Damage level and area suitability of mangrove in small island Indonesia

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Abstract. The mangrove ecosystem has functions that important for economic and ecology. Increased utilization activities that are damaging accompanied decline mangrove area, it is appropriate rehabilitation condition and maintenance mangrove ecosystem. Improvement effort rehabilitation mangrove ecosystem. The aim mangrove rehabilitation effort for restore ecosystem. Study aimed to determine the extent of damage level, area suitability biophysical and mangrove specieses planted. The survey method used measurement directly to determine the damage level and area suitability biophysical assessment. The Results showed mangrove ecosystem destruction overall research stations are medium damaged condition. Analysis suitability index (IKW) showed that mangrove ecosystem overall stations were suitable rehabilitation area. The mangrove specieses are Rhizophora sp, Bruguiera sp, Sonneratia sp, Xylocarpus sp, Scyphiphora hydrophyllacea and Heritiera littoralis sustainable to planting.

1. Introduction
Mangrove ecosystem is natural resource that has typical characteristics and on the seashore influenced by the tide so that their habitat is always flooded by saline water. Mangroves has high ecological potentials among others, are as (orphanage, feeding, enlargement, spawning). The economy contribution among are as firewood, tanin materials, ecotourism and materials others. Mangroves ecosystem include natural resources that can be recovered that it requires appropriate handling, especially to prevent nature of such natural resources and ensure sustainability present and future [1].

High population growth and development activities have been impact to mangrove ecosystem. The impact factor decline mangrove ecosystem function in terms economic development and environmental sustainability. Exploitation activities is important role in determining sustainability mangrove ecosystem. Conversion of mangrove forests to other land uses (e.g. settlements and ponds) have an impact threatened fish and organism marines population. Mangrove as habitat organism to spawning and feeding. Therefore necessary for environmental management efforts that can ensure the sustainability mangrove ecosystem [2].

The role and function mangrove very important is accompanied increased utilization activities that are damaging accompanied decreased mangrove, appropriate repair condition and maintenance mangrove ecosystem. Mangrove rehabilitation is effort to restore mangrove ecosystem to be natural
condition. The rehabilitation program finished agencies and non-government organizations supported surrounding community [3].

Mangrove ecosystem in Guraping, North Oba Subdistrict the habitat has been disturbance human activities as agricultural land, housing and wood fired. Degradation mangrove area result from utilization activities conducted. Reported 2004 years showed that mangrove ecosystem area is 151.3 Ha and 2019 years based on ETM 7 + Landsat analysis is 142.9 ha (decline 8.4 ha). Avoid effort the increase degradation, needs strategy like restoration areas.

The rehabilitation activities that have been conducted the Ecosystemry Service in 2003 and the provincial Environment North Maluku (2018) are experiencing failures or seeds. The possible assessmet that degraded coastal land that can overgrown mangrove recovered only planting mangrove seeds in simple. Mangrove rehabilitation research in Indonesia has been reported, but specification damage level and area suitability unreported especially in North Maluku. Several reported [3] about limited to evaluation of rehabilitation programs, [4] success rate of mangrove planting on post-mining land [5] feasibility mangrove rehabilitation with technique carbon trading. Based o several research, the novelty this research were damage level, area suitability mangrove and determination mangrove species that suitable for planting analysis.

2. Method
2.1. Research location
Location site in Guraping village North Oba Sub-district Tidore Islands Figure 1.

![Figure 1. Research site](image)

2.2. Data sampling
Slope land
Data was collected using field survey method. Land elevation measured at lowest receding on each profile using assembled "Profiler" in form two-sided boards connected with 50 cm strap along and protractor strap. The stick is given a penal to ensure the firmness of both sticks. Slope measurement using establishing each upright stick. During measurement it is ensured that both the pendulum straight in order to get the correct measurement result. The indicated angle value is recorded as data for each slope length 50 cm. Analysis slope data, directed at a regression relationship between land surface height (Y) and land Length (X) [6].
Mangrove species
Mangrove collection with "Check spot" method. The transect is pulled perpendicular to the coastline along mangrove vegetation. The total number of plots in this study is and 5 observation plots at each stations. Quadrant line transects were drawn in which sampling plots were established to record and identify the plant species contained within the plot with size. Vegetation data collected using a plot 10 m x 10 m (tree category), 5 m x 5 m (saplings category) and 2 m x 2 m (seedlings category). Identification mangrove specieses using biological tissue from leaves, flowers, fruit and measured by the Tree plants with stem diameter ≥10 cm and height ≥ 1.5 m [7]. Mangrove identification using guidelines book [8].

