

The Analysis of Zone Based Land Suitability to Evaluate the Sustainability of Coastal Area Management in Ambon City – Maluku- Indonesia

Pieter Thomas Berhиту*, Sahala Hutabarat**, Supriharyono**, Djoko Suprpto**

* Doctoral Student of Coastal Resource, Faculty of Fishery and Oceanography –University of Diponegoro, Semarang - Indonesia . ** Lecturer of Faculty of Fishery and Oceanography. Faculty of Fishery and Oceanography, Coastal Resource Doctoral Program, University of Diponegoro, Semarang Indonesia

patrickberhиту@gmail.com

085197361204

Abstract-- The purpose of this research is to conduct analysis on land suitability in Ambon City for evaluation of the sustainability of coastal area management by using zone based approach from three zone laws. The findings showed that land suitability for cultivation area is 6,639.488 hectares (66,395 km²), conservation areas of 13,055.23 hectares (130.55 km²), and the buffer area of 16,250.28 hectares (162.50 km²). The level of damage to coastal areas of Ambon city caused by erosion, abrasion, sedimentation and the environmental degradation can be categorized as heavy to extremely heavy at 61.54 %, the category of mild to moderate is 38.46 %. The weight of damage and interests is calculated at 38.46%. This is considered as a highly prioritized category (B), to extremely prioritized category (A). Meanwhile, 61.54 % must be addressed as priority or category (C). The suitability level for S¹land with highly suitable for utilization categories is 57.69 %, while S²category which is suitable to for utilization with certain conditions is 42.31 %. The results of this study will become an input for city government for evaluation and in decision-making and policy formulation regarding the efforts to manage and to control damage to coastal areas of Ambon city sustainably.

Index Term-- Zoning, Ambon, land suitability

1. INTRODUCTION AND SCOPE

Actions for protection of marine resources from exploitation and degradation is fundamentally important to ensure the sustainability of marine and coastal resources. Marine resources and ecosystems management towards the goals of economic development, business, settlement, agriculture and fisheries can be done by using zoning system approach.

This model, will provide guidelines for decision-making to formulate the right policy in the development and the utilization stage of the management of marine and coastal resources ecosystem (Rosemary et. al., 2008). Regional development planning, which include human and community activities at various levels of utilization of marine and coastal resources has been done through marine spatial planning and marine zoning at every stage of development to establish strategies for sustainable development and protection of the marine environment. This will also minimize conflicts between users of marine and coastal areas resource in various places, such as in England (GHK Consulting, 2004; marine

Spatial Planning Consortium, 2006) Belgium (Douvere et al., 2007), USA (Pew Oceans Commission, 2003; Russ and Zeller, 2003; Sanchirico, 2004; Norse, 2005), Scotland (Tyldesley, 2004), Canada (Fisheries and Oceans Canada, 2005; Rutherford et al., 2005), New Zealand (Ministry for the Environment, 2005), China (Chinese Government, 2001), the Baltic Sea (Helsinki Commission, 2006), and South Africa (O'Toole et al., 2001). Moluccas Province-Indonesia (T. J. Kakisina et. al., 2014; Berhиту, 2010, 2011).

Sustainable and integrated coastal resource management is an iterative and evolutionary process to achieve optimal and sustainable coastal area development. The final goal of ICZM not only to pursue short-term economic growth, but also to ensure that the economic growth can be enjoyed equally and proportionally by all parties involved (stakeholders), while preserving the carrying capacity and the quality of coastal environment so that development can be implemented sustainably (Alan T White et. al., 2005; Dahuri, 2004). There are four aspects related to integration in planning and management of coastal zone, they are: (a) ecological area integration, (b) sectoral integration, (c) knowledge discipline integration, and (d) stakeholder integration (Cordah Ltd., 2001; Gallager A., 2010; Dahuri, 2004). Regional integration is concerned on how coastal management is focused on space allocation for various utilization interests in an integrated and sustainable way (Kay and Alder R. J, 1999; Dahuri, 2004).

