Analysis Of Carrying Capacity Of Land For Special Economic Zones Tanjung Api-Api In Infrastructure Development

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Abstract: Special Economic Zones (SEZs) of Tanjung Api-api is the economic region that has been set through the South Sumatera Goverment's decision to serve as an integrated area development industry in South Sumatra. This area is located in the basin Musi Downstream, an area with a height of less than 16 m above sea level. This is also largely a swampy area, composed of soil type associations Glei humus and organosol, as well as alluvial soil as deposition of sediment Banyuasin river, Telang rivers and the Musi river in downstream. The issue and dimension of decision in the analysis of land use requires the contribution of various disciplines. The conceptual framework of decision support system for land development decision making consists of three main components, namely the analysis of land resources, evaluation of the ecological impact assessment in environmental conservation and analysis of regulation. To perform the analysis and assessment approach GIS and MCE (Multi Criteria Evaluation) are used. GIS as a tool that systematically is used to present the spatial appearance of the area of study and prediction of impact. While the MCE is an approach to assess the impact of alternative decisions and plan for the future (predictions).This technique will give a great contribution in maintaining a database of environmental conditions early, up to monitoring and provide preliminary analyzes to predict the consequences of failure would be a change, as well as an operational tool in spatial planning and development of regional infrastructure Economic in Tanjung Api-api area.

Keywords: land resource, industry infrastructure, ecological impact, GIS, MCE

1. INTRODUCTION

SPECIAL Economic Zones (SEZs) Tanjung Api-Api, is one area in Indonesia Economic defined by decision of the Governor of South Sumatra, and is expected to develop into Economic Zone as well as being one of the Gate West Region Investment island of Sumatra, and Indonesia. In the region, the whole building will be built large scale industries for agricultural purposes, oil, fertilizers, rubber and other export commodities purposes. The industrial area will be linked to the road network land, as well as railway tracks, which will transport the commodities from the entire region into areas of existing processing industry, as well as towards the Port of Tanjung Api-Api to be transported out of the territory of Sumatra. Long debate about regional development in sub-optimal land, always concerned with the question of how to secure the environmental conditions, the economic development of the region have a greater impact. Economic development, has always been a contentious issue in environmental sustainability[1]. The development of industrial sector in the region, has always fueled the growth of the population who will occupy the surrounding area, so that it feared would happen accelerated degradation of soil and pollutants[2]. Isue and policy dimension in the analysis of land use requires the contribution of various disciplines. Problems of land use with a wide range of interests, especially between the functions of different land, and conflicts of interest in the category of users, and between individual desires and interests together[3].

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Under these conditions, policy interventions in support of the successful planning and management of land resources for development of the area on the land as well as to change the desire, while maintaining or maintain the quality of the environment and conservation of natural resources in the development of the region, needs to be presented a method that can be accepted by all interested parties[3].
The diversity of building infrastructure that will be built in the economic area, requires a different type of construction and management of risk. Each type has a standard infrastructure building construction, maintenance, protection and crisis management are different. Both in terms of the environment and technology, which requires a holistic decision making and integrated. Quetions of this research, how to assess the impact of infrastructure development in the study area. This study aims to develop and evaluate the approach to spatial planning support system as an operational instrument impact assessment formula in infrastructure development in the area of Special Economic Zones Tanjung Api-api. The system is built will use all relevant data, such as swamp conditions, the carrying capacity of the land, the influence of tides, depth and strength of soil, land use, geophysical, and socio-economics. Special purpose is develop a model of land resources and environmental analysis

2 METODOLOGY

2.1 Location

The research areas of Special Economic Zones (SEZs) Tanjung Api-Api are the Musi river basin downstream, which is part of the Musi river basin. Based on data from Musi River Basin, nearly 35% of the Musi river basin downstream in critical condition and 42% potentially critical.

