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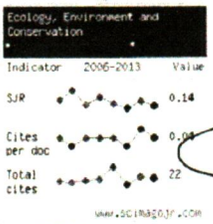

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THE EVALUATION OF MANGROVE ECOSYSTEM DAMAGEAS RESULT CONVERSION OF TOTAL FISHPOND IN COASTAL AREAS OF MAKASSAR STRAIT SOUTH SULAWESI

Budiman Yunus and Gufran Darma Dirawan

The importance of maintaining and conserve mangrove ecosystems and the development of its utilization patterns can increase the biodiversity of the world. Therefore it is necessary to study the management of mangrove ecosystems by first evaluating the extent of its damage to the rehabilitation and construction of sustainable mangrove ecosystem in coastal areas of Makassar Strait, South Sulawesi. The survey method is using to describe the condition spatial of mangrove ecosystem. More over, with direct observation of mangrove conversion patter in some areas (regions/zones) in the coastal of Makassar Strait, South Sulawesi, so obtained major damage level as result of total conversion outside pond "*Silvofishery*" at 6 districts/ cities that border the coast following : Makassar 2,434 ha (68.12%), Pare-Pare 4,694 ha (59.73%), Maros 6,731 ha (57.12%), Gowa 7,716 ha (53.37%), Takalar 8,539 ha (47.58 %), and Jeneponto 7,386 ha (41.27%). While minor damage level until moderate at in 3 districts, namely Barru 3,3750ha (27.36%), Pinrang 10,789 ha (29.17%), Pangkep 5,758 ha (28.57%).

Keywords: mangrove ecosystem conversion, Makassar Strait costal

INTRODUCTION

Mangrove ecosystem is an area of green vegetation lines that dominate the flora life around the Indonesian coastline with a length of approximately 81 km (Soegiarto, 1984). It is known according to the FAO (1982, *in* Onrizal, 2000) that the mangrove areas in this Indonesia is the largest forest areas in the world. However, the areas of this ecosystem becoming declining its condition in terms of quantity, or in quality from year to year. Decline in both quantity and quality of this mangrove area is due to the pressures of degradation since the 1950s, especially since the implementation of Foreign Investment Act (UU-PMA) and Domestic Investment (DCI) in 1970, where in this era the starting of forest exploitation (mangrove) as a source of foreign exchange in the framework of National Development (Kusmana, *et al.*, 2003).

Mangrove as one component of the coastal ecosystem plays an important role, both in maintaining the productivity of coastal waters and in the life-sustaining population in the region. For coastal areas, particularly mangrove forests as a green lines along the coast or estuaries is essential as firewood and building supplier, fry fish and shrimp supplier, as well as protecting and maintaining the quality of agricultural ecosystems, farms and settlements behind it from disruption erosion, abrasion, water intrusion and sea wind.

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Each vegetation areas has a diversity of different plants, the main cause is tidal fluctuations and differences in salinity. For example, the high-salinity coastal waters, mangrove communities compiled by *Rhizophora apiculata*, *R. mucronata*, *Soneratia alba* and *Bruguiera gymnorhiza*. While in the low-salinity coastal waters in river bank, generally found the community composed by *Nypa fruticans*, *Lumnitzera littorea* (main vegetation), ***Heritiera littoralis***, ***Excoecaria*** *sp.*, *Aegeceras corniculatum*, ***Acrostichum aureum*** and ***Hibiscus tileaceus*** (supporting vegetation) (Mustafa *et al.*, 1990; Pirzan *et al.*, 2001).

Intensification of farming as result of mangrove land conversion since the 1980s, especially in Java, Sumatra, Kalimantan and Sulawesi, with the goal of spurring exports of fishery commodities. This is evident from the farm extensive development of approximately 225.000 hectare in 1984 to 325.000 hectare by the end of the Fourth Development Plan (Direktorat Jenderal Reboisasi dan Rehabilitasi Lahan, 1997). Based on the identification of the causes of mangrove destruction in coastal areas in five biggest islands in Indonesia, it is identified that the largest mangrove resource destruction caused by conversion of mangrove areas into fishponds with ignores resource conservation aspect and its ecosystem. Based on the background about the importance of maintaining resource conservation and mangrove ecosystems and the development of its utilization patterns, it is necessary to study the management of mangrove ecosystems by first evaluating the extent of its damage to the rehabilitation and construction of sustainable mangrove ecosystem in coastal areas of Makassar Strait, South Sulawesi.