Space utilization in relation to land use and their usage in an area always changes over time. Recently, land use dynamics happens relatively quickly; and consequently, resulted in the change of land use functions which degrade environmental quality and inevitably will result in low carrying capacity of land. Therefore, land use needs to be aligned according to its function in order to avoid the negative impact of development (Puturu, 2009). At the moment, coastal regions continue to expand because of population growth in the coastal community (Wu, R. Liu, and X. Ding, 2008). Rapid increase in population growth will cause problems in region development. Coastal areas are also prone to conflict between utilization and environmental sustainability aspects (Agus Purwoko, 2009).

The interaction between society and land ownership has strongly influenced the change in land use (A.R. As-Syakur, 2011; Sumbangan Baja, 2012). Changes in land utilization has potential negative impact for the sustainability

of natural resources. Therefore, it must be carefully managed in the perspective of coastal development so as not to cause biophysical and socio-economic problems. Additionally, increase rate of land use conversion due to lack of coordination among stakeholders as well as the tendency of regional authority to excessively intervene in the production at resource location will result in increased vulnerability and coastal degradation on local and regional scale (Wahyudi et. al., 2009; Hamidreza Masoumi et. al., 2011). Ambon city is the capital of Maluku province with a land size of 359.45 km² (3,594.5 ha). In the last 10-20 years, it hasn't been able to establish an integrated and sustainable management of its coastal area due to various problems such as demographic (population growth), lack of synergy among stakeholders in coastal management, overlapping interests in coastal areas, weak legal framework, high rate of land conversion and the utilization of spatial area that doesn't conform to the approved allocation. This has caused various problems in the coastal area of Ambon City such as pollution, abrasion, erosion, sedimentation, (siltation of beaches), destruction and degradation of coastal ecosystems, (mangrove, seagrass and coral), floods and landslides and the degradation of the quality of the coastal environment (Berhita P., Kakisina T.J., 2009; Berhita, 2010; Belvi Vatria, 2010; Kakisina, T.J., 2008; Sahetapy D., 2010).

Various measures have been taken by Ambon city authorities to manage its coastal area from uncontrolled space utilization, conflicts of interest, high conversion rate of land use, and inappropriate utilization of space by issuing Regional and Spatial Planning of Ambon City (RTRW) in 2011-2031 as guidelines and reference in regional development, regional management and the utilization of marine and coastal resources in Ambon City (Planning and Development Agency of Ambon City, 2011). Although the Regional and Spatial Plan has been put in effect, the issue of land use conversion; in conformity to land allocation, environmental degradation and physical damage of the ecosystems still remained. Therefore, efforts to manage the coastal area of Ambon city need to be reviewed by having an evaluation on land suitability analysis in Ambon city based on zoning area. The purpose this evaluation is to determine the zones in coastal areas based on their functions, roles, and suitability of land and zones according to the potential physical and ecosystem damage in order to support the sustainability of coastal zone management. Community need to be involved so as to create integrated and sustainable coastal management, as well as to resolve conflict of resource utilization, and to guide the long-term use, development and management of coastal resources of Ambon City in a sustainable way.

2. LITERATURE REVIEW

Approach to coastal zone management must be done in an integrated and sustainable way (sustainable Integrated Coastal Management, ICM). This means that integration and sustainability must strike a balance among economic interest, sociocultural aspect, preserving natural resource and the environment (Alikodra, 2006). ICM is a management approach that provides direction for the utilization of coastal

and marine resources sustainably by integrating various sectoral plans, various levels of government and at the same time integrating components of terrestrial and marine ecosystems. Sustainable development is the one that meets the needs of present generation without compromising the future generation to meet their needs (Siregar, 2004).

Sustainable development is an integrated/complementary approach to development which combines the three pillars of development namely economic development, social development and environmental protection. There are two important ideas in sustainable development: first idea is based on need i.e essential needs for the continuation of human life. Second, the idea of limitations which is drawn on technological condition and social organization on the environment ability to meet present and future needs. It states that every element of sustainable development can be broken down into four areas: equity and social justice, diversity, integrated and long-term perspective (Djajadiningrat, and Famiola, 2004).

