contrast, the type of occupation of a parking attendant, trader, housewife, farmer, and entrepreneur significantly influences participation in the evaluation stage. This is assumed due to these jobs tend to be located in a research location, where they always interact with the mangrove ecosystem. However, in reality, the mangrove conditions are still not good enough. This is due to the lack of education for respondents with these jobs. Points out that the level of education or higher education has an excellent effect on knowledge level [23]. The higher the knowledge, the more
influential the evaluation and management of the mangroves will be produced. This is assumed because of the low level of education and regulations provided by the government and stakeholders. The lack of role affects mangrove development, following [24] stated that stakeholders’ role in the form of institutions is essential in mangrove development. In this case, stakeholders such as the government, academics, and society must have a mangrove conservation relationship. The stakeholder's linkages can be provided, such as collaboration, coordination, and contribution to society [25]. Even though the size of the evaluation they provide, it still has no significant effect due to the lack of knowledge and stakeholders' role in efforts to conserve ecosystems in the research location.

4. Conclusion

Nypa fruticans dominate mangrove trees' vegetation structure with an average Importance Value Index (IVI) of 200. The mangrove density District of North Pariaman with a value of 841 Ind / Ha is in the damaged category. The mangrove recommended for further planting is species of *Sonneratia caseolaris* and *Rhizophora sp.* Overall, all stages are dominated by a low participation level, with an average percentage of 78% at each stage. This is affected by various factors, both internal and external factors. Based on the regression model results, the formulation that can be undertaken to increase participation is different for the four stages. For job classification, the people who have a significant influence on the decision-making stage are housewives, students, and governments. Meanwhile, farmers play a big part in the implementation stage. Job variables do not affect the "enjoying the fruit of labor" stage. Jobs that can be targeted at the evaluation stage are parking attendants, traders, house helpers, farmers, and entrepreneurs. In the age category, only the implementation stage has an effect, varied from the age of 15-25 years, and all age categories have the same effect on the "enjoying the fruit of labor" stage and evaluation stage. For the period of stay variable, only at the stage of "enjoying the fruit of labor" influence being targeted, they are people with residence period of 25-40 years. On the other hand, the education category only affects the evaluation stage, but all education types have the same effect. Knowing the right target for community participation will directly increase the level of community participation and indirectly improve the condition of the mangrove ecosystem if applied correctly.

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