

QUICKBIRD IMAGERY FOR SUPPORT TO MAPPING OF SALT LAND SUITABILITY IN KUPANG BAY, EAST NUSA TENGGARA PROVINCE - INDONESIA

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ABSTRACT: Indonesia salt production in 2009 amounted to 1.26 million tones, much lower than that of the needs of industrial and household salt which reached 2.86 million tons / year. Indonesian imports salt in 2010 reached 957 thousand tons, while in 2011 reached 923 thousand tons, whereas the need for a national household salt consumption reached an average of 120 thousand tons / month. One of the steps to improve self-sufficiency and reduce dependence on imported salt is the process of extends new lands which was considered potentially to be built according to the characteristics and natural conditions. East Nusa Tenggara is the potential to become a major salt producer in Indonesia. The area has the potential to be developed into a large land salts in Kupang with potential land area of approximately 7,885 ha. The area which is located in Kupang Bay is a gently sloping plain with dry climate that reaches 7-8 months of dry seasons so it has the potential to be developed as a commercial salt production. The purpose of this study is to perform a mapping to determine the suitability of land based on the physical parameters of salt there are soil and climate of the Kupang Bay region. This study uses a visual approach to the interpretation of Quick Bird imagery to determine the distribution of the land Unit. Data analysis was performed with the scoring and weighting of the physical parameters of land suitability salt. The results show, the entire area of 4405.47 ha consists of three classes of land suitability salt, namely: very suitable area of 471.24 ha (10.70 %), the suitable area of 1891.22 ha (42.93 %), and less suitable area of 1492.92 ha (33.89 %). While the area of 550.10 ha (12.49%) remaining an enclave areas with mangrove vegetation.

BACKGROUND

Indonesia has not been able to meet the needs of the national salt especially in salt quality (Purbani, D., 2010). Therefore the numbers of high salt imports from year to year those required by the industry. One of the important steps to improve self-sufficiency and reduce dependence on imported salt to make the process of extending the new land that was considered potentially to be built into a new salt land. The area of potentially large enough to be developed into a saltern land in the area of Kupang, East Nusa Tenggara Province with the potential land area of approximately 7,885 ha (Anonymous, 2014). The area is located in Kupang bay with a gently sloping plains in the form of dry climates are suspected to achieve 7-8 dry months so it has the potential to be developed as a commercial salt production of raw materials.

Purpose

The purpose of this study was to determine the level of salt in the area of land suitability Kupang Bay East Nusa Tenggara Province.

Method

Salt land suitability map derived from Quickbird satellite image interpretation by aquisition data of 2010, supported by a variety of physical parameters of soil/land and climatology. Parameters of soil/land required are slope, permeability, type, soil texture (Danoedoro, 2009). While the climatology parameters include air temperature, solar radiation, and the air humidity (Syam, D. et all, 2012). All of these parameters are made scoring and weighting to obtain Salt Suitability Index (ESRI, 1997; Burough, M.D., 1998)

Calculation of physical suitability assessment grade salt land suitability is:

$$SLS = (\sum Ni/Nmaks) \times 100\% \dots \dots \dots (1)$$

Where,

SLS : Salt Land Suitability

Ni : Parameters Number of-i (weight x score)

Nmaks : Maximum value from physical category of salt pond (Herawati, P.E., 2008).

The final result of salt land suitability map divided by 4 class, there are: very suitable, suitable, less suitable, and not suitable.

The calculation of land slope at the field by using equation as bellow:

$$S = H/L \times 100\% \dots\dots\dots(2)$$

Dimana,
 S : slope (%)
 H : hight (m)
 L : lenght (m)

The flow chart of salt land suitability mapping as Figure 1.