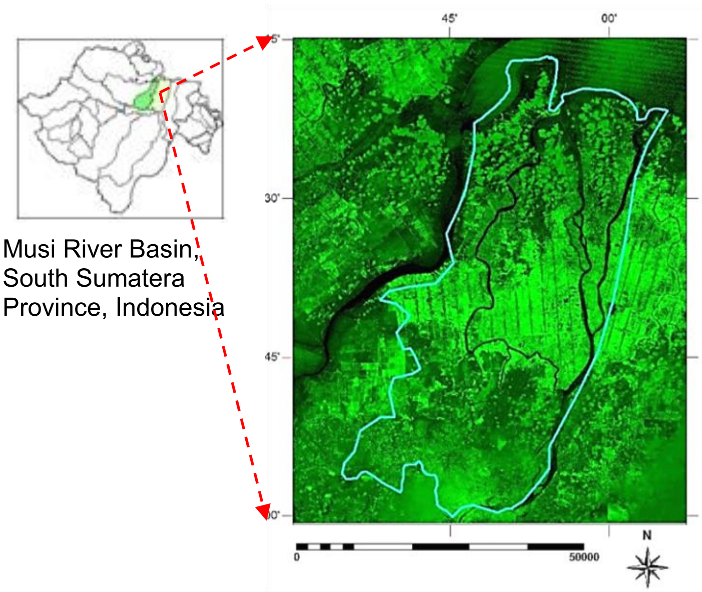


Fig. 1 *Research location of Downstrem of Musi basin*

2.2 Research Method

Vegetation Extraction

Techniques used in classifying land use is using NDVI method. According to Mather[4], this spectral reflectance characteristics can be divided into: (i) the visible spectrum (from 0.4 to 0.7 μm) which has a relatively low reflectance values in red and blue spectrum because the vegetation absorbs a lot of energy in the spectrum, while the peak minor in the green spectrum. The amount of energy which is absorbed up to 70% - 90% of the total energy comes on the leaf surface. The spectral reflectance values in the range of 0.65 to 0.76 μm, and (ii) the near infrared spectrum (0.7 to 1.1 μm), has a high spectral reflectance between 0.76 to 1.35 μm, in the range 1 , from 35 to 2.5 μm spectral reflectance influenced the internal structure of leaves depends on the extent of the water content in the leaves.

NDVI using red wavelengths (R) and infrared (NIR), as in the equation,

$$NDVI= (NIR–Red)/(NIR + Red) \quad (1)$$

NDVI value for vegetation density range of 0.43 ≤ NDVI values ≤ 1.00 = dense vegetation; NDVI ≤ 0.33 ≤ 0.42 for medium density and NDVI ≤ ≤ -1.00 0.32 for sparse density

Soil Extraction

Techniques used in the extraction of soil types is the Normalized Difference Soil Index (NDSI).

Deng et al.,[5] by comparing the value of the average reflectance band 4, 5, and 7 tend to be higher than the band 1, 2, and 3, so constructed index is normalized by choosing one of the bands with reflectance is high and the other with relefansi lower, and among all the possible combinations, the difference normalization band 5 and 4, the band 7 and 1, and band 7 and 2. It was found that the band 7 and 2 is the most appropriate combination in improving land information and is the best model to calculate NDSI equation, as in the following equation:

$$NDSI = \frac{(SWIR-NIR)}{(SWIR+NIR)} \quad (2)$$

Water Exstraction

The technique used is to use Normalized Different Water Index (NDWI), where the index of satellites minus of channel Near Infra Red (NIR) and Short Wave Infrared (SWIR), which is a reflectance of reflection of changes in the moisture content of vegetation and structures on vegetation cover, while reflectance NIR is affected by the structure within the leaves and dry leaves that do not contain water. The combination of NIR and SWIR would eliminate variation caused by structures within the leaves and dry leaves, and will increase accuracy in taking the moisture content of vegetation[6].

$$NDWI = \frac{SWIR-NIR}{2!SWIR+NIR} \quad (3)$$

Weighting Components of the physical environment

To carry out an analysis of land capacity in its ability to develop the Tanjung Api-api Special Economic Zones (SEZs) infrastructure as an Economic Zones, weighting is carried out on physical environmental parameters. Scoring is performed on criteria for inundation height, soil texture, CBR value and land use parameters.