Substrate
Sediment sampling using pipe paralon (PVC, diameter 2.5 inches) plug the pipe into sediment (0-20 cm). Sediment intake as much as 500 grams. The obtained sedimentary sample is inserted into the plastic bag and then taken to the soil and water physics and Conservation Laboratory, the Faculty of Agriculture of Unsrat Manado to analyze the soil texture.

Salinity
Salinity using handrefracrometer. The procedure using appliance is calibrate first, then take a sample of the water and store it on the glass container, and then see the result of salinity on the board and record the Salinity listed on the refractometer scale.

Temperature
Temperature were performed using thermometer that is dipped directly into the water capturing time and location data retrieva.

2.3. Data analysis
Damage level
Density of mangrove and percentage land cover as damage level data. Density (in), i.e. the number of individual species i in an area measured [7].

Area suitability analysis
Analysis uses scoring method, evaluate mangrove land at each research station. This study each 4 categories were very appropriate, appropriate, conditional and inappropriate. Category is suitable to be rated 4, the corresponding category is rated 3, according to conditional is given a value 2 and not suitable given a value 1. Based on the score each parameter, there are assessments to determine whether the land is suitable for mangrove rehabilitation planning using formulations [9]

3. Results and discussion
Mangrove species
Based on observations in mangrove area found that 8 specieses namely: Rhizophora apiculata, Rhizophora mucronata, Bruguiera Gymnorrhiza, Ceriops decandra, Sonneratia alba, Xylocarpus granatum, Heritiera littoralis and Scyphiphora hydrophyllacea table 1.

Table 1 showed that family Rhizophoraceae have high compositions of species in overall stations of 4 species (Rhizophora apiculata, R. Mucronata, Bruguire Gymnorrhiza, Ceriops Decandra). The species distributions overall areas and has ability growing in variations substrate were muddy sand, mud and sandy mud. [10]stated that the area that has a muddy substrate, muddy sand, sandy mud strongly supports the habitat mangrove. The diversity of mangrove species in the area is one of the attractions for visitors to conduct tours and educational activities related to mangrove ecosystem.

Mangrove composition species obtained comparision with the results of previous research such as in East Halmahera Regency [1], [10] North Halmahera Regency as many 9 species and [11] in West Halmahera Regency as many 12 species. The difference results previous research mangrove normal
conditions while results this research has mangrove condition always experiencing anthropogenic pressure from the peoples in the form land conversion into residential land, agriculture, livestock, firewood and materials others.

Table 1. Mangrove specieses in Guraping

| No | Families         | Speciess           | Local names      | Sites |
|----|------------------|--------------------|------------------|-------|
| 1  | Rhizophoraceae   | Rhizophora apiculata | Soki-soki        | +     |
| 2  | Rhizophoraceae   | Rhizophora mucronata | Soki-soki        | +     |
| 3  | Rhizophoraceae   | Bruguiera gymnorrhiza | Dau             | +     |
| 4  | Rhizophoraceae   | Ceriops decandra   | Ting             | +     |
| 5  | Sonneratiaeae    | Sonneratia alba    | Posi – posi      | +     |
| 6  | Sonneratiaeae    | Xylocarpus granatum | Kira – kira      | -     |
| 7  | Rubiaceae        | Scyphiphora hydrophyllaceae | Rambat | +     |
| 8  | Sterculiaceae    | Heritiera littoralis | Kolot kambing   | +     |

information : + = found, - = not found

Damage level

The degradation level of mangrove ecosystem were obtained from results analysis mangrove density. Density station 1 are 0.63 ind/m², station 2 (0.053 ind/m²), station 3 (0.045 ind/m²) and station 4 (0.063 ind/m²). The result analysis mangrove density in table 5 and damage level in Figure 2