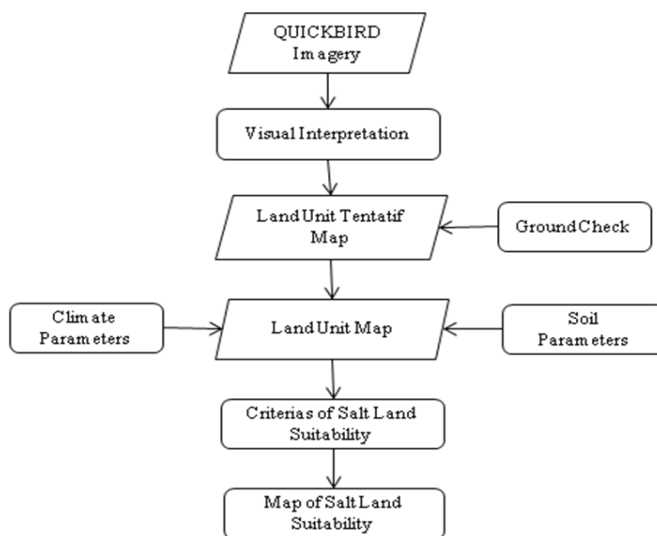


Figure 1. Flow chart of Salt Land Suitability Mapping

RESULT AND DISCUSSION

Salt Land Availability

The covering an area of salt land availability in Kupang Bay is 3,720 hectare. land owned by investors PT Panggung Guna Ganda Semesta, which the statute permission Hak Guna Usaha since 1992 with certificate number 6/1992 (Anonymous, 2013). The land condition are neglected until recently, so there is some good land used by local governments and communities for livelihood. The land is being proposed by the National Land Agency of East Nusa Tenggara Province as wastelands, so that later can be used for other purposes that are economical. Map of salt land availability in Kupang Bay derived from Land Use and Soil Map former PT. Panggung Guna Ganda Semesta sourced from National Land Agency of East Nusa Tenggara Province. The map has been adjusted with field check in November 2013 (Figure 1). The present condition of land use are presented in Table 1.

Table 1. Present Land Use Condition of Kupang Bay Area.

LANDUSE	AREA (Ha)	AREA (%)
Mangrove Forset	706,30	16,03
Settlement	41,74	0,95
Paddy Field	2.032,32	46,13
Pond	54,37	1,23
Open Land	1.423,91	32,32
Arid Land	146,84	3,33
Jumlah	4.405,47	100,00

Source: Calculation Result, 2013

Salt Land Suitability

Calculation of salt land suitability of Kupang Bay based on scoring and weighting of physic parameters, as the following Table 2.

Table 2. Scoring and Weighting Criterias of Physical Parameters

Parameters	Weight (%)	Score x weight		
		Very Suitable, score = 3	Suitable, Score = 2	Less Suitable, Score = 1
Soil/land permeability	15	45	30	15
- Slope	15	45	30	15
- Elevation				
Soil/Land Type	10	30	20	10
Soil texture	15	45	30	15
Temperature	15	45	30	15
Solare Radiation	15	45	30	15
Humidity	15	45	30	15
Total	100	300	200	100

Of several parameters obtained in the field and laboratory test results obtained land suitability parameter values as follows:

Climate Parameters

- Air humidity is obtained from Meteorology Climatology and Geophysic Agency of Kupang, which ranged between 65.5% (August) to 86.6% (January). Kupang salt harvest is 7 months, ie April (79.5% moisture) to October (68.9% moisture), or an average of over 7 months was 70.7%. This air humidity is more high.
- Solar radiation time ranged from 52.0% of the sun which occurred in January to 96.4% which occurred in August. Average solar radiation time for 7 months (April-October) was 90.4%.
- The average maximum temperature is lowest at 30.3°Celsius, is the highest in February and 33.5°Celsius in October, or an average of over 7 months is 32.4 °Celsius.

Soil Parameters

- The permeability of the soil, are generally very low to low, in some places, particularly in the south and northeast area are moderate.
- The slope of the land generally <2%, because almost all parts of the alluvial plain. The elevation of the sea surface is generally <4m, except in the south and the northeast could reach 5-7 meters.
- Type of land, all of which are alluvial soil except in the south and northeast fraction is eluvial.
- Soil texture is largely dominated by clay, silty clay in part, silt, and in the south and the northeast generally silty sand.