TABLE 1

SCORING PARAMETERS FOR ASSESSING LAND CAPACITY FOR THE DEVELOPMENT OF THE TANJUNG API-API SEZS INFRASTRUCTURE

No	Variable	Suitability/Scoring		
		Not visible	appropriate	visible
1	Pudle	> 50 Cm	20-50 Cm	0-20 Cm
2	texture Soil Texture	< 0,002 mm clay	0,002-0,075 mm silt	0,075-0,425 mm fine sand
3	CBR Value	< 3 % (bad)	3-5 %	5-15 %
4	Land use			
	Forest	1		
	Plantation	2		
	Village		4	
	Rice field		3	
	bush			5

Source : Scoring Analysis with AHP method

3 RESULT AND ANALYSIS

Based on the results of interpretation composite satellite image Multispectral, 2017, land system in the study area are scattered in the landscape is different, namely the plains, alluvial plains, bend lines, alluvial valleys, beaches, tidal marshes, swamps, and terraces.

a. The area is included in the category of alluvial plains are plains river sand alloys (estuary), plains river sand non-volcanic and volcanic sand deposits along the river headwaters. The areas included into the next category is the path meanders major rivers by dikes wide.
b. Categories alluvial valleys are the basics of a small valley between the hills
c. The area is included in the category of beach according to the land system is an area with rocks and islands, coastal sediment-covered peat, and mountains and coastal sand deposits
d. Tidal marsh areas are inter-tidal mud flats under the mangroves

e. Category swamps covering floodplains are flooded peat remains, floodplains lakes narrow valleys, peat swamps in, usually vaulted, peat swamps and shallow. The latter category, namely terraces covering the sand beach rather looming, terraces sea incised sandy and earthy clay, terraces old marine low sandy and earthy clay, terraces river undulating to undulating, and a terrace -terrace narrow river valleys in small.

3.1 Topography and Land Form

The general topography of the study had the slopes range from flat (rate of 0-8% slope), ramps (slope rate of 8-15%). The topography of the slope is dominated by the level of <8%, which formed the plains area of 18,825.189 ha, alluvial plains and marshes area of 37.565 ha, tidal swamp area of 6,653.156 hectares, an area of 60.976 Hectares-turn lane.

***Fig. 2**. Topography and Land Form*

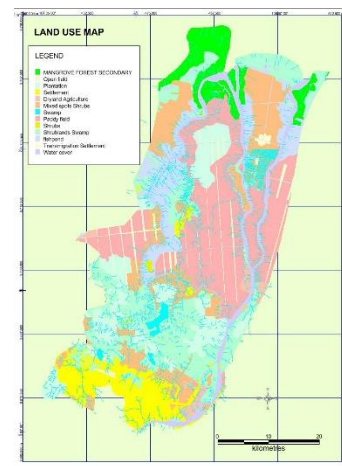
3.2. Land Use

Based on the results of Landsat imagery interpretation (2017), the type of land cover in the forest on Regional Unit Musi downstream watershed management 32.09% dominated by secondary swamp forest is an area of 546,369. 49 Ha; plantations covering an area of 311,341.51 hectares (18.29%); primary dry forest area of 301,610.40 ha (17.71%); and secondary dry forest covering an area of 266,336.49 hectares (15.64%).

Here are the types of natural vegetation found in each zone

a. The type of soil on subzona are peat, with altitude ranging from 0-15 meters above sea level. Natural vegetation that grows is mixed vegetation types as follows Shorea spp.; Dyera spp .; Palaquium spp .; Durio spp .; Campnosperma spp .; Gonystylus spp .; Artocarpus spp .; Koompasia spp .; Strombosia spp .; Eugenia spp .; Mezzettia spp .; Polyalthia spp .; Tristania spp .; Ploiarium spp.

b. The type of soil in this subzona is a swamp, with altitude ranging between 0-2 meters above sea level. Natural vegetation that grows is a swamp with vegetation types as follows Alstonia spp .; Dyera spp .; Gluta spp .; Shorea spp .; Baringtonia spp .; Campnosperma spp .; Ficus spp .; Dillenia spp .; Sapotaceae spp .; Elaeocarpus spp .; Eugenia spp .; Metroxylon spp .; Parkia spp .; Gonystylus spp.