Zoning of coastal areas is fundamentally a form of engineering in space utilization technique through the establishment of functional boundaries in accordance to resource potency, carrying capacity and ecological processes that take place as a unit in a coastal ecosystem (Law No. 27, 2007 on the Management of Coastal Areas and Small Islands). In Spatial planning, zoning is an important aspect that should not be overlooked. Through zoning, an area is allocated for certain function, such as office buildings, residential areas, industrial complex, green spaces or other public space. Zoning could help to determine whether a space can be converted or not. Regulation on zoning is considered as both a plan and a control tool the government and the community. Government can use the plan in giving permission. Zoning regulations allow government to determine whether requests by the public for a permit should be granted or not. While for community, before purchasing a piece of land, they will understand the right status of the land whether they may have the right of ownership or only building rights on the land. It is unfortunate, however, that not everyone understands the importance of zoning regulations; this includes government who sometimes break them. As stated in Law no. 27, 2007 Article 7 section (3); it is the Local Government who has the mandate to compile all plan documents (Strategic Plan for Coastal Areas and Small Islands, Zoning Plan of Coastal Areas and Small Islands Management Plan of Coastal Areas and Small Islands and Action Plans for the Management of Coastal Areas and Small Islands). The objective of the zoning plan is to allocate spaces in coastal areas according to their designated functions and activities that are complementary (compatible) and to separate activities that are incompatible (Suparno, 2009).

Zone allocation is established by focusing on main activities and utilization priorities of coastal resource in order to facilitate control and utilization. Coastal and marine zoning plan will establish a spatial network/grid on the coastal and marine environment. This plan separates conflicting resource utilization and determine which activities are prohibited and permitted. Additionally, the purpose of the zoning plan are: a.

to regulate population density and intensity of activities, to adjust the balance and harmony of land designation and to decide which actions should be taken on a unit of space. b. to protect the health, safety and welfare of the community c. to prevent cluttering and to provide adequate public services to improve the quality of life. d. to minimize unintended negative impact of development and e. to facilitate impartiality and efficacy in decision making and to encourage community participation. The function of zoning regulations is to guide the preparation of operational plan. Zoning regulations contain provisions on comprehensive macro plan broken down to meso and then detailed plan as an instrument to control development efforts.

3. RESEARCH METHODOLOGY

The research was conducted in four sub-districts of Ambon city, Moluccas namely Nusaniwe, Sirimau, Teluk Ambon-Bagualla and Teluk Ambon. The samples used in this research were taken from 30 villages (urban and rural) of the four research sub-districts. The research took place between August 2014 and February 2015. Primary data were obtained from direct survey in the research locations by using questionnaire given to 50 people from village institution who gave zoning score. Secondary data were obtained from the relevant agencies.

The method used in zoning analysis is GIS approach, which was done based on spatial law, water resource law, coastal areas and small island management law. Zoning output of these three laws were compared against the management of existing land use, regional and spatial plan, evaluation and aspiration from community. The output formed an integrated compatibility of the planned zones. Imagery data used was Landsat-7 ETM 2000 and Landsat-7, 2013. The interpretation was done by using land cover and then evaluated based on field confirmation to verify the results of imagery interpretation. Land conversion model was based on data interpretation of the imagery by using Power Sim dynamic modeling. The scoring process of coastal physical criteria to determine the zoning of the land suitability was based on Ministry of Agriculture Decree 837 / KPTS / UM / 11/1980 and 683 / KPTS / UM / 8/1981 (the regulations are still in effect as there are no new provisions). Physical characteristics that are taken include a) topography, b) soil type and c) rainfall.

4. FINDINGS AND DISCUSSION

Land Suitability Analysis based on Law. No 26, 2007 on Spatial Planning

a. Suitability to Soil Characteristic

As stipulated in Law No. 26 of 2007 on Spatial Planning, zoning for coastal areas is divided into three zones: the preservation zone, conservation zone, and the utilization zone. The division of these zones is based on the role and function of the area. Areas for protection which has border with the beach line are categorized into area with conservation pattern; zone 1 and 2 are included in this pattern. Zones which will be

used for supporting activities such as in coastal area are called zone with cultivation pattern; zone 3 is categorized into this pattern. Based on analysis type of soil suitability by using geographic information systems approach, soil type distribution in Ambon City can be classified as follows: alluvial, organosol, podzolic and complex. Soil type along the coastal area is alluvial; score for this type of soil is 15. The result is presented in table 1 and figure 1.