Purposes and Objectives

Concerns about the continued decline of mangrove forests that occur both in Java and outside Java such as Kalimantan and Sulawesi, where this phenomenon will obviously result in damage to the quality and quantity of the resource potential of coastal ecosystems, as well as loss of environment protected function of the mangrove forest. Therefore, to restore the functions and benefits of mangrove forests are damaged, needed rehabilitation and conservation activities by first evaluating the extent of the damage. In order to support the achievement of the above objectives, it is necessary to identify and inventorization the damage of mangrove areas in Makassar Strait South Sulawesi.

Methods and Evaluation Parameter

1. **Time and Location**: Research and evaluation of destruction level of this mangrove areas has been running for more than 4 (four) months, i.e since the beginning of April 2012 until the end of July 2012, which includes the location of 9 districts/cities along the coast of Makassar Strait, South Sulawesi.
2. **Sampling Methods**: Sampling data flora performed with 2 (two) ways, namely through the inventorization and vegetation analysis techniques. Inventorization

of flora is intended to provide a general description of vegetation conditions in the study area, vegetation analysis techniques are intended to look at the structure and species composition. Vegetation analysis techniques performed with plot lines (*transects*) by *nested sampling* with sub-sub samples for regeneration, such as: 2^{m2} for seedling, 25^{m2} for stake and 100^{m2} for trees.

Regeneration rate criteria used were: a) seedling = sapling begin sprout to height ≤ 1.5 m, b) stake = sapling with diameter <10 cm and height> 1,5 m, and c) tree = young and adult sapling with diameter ≥ 10 cm. The data obtained were recorded and analyzed by Greig-Smith (1964) method.

3. **Soil**: Soil samples will be taken from each of the *training area*. Analysis of soil samples conducted on the physical and chemical properties as listed below.

   Soil physical; texture, depth, stone/gravel, slope/physiographic, and dept of standing water and groundwater. ***Soil chemical;*** Potential content of pyrite and its depth, pH(H_2O), and pH(H_2O_2).

4. **Water**: Water sampling conducted at several locations that are representative of conditions in the survey area waters. While the parameters of water properties are measured and analyzed were parameters that become standard quality requirements for marine life in accordance with applicable regulations.

5. **Green Line Width**: The measurement of green line width was conducted begin from beach or the river continuously vegetated landward until area border not vegetated, so then obtained green line widest and narrowest.

6. **Abrasion:** Estimate the magnitude of abrasion rate at a location determined by the local indigenous population interviews about the history of beach conditions and the changes to the current study. From data obtained later made an average annual erosion rate by dividing the change in the width of beach with the year during the changes. If the width of beach is increasing, then there is sedimentation. While the said abrasion if width of beach is decreasing.

7. **Determination of damage level of Mangrove Forest**: Determination of area damage level with mangrove potency is determined through a predetermined formula of Directorate General of Reforestation and Land Rehabilitation, Department of Forestry (Director RRL, 1997), as shown in Appendix 2. While calculating each area is done through Mangrove Area Damage Rate Map issued by the Director RRL 1997.

Results and Discussions

The growths of mangroves ecologically are grown in coastal areas affected by the tides. Based on Land System Map and observations in the field, soils on *Land System* of PRT, KJP, KHY, PTG, UPG, and MKS in South Sulawesi can overgrown

with mangrove vegetation due to tidal influence. Areas relating to the *Land System* can be seen in Table of Appendix 1.

1. Bio-Physical Conditions

Vegetation

LS-PRT; mangrove vegetation in this *Land System* is generally a transition between mangrove ecosystem with coastal forest ecosystems. From the observations result found 9 types of vegetation that distributed well for seedling, staking, and tree levels, i.e; api-api (*Avicenia marina*), bogem (*Sonneratia caseolaris*), buta-buta (*Excoecaria agallocha*), tingi (*Ceriops tagal*), dungun (*Heritiera littoralis*), ketapang (*Terminalia catappa*), nyiri (*Xylocarpus molluccense*), tancang (*Bruguiera cylindrica*), and duduk (*Lumnitzera littorea*).