Table 2. Mangrove density

| No. | Jenis               | Density/ Station |
|-----|---------------------|-------------------|
| 1   | Bruguiera gymnorrhiza | 0.009 0.005 0.008 0.014 |
| 2   | Ceriops decandra    | 0.011 0.007 0.005 0.017 |
| 3   | Rhizophora apiculata| 0.020 0.023 0.023 0.022 |
| 4   | Rhizophora mucronata| 0.013 0.004 0.000 0.000 |
| 5   | Sonneratia alba     | 0.002 0.004 0.004 0.007 |
| 6   | Xylocarpus granatum  | 0.000 0.002 0.003 0.003 |
| 7   | Scyphiphora hydrophyllaceae | 0.003 0.005 0.002 0.000 |
| 8   | Heritiera littoralis | 0.002 0.002 0.000 0.000 |
|     | Jumlah             | 0.060 0.053 0.045 0.063 |

The high density in stations was Rhizophora apiculata because it has individual numbers and substrate like mud and sandy mud as a suitable habitat for this species. The low density founded Heritiera littoralis. This is caused only to be found in the rear zone and has low total number of individuals as well as the existence of human activity in the form of illegal logging. Density is related to tree spacing, the number of individuals it finds mangrove species and research locations. The more number individuals gained, the higher the density value [10].
Figure 2 showed that degree damage of mangrove ecosystem based on total density in station 1 (6 trees/100 m²), station 2 (5 trees/100 m²), Station 3 (4 trees/100 m²) and station 3 (6 trees/100 m²) are in medium damaged condition. The categorized as damage has been report the Ministry of Environment and Ecosystemry No. 201 Year 2004 is dense (density ≥ 15), good (density ≥ 10-< 15), sparse (density ≥ 7-< 10), Medium (density ≥ 4-< 7) and damage (Density < 4).

The condition mangrove ecosystem is damaged because illegal logging such as used firewood, materials, livestock feed, boat landing and conversion as residential and agricultural land. This showed counseling less from government about functions, benefits mangrove ecosystems and human impact (anthropogenic).

**Slope analysis**

Slope land as an oblique and forms certain angle against horizontal field in table 3.

| Station | Slope value | Evarages |
|---------|-------------|----------|
|         | Profile 1   | Profile 2 |          |
| 1       | 0.014       | 0.015     | 0.015    |
| 2       | 0.027       | 0.019     | 0.023    |
| 3       | 0.016       | 0.028     | 0.022    |
| 4       | 0.044       | 0.043     | 0.044    |

Table 3 showed that average slope value at station 1 of 0.015 (1.50%), Station 2 (0.023/2.30%), Station 3 (0.022/2.20%) and station 4 (0.044/4.40%). The land slope acquired flat and ramps. Flat fields are Station 1, station 2 and Station 3, while the ramps are located at station 4. The slope flat with a value of 0.0-2.9%, ramps slope (3.0-7.9%), slope (8.0-13.9), a very sloping slope (14.0-20.9), steep slopes (21.- 55.9%), a very steep slope (56.0-140.9%) and a steep slope (> 140.9%). Degraded mangrove land with land slope 0-0.05 is suitable used rehabilitation land [9].

Slope land and hydro oceanographic processes especially currents that can cause erosion processes. Tidal currents can also carry sedimentary materials, thereby affecting the slope of the land. The 1 and 3 stations are located in rear zone, visualizing when tidal are visible in current movement so that the sediment process is rare and generally muddy. Station 4 close with ocean so tidal currents often carry a smoother sediment material, so that the material produced in form muddy sand and sledge ramps. Factors influencing coastal erosion such as climate change, surge, seawater increase, angular
displacement comes wave, tidal and sedimentary displacement of sediment [12]. The occurrence of coastal erosion due to loss of material at the location, part of the land that there is flat mangrove, while on the part of the land that is not contained mangrove-slimy ramps [1].