(a) (b)

***Fig. 3**. (a) composit TM 8 Image 5-4-2 band and (b) Classification of land use map*

3.3. Soil and Geology

There were six (6) the type of rock in the study area are scattered in the sub watershed Musi Hilir, namely: mudstone, stone silt, sandstone, mix estauri and marine, alluvium of the river is still young, and peat.Figure 4. presented the sub-basins downstream Musi is dominated by rock types in the form of swamp deposits (34.18%), rock young alluvium (27.10%) and young river alluvium rock type (20.65%).

TABLE 2

THE RELATIONSHIP BETWEEN THE RESULTS OF THE SONDIR TEST AND THE PHYSICAL PROPERTIES AND CLASSIFICATION OF THE SOIL

Type Tanah	Depht (m)	q (Kg/Cm2)	Sticky barriers, f (Kg/Cm2)	Soil consistency (Begemen, 1965)	Density (Meyerhoff, 1965)	Soil Classification (Das, 1994)
Dust Clay	0-5	0,00 - 5,351	0,15 - 0,40	Very soft		Clay, very soft, soft clay, soft silty clay

	5-10	4,281 - 8,561	0,998 - 1,361	Soft is a bit stiff		The clay is soft, the clay is rather chewy
	10-15	4,281 - 23,543	0,998 - 3,086	Rather stiff - very stiff		The clay is rather springy, the clay is rubbery, the sand is silty
	15-20	19,263 - 28,894	2,269 - 3,630	Stiff - very stiff		Clay, rubbery clay, silty sand or solid clay and silty clay
	20-25	21,403 - 53,505	3,176 - 4,992	Stiff - hard	Rather compact	silty sand, rather dense sand, silty clay
	25 - 26,80			Hard	Rather compact-compact	Clay sandy gravel, solid sand and silty clay
Clay	0-5	0,00 - 2,140	0 - 0,272	Very soft		Very soft clay
	5-10	2,140 - 4,281	0,182 - 0,363	Very-very soft		Clay is very soft, soft clay
	10-15	4,281 - 26,754	0,454 - 8,168	Soft-very stiff	very loose	Clay silt, silt sand is rather dense
	15-20	32,105 - 80,262	> 3,00	Very rigid-hard	Remove rather compact	Solid sand, silty sand or solid clay and silty clay
Silty Loam		0,00 - 2,140	0 - 0,363	very soft		Topsoil, clay is very soft
		2,140 - 7,491	0,272 - 0,746	Very soft-rather stiff		Very soft clay, soft clay, soft silty clay
		5,351 - 26,754	0,454 - 2,269	Rather stiff - very stiff	Very loose	Silty clay, silty clay, loose sand
		10,702 - 37,455	0,726 - 4,538	Stiff - very stiff	Remove rather compact	The clay is rather springy, the clay is resilient, the sand is silty, the sand is rather solid
		42,806 - 85,612	> 3	Hard	Rather compact	Solid sand, silty sand / silty clay and silty clay, rubbery pebbly clay
Sand	0 - 5	0,00 - 2,140	0,15 - 0,40	Very soft		Very soft clay, soft clay, soft silty clay
	5 - 10	2,140 - 5,351	0,18 - 0,54	Very-very soft		Soft silty clay, very soft clay
	10 - 15	4,281 - 16,052	0,28 - 1,523	Soft-rigid		Clay is soft, clay is rather chewy
	15 - 20	10,702 - 21,403	2,19 - 3,130	rather rigid - rigid	loose	Sand is loose, clay is rather chewy
	20-25	23,543 - 28,894	> 3	rigid	loose	Sand is rather dense, silt sand
	25 - 30	21,403 - 56,718	> 3	Very rigid - hard	loose rather compact	Clay sandy gravel, solid sand and silty clay
	30 - 32,80	48,403 - 69,560	> 3	hard	rather compact	Clay sandy gravel, solid sand and silty clay