Based on the analysis result and evaluation of vegetation, the dominant species at the tree level i.s *E. agallocha* (INP = 97.65%), *H. tiliaceus* (INP = 73.50%), *A. marina* (INP = 67.35%), and *B. cylindrical* (INP = 46.87%). Total density of individuals around 143 trees/ha. The dominant vegetation species of stake i.s; *E. agallocha* (INP = 68.97%), *H. tiliaceus* (INP= 33.30%), *L. littorea* (INP = 27.68%). Total density of individuals for all species is 397 indiv./ha. Seedling level is dominated by; *E. agallocha* (INP = 74.65%),%), *H. tiliaceus* (INP = 67.57%), and *A. marina* (INP = 17.35%). Total density of individuals for all species is 876 indiv./ Ha. The dominant under vegetation in this *Land System*, among others; jerujon (*Acanthus illicifolius*), paku laut (*Acrosticu aureum*), bluntas (*Plucea indica*), Lantana camara, *Pandanus sp*, *Flagellaria indica*, and *Ipomea caprae*.

LS-KHY; From observations result on *LS* found 7 types of vegetation that distributed with tree level, i.e api-api (*Avicenia marina*), bogem (*Sonneratia caseolaris*), buta-buta (*Excoecaria agallocha*), tingi (*Ceriops tagal*), ketapang (*Terminalia catappa*), nyiri (*Xylocarpus molluccense*), tancang (*Bruguiera cylindrica*). For stake level is found *R. stylosa* and *L. littorea*. The dominant species is *A. marina* (INP = 78.90%) with a density of 149 indiv./ ha, while the total of all the individual of this stake level is 572 indiv./ha. For seedling level is found 5 species, i.e : *E. agallocha* (INP = 34.35%),%), *H. tiliaceus* (INP = 27.57%), and *A. marina* (INP = 27.35%), *C. tagal* (INP = 98%). For *C. tagal*the density is 5,120 indiv./ha. Total density for all individual with seedlings level is 5,875 indiv./ha. The dominant under vegetation in this *land system*, among others; jerujon (*Acanthus illicifolius*), paku laut (*Acrosticu aureum*), and *Ipomea caprae*.

LS-PTG; mangrove vegetation in this *Land System* is generally overgrown coastal vegetation such as coconut (*Cocos nucifera*), ketapang (*T. cattapa*), waru (*Hibiscus tiliaceus*), malapari (*Pongamia pinnata*) and bidara laut (*Ximenia americana*). Mangrove is only found around the estuaries to the breadth and density

of individuals per hectare is not too broad. Species encountered in this LS are: *A. marina*, *S. alba*, *B. cylindrical*, *E. agallocha* and *C. tagal*. At the tree level there are only two types of vegetation namely; *A. marina* with a density of 47 indiv./ha with a stem diameter of about 10-15 cm, and *S. alba* with a density of 27 indiv./ha. Mangrove species of stake level were found*A. marina* with a density of 39 indiv./ ha, *C. tagal* (6 indiv./ha), *B. cylindrical* and *E. agallocha* have the same relative density of about 17 indiv./ha. While, under vegetation found in this LS are jerujon (*Acanthus illicifolius*), paku laut (*Acrosticu aureum*), *Ipomea caprae*, seruni (*Widelia biflora*), and teki laut (*C.maritime*).

LS-KJP; mangrove vegetation is found in this LS is generally in a state already badly damaged. Based on the vegetation analysis obtained density of *A. marina*for tree level is 23 indiv./ha with a range of 7-13 cm in stem diameter, and *E. agallocha* with tree density is 11 indiv./ha. Total density of tree level is 34 indiv./ha. For stake level is dominated by *A. marina* with a density of 330 indiv./ha. While for seedling level is also dominated by *A. marina* with a density of 1,340 indiv./ha, and *E. agallocha* with a density of 200 indiv./ha. Total density of seedling is 1,540 indiv./ha. Under vegetation is found in this LS are bluntas (*P. indica*), seruni (*W. biflora*) and teki laut (*C.maritime*).