**Substrate**

The composition sediment (sand, dust and clay) of station 1 is sand, station 2 (loam), station 3 (sandy loam) and station 4 (loamy sand). The different substrate type variations on each station are influenced location of each station. Stations 1, 2 and 3 are located close to mainland that sediment material indicated through the land that is affected, in addition to that the sea currents are weak so that the erosion process is low. The station 4 is located close ocean with strong tidal currents that influence carrying finer materials so that the substrate produced in the form of a rather rough material sand. Coastal areas of the mangrove system have a sandy soil species for areas close to the sea [13]. The size difference of sedimentary grain is related sedimentary source. The areas near the land or estuary of the river and the mangrove area of sedimentary grain size tend to be smoother, while the grain size facing off with the sea and away from the river estuary is more coarse grain size [14]. Commonly acquired substrates reported [15] and [13] acquired species substrate sand, sand, clay and sandy clay. This shows the soil texture in the mangrove ecosystem ecosystem is one of the factors that determine the species of mangrove that can thrive in the area. The composition mangrove is correlated with characteristic sedimentary example Avicennia sp. Generally develops on fine textured soils, Rhizophora of apiculata develops in relatively rougher soils compared to Avicennia sp, but in general can still classified on finely textured soils. Bruguiera Gymnorhiza in general develops textured soil somewhat smooth moderate. Species Sonneratia alba develops on sand soil on the seafront, where the substrate stable.

**Salinity and temperature sea**

Salinity and temperature for station 1 are 26-27 ‰ and a temperature range of 27-30°C, station 2 with a salinity range of 24-27 ‰ and a temperature range of 26-28°C, station 3 a range of salinity 26-27 ‰ and temperature range of 28-30°C. Station 4 range of salinity 27-30 ‰ and a temperature 29-33°C. Salinity is an important factor for the growth, survival ability and zoning of mangrove species. The highest acquired salinity is found at stations 4 and stations 1, 2 and 3 have the lowest salinity. The variation salinity is caused by a mixture of fresh water with seawater. Stations 1, 2 and 3 have low salinity because close the mainland so that there is freshwater runoff. Station 4 which is near the sea. The content of salinity shows the mangrove land both stations are suitable used as land rehabilitation activities. The range of salinity 20-30 ‰ suitable to serve rehabilitation land [9].

Temperature difference is influenced the amount light intensity sunlight that enters area each research station. Station 4 has the highest temperature because it is located near the beach and is in an open area so it has a high intensity of light while stations 1, 2 and 3 are located in area near the mainland that has a closed area that the intensity low light. Temperatures can influence processes such as photosynthesis and respiration. In addition, temperature also limiting factor for certain biota [16]. Generally, the temperature condition several stations are suitable to serve rehabilitation land.

**Area suitability rehabilitation**

Determination land suitability for planting or mangrove growth, determined conducting conformity assessment the parameters of each research station. Mangrove rehabilitation land appropriateness, scoring method. Parameters There are 4 classes that are very appropriate, appropriate, conditional and not corresponding table 3.

Station 1 and Station 2 have a region analysis suitability index (IKW) = 100%, because overall parameters as criteria for determination of rehabilitation land (slope, mangrove, substrate, salinity, temperature) have score 4 (very suitable) Table 3. Station 3 with the value of IKW = 89% Because of all the parameters only 4 parameters (land slope, mangrove species, substrate, salinity) has a score value 4 (very suitable) while the temperature parameter with the score value 3 (accordign). Station 4 has IKW value = 83% because only 2 parameters (land slope, salinity) have a score of 4 (very
suitable) whereas 2 parameters (mangrove species, substrate) with a score value of 3 (corresponding) and 1 parameter (salinity) with a score value of 1 (not appropriate). The result regional conformity index indicates it is suitable to serve as rehabilitation land. States that the score range is 75-100% (very suitable), 50-75% (suitable), 25-50% (conditional) and < 25% (unreasonably) figure 3 [9].