Table 3. Physical Parameters Value of Land Salt Suitability

Suitability	Land/Soil Parameters				Climate Parameters		
	Soil Permeability	Land Slope (%)	Land Type	Soil Texture	Temperatur (°C)	Solar Radiation (%)	Humidity (%)
Very Suitable	Low	<2%	Alluvium	Clay	32,4	90,4	70,7
Suitable	Low	<2%	Alluvium	Silt	32,4	90,4	70,7
Less Suitable	Low	<2%	Eluvium -aluvium	Sand - Silt	32,4	90,4	70,7

Source: Calculation Result, 2013

Based on computer calculation of salt land suitability map with Geographic Information System, thus resulting suitability class with the area of each class. From the results of the study note that the suitability of salt land in Kupang Bay is:

- Very Suitable, covering an area of 471.24 ha (10.70%), found in villages Nunkurus, Merdeka, Oebelo, and Tanah Merah. Existing present condition is largely a salt ponds that are still operational, the elevation generally <1m, relatively close to the sea.
- Suitable, an area of 1891.22 ha (42.93%), found in villages Nunkurus, Merdeka, Oebelo, Tanah Merah, Bipolo, and Babau. Existing condition is currently open land and partly dead salt ponds (former salt ponds). The elevation of this area generally (1-2) m, and relatively close to the sea, thus simplifying the drainage ponds from the sea to salt pond.
- Less Suitable, an area of 1492.92 ha (33.89%), found in all villages except Noelbaki, and the widest area in the Babau village. Currently the existing condition of wetland and some settlements. Elevation from sea level > 3.5 meters, soil permeability is generally moderate, and distant from the coast more than 3 km.
- Mangrove, covering an area of 550.10 ha (12.49%), found in all villages except in Oesao and Tuapukan, and the largest in the Nunkurus village. Currently existing condition is a mangrove forest) along the coast and

rivers (restricted areas), but there is also a possibility that open land by the local government will be planted mangroves in accordance with the spatial planing.

Map of salt land suitability in Kupang Bay are presented in Figure 5, while the classification results along with its range and the limiting factor as in Table 4. Table 5 is the distribution of salt land suitability in Kupang Bay based on administration.

Table 4. Land Salt Suitability of Kupang Bay with Constrain Factors

Suitability	Area (Ha)	Area (%)	Constrain Factors
Very Suitable	471,24	10,70	- Kelembaban tinggi, tapi masih dalam toleransi - High humidity - Elevation >1,5 m above sea level. - Soil permeability (low – moderate)
Suitable	1.891,22	42,93	- No used land existing - High humidity - Elevation >3, 5 m above sea level. - Distance from shoreline(> 3 km) - Soil permeability (moderate – High)
Less Suitable	1.492,92	33,89	- Land existing paddy field and settlement. - Enclave area - Restricted area
Mangrove (enclave)	550,10	12,49	- Mangrove existing
Total	4.405,47	100,00	

Source: Calculation Result, 2013

Table 5. Land Salt Suitability of Kupang Bay based on Administration

Vilages	Suitability Class				Total
	Very Suitable	Suitable	Less Suitable	Mangrove	
Oebelo	5,14	152,24	115,21	46,97	319,56
Tanah Merah	1,99	64,72	0	78,33	152,59
Babau	0	19,54	204,03	0	223,57
Merdeka	86,48	337,35	492,62	36,62	953,05
Nunkurus	302,40	1.280,99	569,96	336,33	2.489,68
Oelatimo	0	0	21,11	0,09	21,19
Oesao	0	0	0,03	0	0,03
Tuapukan	0	0	45,27	0	37,72
Bipolo	75,24	36,38	44,70	51,76	208,08
Total	471,24	1.891,22	1.492,92	550,10	4.405,47