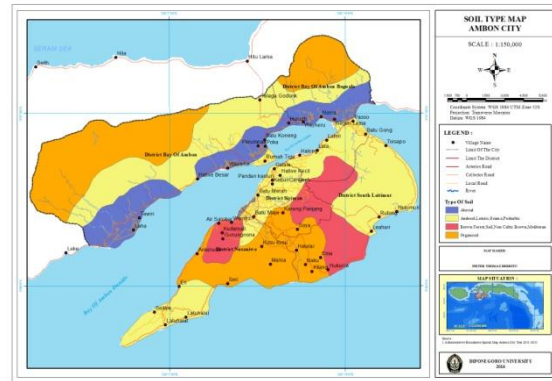


Fig. 1. Type of Soil Result Map

Table I
Tabulated Value and Soil Score

Soil Type	Size	Score
Alluvial	2.503789	15
Organosol	7.51196	75
Alluvial	244.807798	15
Podzolic	2766.767883	60
Alluvial	92.867893	15
Alluvial	35.54032	15
Alluvial	13488122	15
Alluvial	21.002651	15
Alluvial	2.503541	15
Podzolic	5.964.004855	60

b. Suitability to Slopeness Characteristic

The topography of Ambon City is dominated by hilly areas with steep slopes in approximately 73 % of the total size, and with the steepness of over 20 %. 17% of the land area is classified as flat or undulating with a steepness of less than 20 %. Results of slopes with a score of 20-40 gives topography description between 0-8 % and 8-15 %.

The topography which relatively flat (between 0-100 meters with steepness of 0-10 %) is in the area along the coast between 0-300 meters radius from the beach line as presented in table 2 and Figure 2.

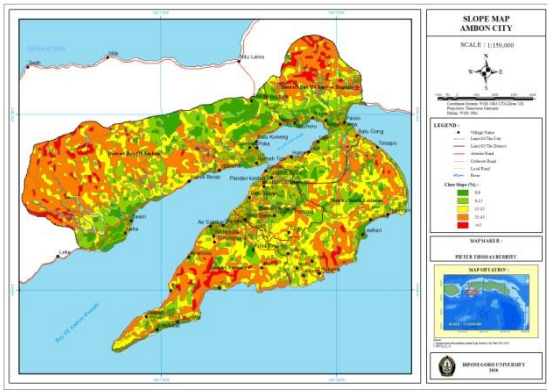


Fig.2.Slopesness Result Map

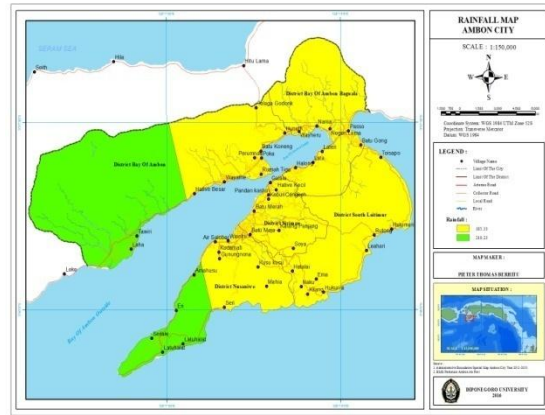


Fig. 3.Rainfall Result Map

Table II
Tabulated Result of Slope Score

Gridcode	Height_mdpl	Steepness	Slope_Score
1	500-1000	0 - 8	20
1	100-500	0 - 8	20
1	100-500	0 - 8	20
2	100-500	8 - 15	40
2	10-100	8 - 15	40
2	100-500	8 - 15	40

c. Suitability to Rainfall Characteristic

Rainfall result with GIS by using rainfall data from Sirimau and Teluk Ambon stations shows that the level of rainfall in the city of Ambon in 2015 is quite high with a value of 185.330 - 210.230 each with a score of 30. See Figure 3 and Table III.