LS-MKS; Most of mangrove area in this LS has been converted into fishponds and rice fields. Mangrove vegetation commonly found growing solitary and isolated the area and very low density. Based on the information obtained, in this LS was formerly contained in *A. marina*, *C. tagal*, *Rhizophora spp.*, and *Sonneratia spp.*, while under vegetation is found today among others; *C. maritime*, *Fimbristylus globulosa*, *Nypa fruticans* and *W. biflora*.

LS-UPG; Most of mangrove area in this LS also been converted into fishponds, rice fields, and industrial areas. Mangrove vegetation commonly found growing solitary and isolated the area and very low density. Based on the information obtained, in this LS was formerly contained in *A. marina*, *C. tagal*, *Rhizophora spp.*, and *Sonneratia spp.*, while under vegetation is found today among others; *Nypa fruticans* and *W. biflora*.

The Mangrove Green Line

LS-PRT; On land system of PRT, mangrove green line is only found on the left and right banks of the river with an average width of approximately 40 m and a length of 70-1500 m. the destruction of mangrove vegetation in this area due to the intensive use of wood for fuel wood (charcoal) and construction materials by local people since many years ago (1970/1980).

LS-KHY; On land system of KHY, mangrove green line in scattered condition with a width varying between 3-145 m and a length between 7-130 m. The destruction of green line in this LS is due to the intensive conversion of mangrove areas into aquaculture areas since the 1980s.

LS-PTG; mangrove green line is only found in estuaries or along the banks of the river discontinuously with a width of less than 30 m and a length ranging from 23-75m. The destruction of mangrove vegetation due to the activity of land conversion to rice fields, which began in 1980 and today is generally become unproductive dry field.

LS-KJP; On land system of KJP, mangrove green line is found along the coast with a width varying between 7-79 m. The destruction of vegetation in this LS, is also due to the conversion activity of farms since the 1980s.

LS-MKS; Generally the green line in this LS is fragmented with varying width and length. Also due to the conversion to farms, plantations, and industrial areas.

LS-UPG; Vegetation condition in this LS is generally same relatively with LS-MKS, and most of the specific flora is not found anymore. It is also caused by the conversion activity since the 1980s.

Soil

LS-PRT; soil type found in this land system is *Tropopsamments* with soil parent material derived from sediments of sand and gravel. This soil has sandy clay loam texture with consistency rather closely on each layer. Drainage of land classified as rather stable, the color is generally brown with chroma 4, pH ranged from 6.0 to 7.0 and found no potential pyrite at depth <1m.

LS-KHY; soil type found in this land system is *Tropohemists* with peat soil parent material has a moderate level of ground stability. For no vegetated land, the land has the texture of clay loam to clay dust with concentrations rather closely to very closely. Soil drainage is poor with ground color is generally gray with chroma 2 or less. pH ranged from 7.0 - 8.0. Potential of pyrite encountered at a depth of 70-100 cm and 100-120 cm, with a pyrite content of 0.21%, and 0.78%, respectively. It is also relatively common in the land with sparse vegetation density with relative to the same texture as well.

LS-PTG; soil type found in this land system is *Tropaquents* with parent material derived from alluvium sediment and young marine beach sand. The type of this soil is clay in texture with concentrations rather closely to closely. Drainage of soil is poor with gray in color and chroma 2. pH ranged from 5.0 to 8.0. Potential of pyrite encountered at a depth of 30-60 cm and 45-87 cm, with the pyrite content in each depth 1.74% and 2.0%, respectively.

LS-KJP; soil type found in this LS is *Hydraquents* with parent material derived from a mixture of estuarine and marine are still young with a smooth texture. In the rare condition of vegetation, this soil type is sandy loam to clay textured with consistency rather closely to very closely. Soil drainage is very poor with gray in color and chroma 2 or less. pH ranged from 6.0 to 7.0 and found no pyrite potential at depths <100 cm. While on land rather tight vegetation, hydaquents soil encountered sandy loam to clay loam dusty textured with consistency no closely

to closely. Soil drainage is very poor with a dark gray in color and chroma 2 or less. pH ranged from 6.0 to 7.0 and was not found pyrite potential at the depth <100 cm.