Table 4. Area suitability rehabilitation analysis

| No | Parameters       | Value | Scores/Station |
|----|------------------|-------|----------------|
|    |                  |       | 1  | Ni | 2  | Ni | 3  | Ni | 4  | Ni |
| 1  | Slope land       | 0.33  | 4  | 1.32 | 4  | 1.32 | 4  | 1.32 | 4  | 1.32 |
| 2  | Species Mangrove | 0.27  | 4  | 1.08 | 4  | 1.08 | 4  | 1.08 | 3  | 0.81 |
| 3  | Substrate       | 0.2   | 4  | 0.8  | 4  | 0.8  | 4  | 0.8  | 3  | 0.6 |
| 4  | Salinity (‰)    | 0.13  | 4  | 0.52 | 4  | 0.52 | 4  | 0.52 | 4  | 0.52 |
| 5  | Temperature (°C) | 0.07  | 4  | 0.28 | 4  | 0.28 | 3  | 0.21 | 1  | 0.07 |
|    | Total           |       | 4  | 4   | 3.93 | 3.32 |
|    | Score value     |       | 1  | 1   | 0.98 | 0.83 |
|    | IKW index (%)   |       | 100 | 100 | 98 | 83 |

Figure 3. Map area suitability mangrove ecosystem

Rehabilitation is restoration effort and habitat transforming broken system into stable to be natural ecosystem [17]. Function and role mangrove ecosystem for human and organism associations, then overall research stations must managed according to function and allocation land through rehabilitation efforts. Anthropogenic process are left without rehabilitation activities resulting in habitat degradation. The rehabilitation mangrove ecosystem activities is complex activity to carried out because these activities desperately need accommodating properties (participatory involvement) parties both around the area. This property will be more perceived benefits when the alignments to community that is very vulnerable mangrove resources are given a larger portion. This rehabilitation
needs to involved in arranging the process of rehabilitation mangrove ecosystem. The pattern community-based approaches is expected every formulation planning arises from community aspirations. Rehabilitation such as land identification, substrate analysis, preparation of ripe seedlings, duration of nursery (4-6 months), preparations for planting (adjusting species subtrat) and maintenance.

Factors affecting failure mangrove rehabilitation are selection inappropriate planting locations, improper use plant species for planting, lack of silviculture knowledge and lack coordination government and donors. The failure rehabilitation program is oriented towards the human interest, natural seed, garbage and impaired hydrological dynamics at planting site, as well as lack information publications and references to previous rehabilitation failures [12].

Species opportunities planted
Generally, mangrove rehabilitation projects in Indonesia experienced a technical failure caused mistake to assess that degraded coastal land can be overgrown mangrove recovered only planting mangrove seeds in a simple way. Rehabilitation activities must be qualified for rehabilitation activities such as seed suitability subtratw. The results analysis substrates obtained at overall research stations (clay, sand-flung, sandy loam) then recommended species mangrove planted, namely Rhizophora sp, Bruguiera sp, Sonneratia sp, Xylocarpus sp, Scyphiphora hydrophyllacea and Heritiera littoralis. Xylocarpus granatum and Lumnitzera littorea produce sanded sand soil. Rhizophora spp is suitable for living in areas with muddy substrates sandy mud, as well other members family Rhizophoraceae [8]. Rhizophora species has ability of adaptation and survival rate in condition environment very high so that this species is easy growing every region [18]. The waiting rooting system makes this species able to precipitate mud on substrate overgrown so as to cause area to be covered with this species becomes more mushy and muddy.

4. Conclusion
The damage level mangrove ecosystem research stations are medium condition. The analysis suitability index (IKW) from overall show that mangrove ecosystem area Guraping which is highly suitable for rehabilitation land. Opportunity species of mangrove planted namely Rhizophora sp, Bruguiera sp, Sonneratia sp, Xylocarpus sp, Scyphiphora hydrophyllacea and Heritiera littoralis.

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