Table III
Tabulated Result of Rainfall Score

Shape	Location	Sub-District	Shape Area	Score
1	Ambon Island	Sirimau	0,03471	30
2	Ambon Island	Teluk Ambon	0.02821	30

d. Overlay

The analysis result of these three characteristics above were then put together in an overlay combination to obtain the score sum in order to determine zoning based on the function of the area. The result can be seen in table 4. The overlay map in Figure 4 shows the land suitability zones, where < 125 zone functions as cultivation area. Area ranging from 125-175 is a buffer zone and > 175 for conservation. The color code in the map represents cultivating zone is shown in yellow, green for conservation zone and buffer zones are shown in red. Total land area for cultivation is 6,639.488 hectares (66,395 km²), conservation area 13,055.23 hectares (130.55 km²), while the buffer zone is 16,250.28 hectares (162.50 km²)

Table IV
Tabulated Result and Area Score

Score	Function
125	Buffer
80	Cultivation
180	Conservation
145	Buffer

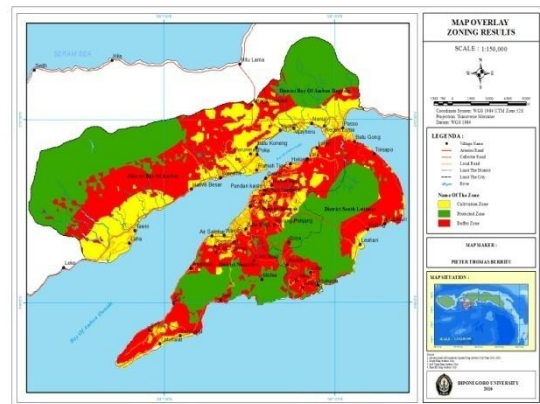


Fig. 4.Zoning Overlay Result

Land Suitability Analysis Based on Law No. 7, 2004 on Water Resource.

Land suitability analysis based on Law No. 7, 2004. The regulation divided zones based on critical beach area such as coastal erosion rates, land productivity, land cover, hydrology and land use by the community. Three zones are divided based on elements from the criteria a. Distribution of sensitive zones which are prone to hydrological circulation or water damage such as headwater area below steep slopes, riverbank or seashore. b. The distribution of fragile ecosystem. This is the area covered by natural vegetation and is considered to have a relatively high biological diversity. This area is rather fragile and sensitive to human disturbance. c. Distributed zones with the potential to critical soil damage.

Analysis result of land suitability based on Law No. 7, 2004 can be seen in Figure 5 and 6. It can be explained that the highest rate of damage caused by erosion/abrasion is in Amahusuvillage of Nusaniwesub-district with a score of 183 and the lowest is in Batumerah and UritetuvillageinSirimau with a score of 67. It is concluded that erosion and abrasion with score of >100,categorized as heavy to extremely heavy, is 34.615% and score of <100,categorized as moderate to light,is65.385%. The highest sedimentation occurred in Passo and Lattavillage, Teluk Ambon Bagualasub-district with scores of 92 and 83 respectively, lowest sedimentation with score of 25 is found in 7 rural villages, and 7 urban villages, they are Nusaniwe, Benteng, Wainitu, Waihaong, Silale, Honipopu and Uritetu. It is concluded that sedimentation with a score of >50,categorized as moderate to heavy, is 23,076%, while score <50, which categorized as light to moderate, is 76.9%. The environmental damage is the highest in Galala village with a score of 140; the lowest is in Hunuthwith a score of 60. It is concluded that the environmental damage with a score of >100, category of moderate to very severe,is 57.69% whereasthe score of <100, categorized as mild to moderate,is42.307%.