From the results of the classification as shown in Figure 4, then do soil sample testing in the laboratory and soil classification using the USCS (Unified Soil Classification System) and AASHTO (American Association of State Highway and Transportation Officials) classification systems. Sondir testing is carried out to determine the depth of hard soil. From the results of the sondir test, it was obtained that the depth of hard soil at the study site was 18 m. up to 32 m below ground level. In general, soft soil is at a depth of 0-10 m, with a type of soft clay soil, while at a depth of > 10 is clay or silt clay with conditions rather rigid to rigid. From the test results, as shown in Table 2, it shows that the type of soil in the Tanjung-Api-Api Area based on USCS classification is included in fine-grained soils containing silt or clay with low to high plasticity. The value of plasticity index (IP) of land in the Tanjung Api-Api region ranges from 6.66 to 24.22. Based on the USCS classification, the soil is classified as non-organic silt (MH) and organic clay soils with moderate to high plasticity (OH). In general, this type of land has a low carrying capacity, so it requires handling and selection of construction that is appropriate for this type of soil. While based on the AASHTO, the land in the Tanjung Api-Api Area is classified as A-7-5 and A-5, namely clay and silt soil with moderate to bad criteria when used as subgrade, so this land usually requires special handling if used as subgrade because it has the potential to decrease.

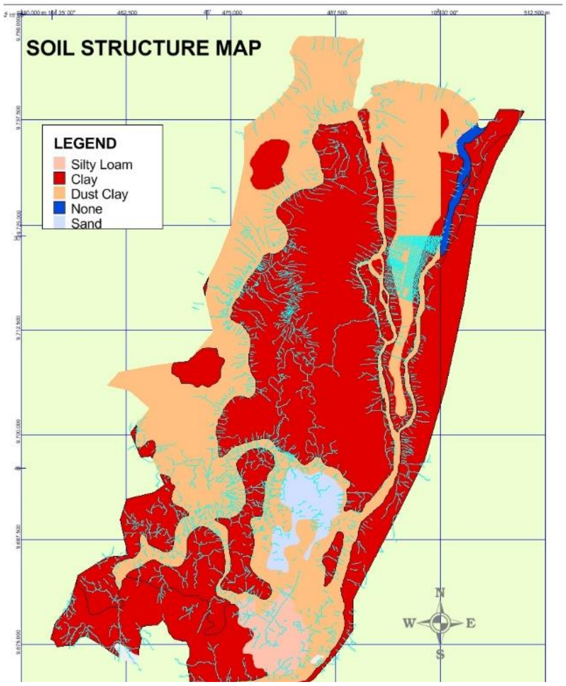


Fig. 4. *Extract composit TM 8 Image with NDSI Method for Classification of Soil structure*

3.4. The Level of The Land Damage

The formation of degraded land is one of the indicators of ecological and environmental damage. Land that has been damaged will automatically be reduced anyway function and role. The decline in the function caused by land use patterns that have little or no attention to soil conservation techniques[7]. The development of the Tanjung Api-api special economic zones will cause the conversion of land from plantation/ agricultural areas to industrial and residential areas. Land conversion will cause environmental degradation, one of which is land subsidence. Figure 5, shows that the potential for land subsidence in the medium category will occur in industrial estates, while in residential areas, mangrove forests and tourism zones have a low potential for land subsidence[8]. However, if the landfill process is started in an industrial area, it will cause an increase in the burden that must be borne by the subgrade soils will increase so that the potential for land subsidence is moderate. While in industrial estate and residential areas, it will have a high potential for land subsidence. This is due to the potential for landfill to increase to reduce the occurrence of inundation, as well as the potential for land subsidence, due to excessive groundwater extraction for industrial and residential activities. The high potential for land subsidence will occur due to the increased burden that must be borne by the subgrade, while compressible soils will be more easily deformed due to loading and changes in land elevation[9], [10],[11],[12],.