LS-MKS: soil found in this LS is *Fluvaquents* with parent material derived from young marine alluvium sediment. This soil is loamy clay textured with consistency rather closely to very closely. Soil drainage is very poor with gray in color and chroma 2 or less. pH ranged from 7.0 to 8.0. Pyrite potential encountered at a depth of 30-50 cm, 60-70 cm, and 80-100 cm, with a content of 0.07%, 0.09%, and 0.15%, respectively.

LS-UPG: soil found in this LS is *Dystropepts* with parent material derived from alluvium sediment and young marine beach sand. This soil is clay dust textured with consistency closely to very closely. Soil drainage is very poor with gray-brownish in color and chroma 2-4. pH ranged from 4.6 to 6.5 and found no pyrite potential at depths <100 cm.

Water

LS-PRT; Based on measurements of water samples, found water chemistry parameters on land system of PRT that is above the environmental quality standards for marine biota is COD (115.55 mg/l) and Hg (0.004 mg/l). While the value of other water quality parameters are below the threshold of environmental quality standards.

LS-KHY; salinity levels in this LS is 12-16 ‰, with a temperature of 31°C, the brightness of 23 cm and pH about 6.5. The condition was classified as normal and do not exceed the quality standard. Generally, the value of water parameters, except COD, are below the threshold of environmental quality standards.

LS-PTG; salinity levels in this LS is 10-12 ‰, with a temperature of 31°C, the brightness of 17 cm and pH about 7.5. Dissolved O_2 content of 6.4 mg/l. The content of COD was 121.13 mg/l. Physical-chemical conditions of water, including ammonium (NH_3-N) showed the value of 0.025 mg/l, detergent of 0,105 mg/l, heavy metal mercury <0.001 mg/l and cadmium of 0.006 mg/l.

LS-KJP; water quality of this LS, both for physical and chemical parameters are generally still below the environmental quality standards for marine biota.

LS-MKS; waters in these LS have physical properties that are still appropriate with environmental quality standards with the result of following measurements: temperature of 29°C and brightness of 17 cm. In general chemical parameters are still appropriate with the environmental quality standards, except COD of 121.93 mg/l which exceeded the quality standard. Other chemical parameters such as pH (7.0),DO (5.6), Ammonium (0.018 mg/l), detergents (<0.001 mg/l), Hg (0.001 mg / l) and Cd (0.005 mg/l) and salinity (17‰).

LS-UPG; measurement results of physical-chemical parameters of water in this LS showed the following values: temperature (29°C), pH (6.5), Ammonium

(0.021 mg/l), detergents (0.065 mg/l), Hg (0.002 mg/l), salinity (5 ‰), and Cd (0.005 mg/l) does meet environmental quality standards. While the brightness parameter (14.75 cm), DO (3.35 mg/L), and COD (125.47 mg/l), does not meet environmental quality standards.

2. Abrasion

Based on interviews with local residents, abrasion estimate for each *Land System* of mangrove areas in coastal southern Makassar Strait, are shown in Table 2. Coastal areas are experiencing high abrasion occurs on Land System of PTG (4.5 m/yr) and UPG (3.5 m/yr). In Land System of KHY, actually the line are experiencing abrasion nearly relatively stable, because the silt carried by the water flow of the river.

TABLE 2: ESTIMATES OF SHORELINES AND ABRASION FOR SOME LAND SYSTEM IN MANGROVE AREAS ALONG THE COAST OF MAKASSAR STRAIT

Land System	Estimation of Shorelines from Abrasion (M/yr)	Present Shorelines (M)
PRT	8.5 (1997)	2.5
KHY	1.5 (1999)	1.5
PTG	20 (1978)	4.5
KJP	1.5 (2002)	2.3
MKS	2.5 (2002)	1.0
UPG	25 (1978)	3.5