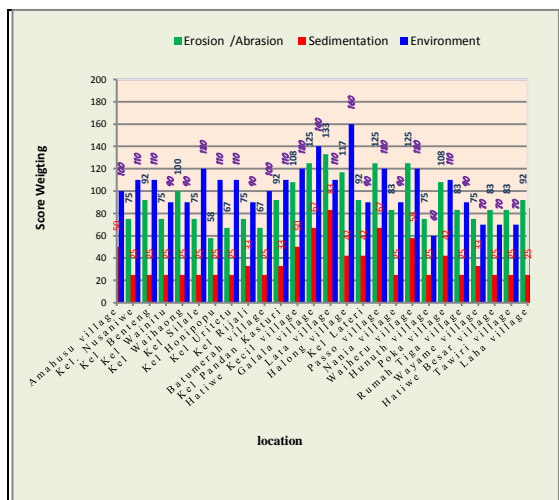


Fig. 5.Damage Level Distribution

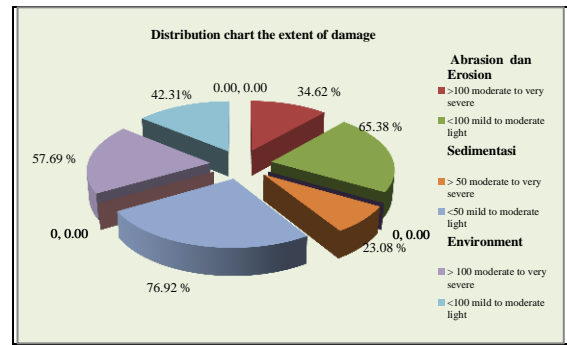


Fig. 6.Percentage of Damage Level Weight

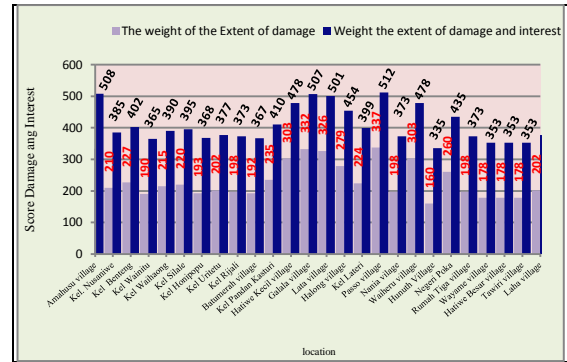


Fig. 7.Interest and Damage Level Weight

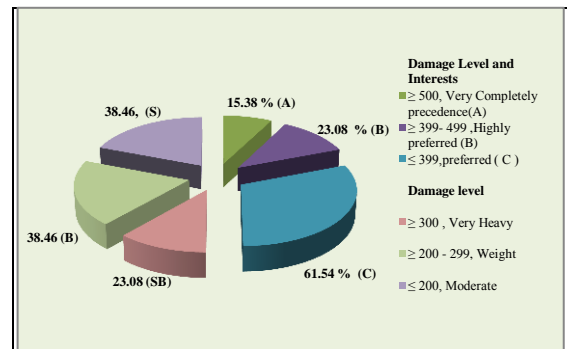


Fig. 8.Percentage of Damage Level Weight

As Figure 7 shows, the highest weight of damage and interests is in Passo, scoring at 512. The status is extremely prioritized for action or category A, while the lowest value of 353 is in priority status or category C. It is concluded that weight level of damage and interest with the value of ≥ 500 is 15.384%. This is considered as A category (must be addressed immediately). The value between 400 and 499 is 23.08%. This is a highly prioritized status and considered as category B, while the value of 300-399 or C category is 61.53%. The highest total score of damage is in Galalavillage totaling at 332 and the lowest is in Wayame, HativeBesar, and Tawiri village, each with the score of 178. It is concluded that the damage level with the weight value of ≥ 300, categories as extremely heavy, is 23.08%, the value exist in five locations, they are Amahusu, Hatiwe Kecil, Galala, Halong, Passo and Waiheru village. Values of 200-299orheavy damage category accounted for 38.46% from 10 locations, whereas the rest,

with the value of ≤ 200 categorized as moderate to light damage is 38.46%, in 10 locations. Data in Figure 8 showed that overall, the damage to coastal areas categorized as heavy to extremely heavy is found in studied area at 61.54%, the rest 38.46% is categorized as mild to moderate. The weight of the damage and interest in research areas with a highly prioritized category has the score of $\geq 399-499$ (B), and extremely prioritized category, ≥ 500 (A) accounted for 38.46%. The remaining 61.54% is a priority (C).

Land suitability analysis based on Law No. 1, 2014 on Coastal areas and small islands management.