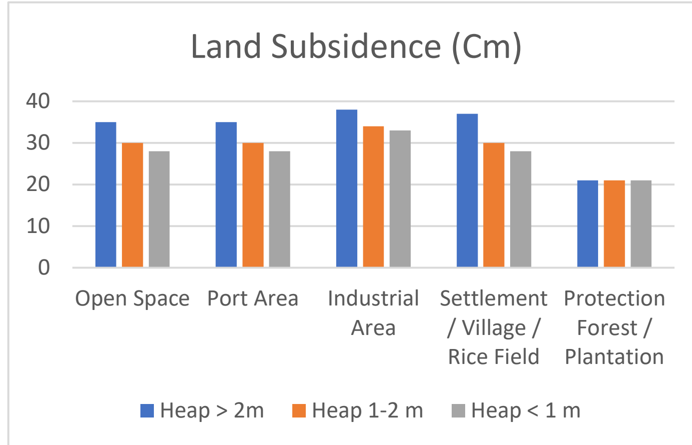


Fig. 5. Potential *Land Subsidence in the SEZs area*

The results of field tests conducted using an Oedometer, obtained the value of the Compressibility index at each point in the study area as a result of landfill as high as 2 m, a decline in primary consolidation in the soil layer at several points. The amount of land subsidence that occurred ranged from 90-130 Cm. Based on a review of critical land in 2017, is currently listed in critical land area surveyed an area of 1,890.78 million hectares in the category rather critical, 3,439,632.73 hectares in critical categories, and 208,507.77 hectares in the category of very critical. Various forest and land rehabilitation activities continue to be encouraged as you recover functions of forests and land. Figure 6 illustrates the results of the analysis of the distribution of critical land in the study area with the assessment criteria based on the expansion of standing water due to sea water intrusion, conversion of protected forest land to plantation and residential land and industry, and land subsidence based on field observations.

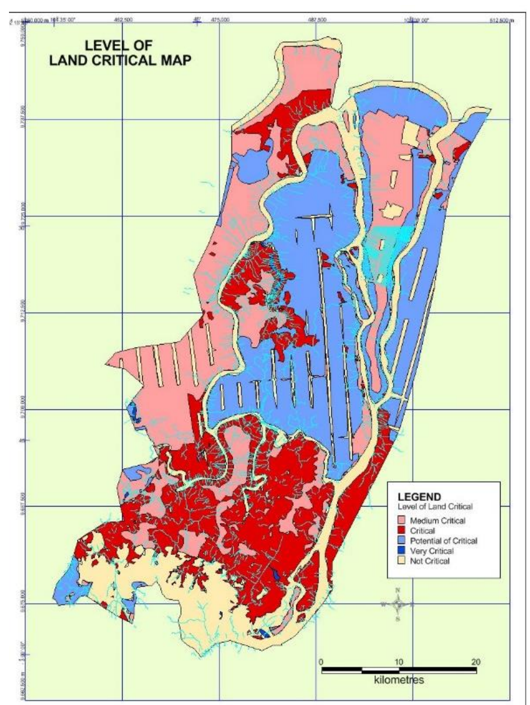


Fig. 6 *Critical area of Tanjung Api-api area*

4 CONCLUSION

Based on the approach of remote sensing interpretation, the classification of land use, soil type and topography and landforms, can be interpreted as the dominance of forest vegetation in swamp areas and community plantation areas, in the study area. Only a few areas have been built, which are generally inundated with high humidity. Constructing land consists of MH and OH, as well as ML and OL, with hard soils at an average depth of 20 m - 30 m.

Using the multi criteria evaluation approach and map overlay, the following analysis results are obtained:

1. The existing condition, the Tanjung Api-Api area has low land subsidence potential for various land uses
2. The main factors causing soil subsidence are soil types with soft soil thickness and embankment, as well as the use of drill to obtain ground water
3. In the condition of the Special Economic Zone (SEZs) development plan, the potential for a high reduction will occur in the Industrial and residential zones, when using deep wells / drills and heaps> 2 m (S = 35.23 - 39.28).

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