3. Damage Levels Mangrove

From the sixth of *Land System* which assessed the damage level of mangrove, there are three (3) of *Land System* were UPG, MKS, and PTG are categorized major damage, two (2) of *Land Systems*, KHY and PRT are categorized moderate damage, and 1 (one) of *Land System* are categorized minor damage (Table 3). The total area potentially mangroves along the coastal of Makassar Strait of South Sulawesi is approximately 148.223,39 hectares, the majority (69.76% or 86.175,25 hectares) located outside the forest area and the rest (30.24% or 62.048,14 ha) is located in the forest area. Potentially mangrove spread in 9 districts/cities, namely: Pinrang (27.545,37 ha), Pare-Pare (7.858,75 ha), Barru (29.375,50 ha), Pangkep (19.783,45 ha), Maros (11.785,60 Ha), Makassar (3.573,15 ha), Gowa (14.457,67 ha), Takalar (17.946,45 ha), and Jeneponto (17.897,45 ha). Based on the damage level of areas, potentially mangrove area in Makassar Strait are generally classified as heavy and moderate damages by the damage percentage of each area as follows; heavy damage; Makassar (68.12%), Pare-Pare (59,73%), Maros (57.12%) Gowa (53.37%), Takalar (47.58%), and Jeneponto (41.27%). Which is classified as moderate damage; Pinrang (39.17%), Pangkep (33.67%), and Barru (17.57%, are classified as minor damage).

TABLE 3: LIST OF MANGROVE AREA DAMAGE ASSESSMENT

Land System	*N*	*Np*	*L*	*A*	*P*	*C*	*TNS*	*Damage Level*
PRT	30	20	15	60	50	40	215	Moderate
KHY	30	80	30	75	50	50	315	Minor
PTG	30	20	15	30	50	50	195	Major
KJP	30	20	15	60	50	20	195	Minor
MKS	30	20	15	75	50	50	240	Major
UPG	30	20	15	30	50	50	195	Major

Note: N (density of trees/ha), Np (regeneration density/ha), L (width of mangrove green line), A (abrasion level), P (content and depth of pyrite), C (water pollution), TNS (Total Scoring Value).

Conclusion

Based Land System Map and observations in the field, soils/sediment on Land System of PRT, KJP, KHY, PTG, UPG, and MKS in South Sulawesi can overgrown with mangrove vegetation due to the tidal influence with environmental quality conditions are still normal.

In general, all types of *Land System* area of coastal Makassar Strait experiencing degradation due to land conversion, so the green line shows no longer intact unity of mangrove ecology.

Results of evaluation/research found 9 types of vegetation distributed good for seedlings, stake, and tree levels, i.e; api-api (*Avicenia marina*), bogem (*Sonneratia caseolaris*), buta-buta (*Excoecaria agallocha*), tingi (*Ceriops tagal*), dungun (*Heritiera littoralis*), ketapang (*Terminalia catappa*), nyiri (*Xylocarpus molluccense*), tancang (*Bruguiera cylindrica*), and duduk (*Lumnitzera littorea*).

Based on the damage level, *Land System* potentially mangrove in Makassar Strait are generally classified as major and moderate damage by the percentage of damage of each area as follows; which is classified as major damage are; Makassar (68.12%), Pare-Pare (59.73%), Maros (57.12%) Gowa (53.37%), Takalar (47.58%), and Jeneponto (41.27%). Which is classified as moderate damage are: Pinrang (39.17%), Pangkep (39.17%), and Barru (27.36%, is classified as minor damage).

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APPENDIX 1: TRAINING AREA LOCATION IN 9 DISTRICTS/CITIES WHICH APPROPRIATE WITH MANGROVE AREA LS IN COAST MAKASSAR STRAIT SOUTH SULAWESI

No.	*Land System*	*Point Coordinate of Training Area*	*Districts/Cities*
1.	PRT	7° 07' 33" LS; 134° 16' 24" BT	Pinrang
2.	PTG	6° 09' 23" LS; 122° 57' 17" BT	Pare-Pare
3.	KJP	6° 09' 32" LS; 119° 23' 41" BT	Barru
4.	KHY	5° 09' 53" LS; 116° 36' 74" BT	Pangkep
		5° 10' 13" LS; 114° 16' 38" BT	Maros
5	MKS	4° 11' 33" LS; 116° 48' 24" BT	Makassar
		2° 12' 13" LS; 97° 57' 24" BT	Gowa
6.	UPG	1° 12' 33" LS; 34° 16' 27" BT	Takalar
		0° 12' 38" LS; 54° 16' 39" BT	Jeneponto

Sources: Bakorsultanal (2007)