In order to determine, it is crucial to understand role and functions of the area according to the spatial plan. This law focuses at Zoning for conservation and cultivation. This has technically regulated in coastal area spatial plan guidelines in Ministerial decree No. 34, 2002. Based on coastal area regulations, conservation area are directed to regions which have conservation function such as national strategic zone protected by legislation directed to coastal areas that have protective functions among other national strategic area, conservation areas and coastal preservation area. Some of the criteria that can be used in the determination of suitability of spatial zone utilization such as beach line, disaster-prone areas, settlements and coastal dynamics. The score is multiplied by the weight of the score using this formula: $N = (\text{Conservation Score} \times 10\%) + (\text{Utilization Score} \times 60\%) + (\text{Special Score} \times 30\%)$

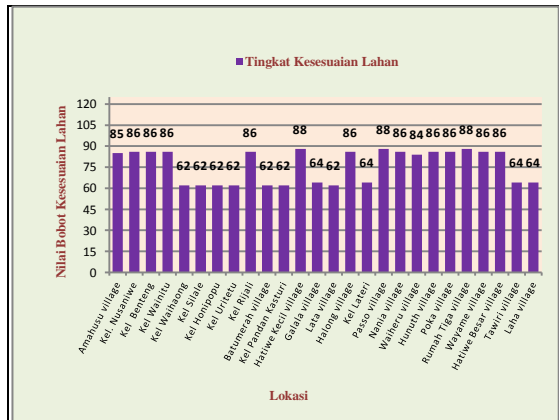


Fig. 9. Distribution of Land Suitability Level

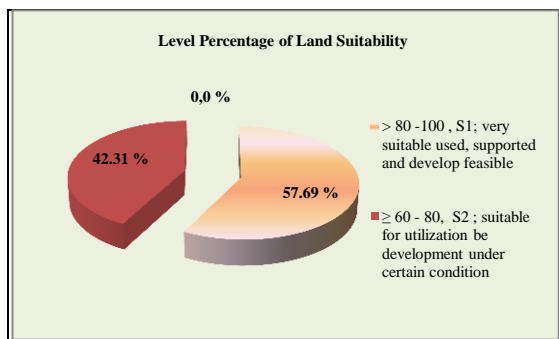


Fig. 10. Level Percentage of Land Suitability

Analysis result in Figures 9 and 10 presented that the highest score on land suitability has a value of 88 with S_1 category. These areas are suitable and feasible to be developed, they are Passo, Rumah Tiga and Hatiwe Kecil village. The lowest value is 62, and classified as S_2 category, there are 11 areas that are suitable to be developed with conditions. It can be concluded that the level of land suitability with a score of $> 80-100$ or S_1 category is appropriate for utilization. The suitable and feasible area for development is 57.69%. For areas with the score of $\geq 60-80$, or category S_2 , the total is 42.31% the area is suitable for utilization with certain provisions.

CONCLUSION

The analysis which derived from three laws on land suitability shows that alluvial soil types with a score of 15 has the largest percentage in coastal areas. Topography suitability scores between 0-8% and 8-15% with 0-300 m radius. Rainfall is considerably high between 185.33 and 210.23 mm, with a score of 30. The total area for cultivation is 6,639.488 hectares (66.395 km²), conservation area is 13,055.23 hectares (130.55 km²), and the buffer area is 16,250.28 hectares (162.50 km²). Damage to the coastal area in Ambon city categorized as heavy to extremely heavy happens in 61.54% of research location; the remaining 38.46% is considered in mild to moderate category. The order of damage and interest level for area management as highly prioritized or (B), and extremely prioritized (A) category are 38.46%. The remaining 61.54% is categorized as a priority for action (C). The level of land suitability with a score of $> 80-100$, or S_1 category is regarded as suitable for utilization. The total is 57.69%. For the score of $\geq 60-80$ or category S_2 , the total area is 42.31%. It means that the area is suitable for utilization with certain conditions. The analysis produced information on zone based land suitability and this information can become an input or evaluation for government in their effort to formulate policy and make decision on the management and damage control of the coastal area in Ambon in sustainable way.

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