APPENDIX 2: SUITABILITY OF SOME MANGROVE SPECIESWITH ENVIRONMENTAL FACTORS (KUSMANA AND ONRIZAL,1998)

No.	*Species*	*Salinity (‰)*	*Tolerance on wave and wind force*	*Tolerance on sand content*	*Tolerance on mud*	*Frequency of tidal inundation*
1.	*Rhizophora mucronata*	10-30	ST	MD	ST	20 days/mo.
2.	*R. stylosa*	10-30	MD	ST	ST	20 days/mo.
3.	*R. apiculata*	10-30	MD	MD	ST	20 days/mo.
4.	*Bruguiera parviflora*	10-30	SV	MD	ST	10-19 days/mo.
5.	*B. sexangula*	10-30	SV	MD	ST	10-19 days/mo.
6.	*B. gymnorrhiza*	10-30	SV	SV	MD	10-19 days/mo.
7.	*Sonneratia alba*	10-30	MD	ST	ST	20 days/mo.
8.	*S. caseolaris*	10-30	MD	MD	MD	20 days/mo.
9.	*Xylocarpus granatum*	10-30	SV	MD	MD	9 days/mo.
10.	*Heritiera littoralis*	10-30	VS	MD	MD	9 days/mo.
11.	*Lumnitzera racemosa*	10-30	VS	ST	MD	Some times per year
12.	*Cerbera manghas*	0-10	VS	MD	MD	Seasonal inundation
13.	*Nypa fruticans*	0-10	VS	SV	ST	Seasonal inundation
14.	*Avicenia spp.*	10-30	MD	ST	ST	20 days/mo.

Note: ST = Appropriate, MD = Moderate, SV = Less Appropriate,VS = Not Appropriate

APPENDIX 3: WATER QUALITY OF LAND SYSTEM OF MANGROVE AREA IN THE COASTAL OF MAKASSAR STRAIT SOUTH SULAWESI

Land System	*Parameters*	*Unit*	*Quality Value*	*Quality Standard*
PRT	Physical :			
	1. Temperature	°C	30	natural
	2. Brightness	cm	18	≥ 5
	Chemical :			
	1. pH		6,5	6 – 9
	2. DO	mg/l	5,4	> 4
	3. Salinity	‰	10	natural
	4. COD	mg/l	117,25	≤ 80
	5. NH_3-N	mg/l	0,134	≤ 1
	6. Detergent	mg/l	0,135	≤ 1
	7. Mercury (Hg)	mg/l	0,004	≤ 0,003
	8. Cadmium (Cd)	mg/l	0,005	≤ 0,01
KHY	Physical :			
	1. Temperature	°C	30	natural
	2. Brightness	cm	18,5	≥ 5
	Chemical :			
	1. pH		6,5	6 – 9
	2. DO	mg/l	6,25	> 4
	3. Salinity	‰	9	natural
	4. COD	mg/l	63,25	≤ 80
	5. NH_3-N	mg/l	0,216	≤ 1
	6. Detergent	mg/l	0,110	≤ 1
	7. Mercury (Hg)	mg/l	0,002	≤ 0,003
	8. Cadmium (Cd)	mg/l	0,008	≤ 0,01
PTG	Physical :			
	1. Temperature	°C	30	natural
	2. Brightness	cm	15	≥ 5
	Chemical :			
	1. pH		7,5	6 – 9
	2. DO	mg/l	6,4	> 4
	3. Salinity	‰	10-12	Natural
	4. COD	mg/l	119,25	≤ 80
	5. NH_3-N	mg/l	0,034	≤ 1
	6. Detergent	mg/l	0,105	≤ 1
	7. Mercury (Hg)	mg/l	0,001	≤ 0,0003
	8. Cadmium (Cd)	mg/l	0,006	≤ 0,01
KJP	Physical :			
	1. Temperature	°C	29	natural
	2. Brightness	cm	16,5	≥ 5
	Chemical :			
	1. pH		7,5	6 – 9
	2. DO	mg/l	4,5	> 4
	3. Salinity	‰	30	± 10%
	4. COD	mg/l	77,25	≤ 80
	5. NH_3-N	mg/l	1,045	≤ 1

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