References

- Anonymous., 2013. Land Status Map of Kupang Bay. National Land Agency of East Nusa Tenggara Timur
- Anonymous., 2014. Kupang Regency in Figure. Statistic Center Agency of Kupang Regency. Kupang.
- Burrough, M.D., 1998. Principals of Geographical Information Systems. Oxford University Press.
- Campbell, J.B., 2002. Introduction to remote sensing (third edition). The Guilford Press. New York.
- Danoedoro, P., 2009. Land-use Information from the Satellite Imagery: Versatility and Contents for Local Physical Planning. Lambert Academic Publishing AG & Co. KG.
- ESRI., 1997. ArcView Spatial Analyst. Environmental Systems Research Institute, Inc. Redlands. USA.
- Herawati, V.E., 2008. Analysis of segara anakan marine suitability for Kerang Totok (*Polymesoda erosa*) cultur based on primary productivity aspect and satellite imagery. Diponegoro University, Master Thesis, Semarang.
- Phinn, S.R., Menges, C., Hill, G.J.E., & Stanfo rd, M., 2000. Optimizing Remotely sensed solutions for monitoring, modeling and managing coastal environments. *Remote Sensing of Environment*. 73: 117-132.
- Purbani, D., 2010. Salt Crystalization Process. Marine and Non Biology Resources Research Center. Marine and Fishery Department.
- Syam, D. and Banuwa, N., 2012. Application of remote sensing for land use changes identification. *Globe*, 14(2), 146 -156.

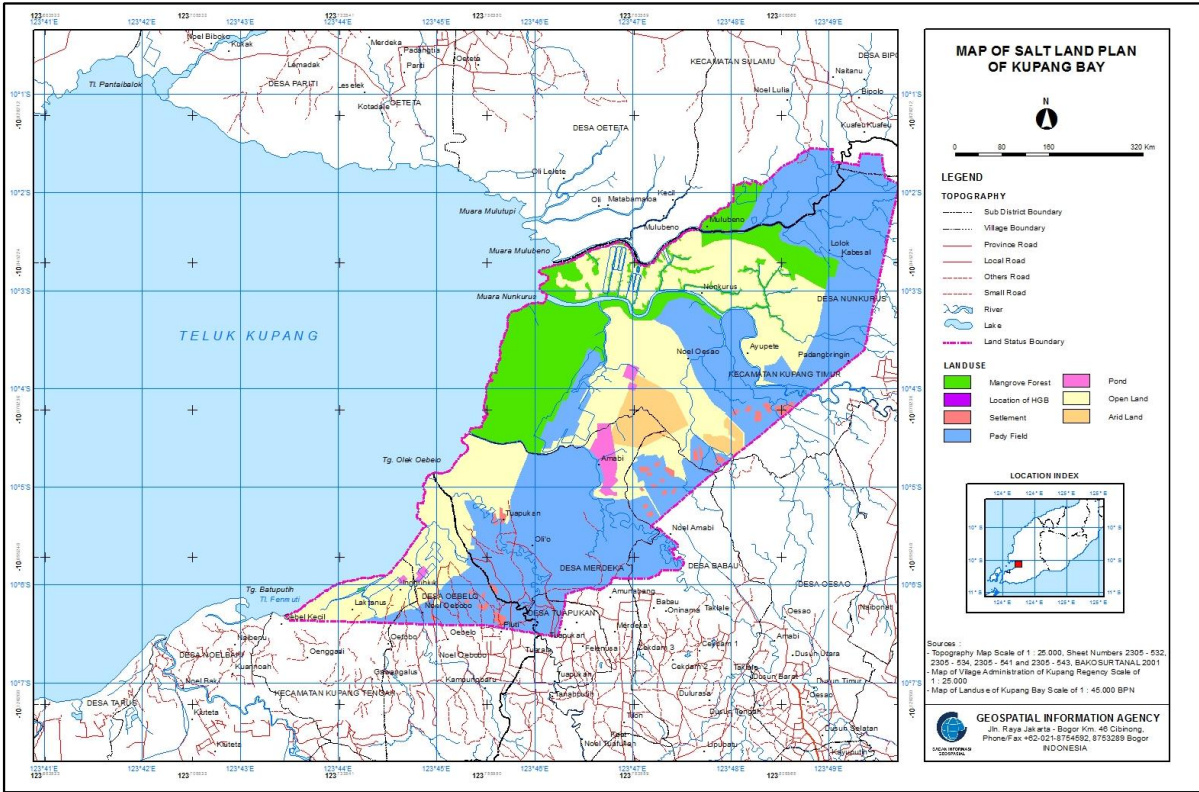


Figure 2. Map of Salt Land Plan in Kupang Bay
 (Source: National Land Agency and Field Ground Check, 2013)

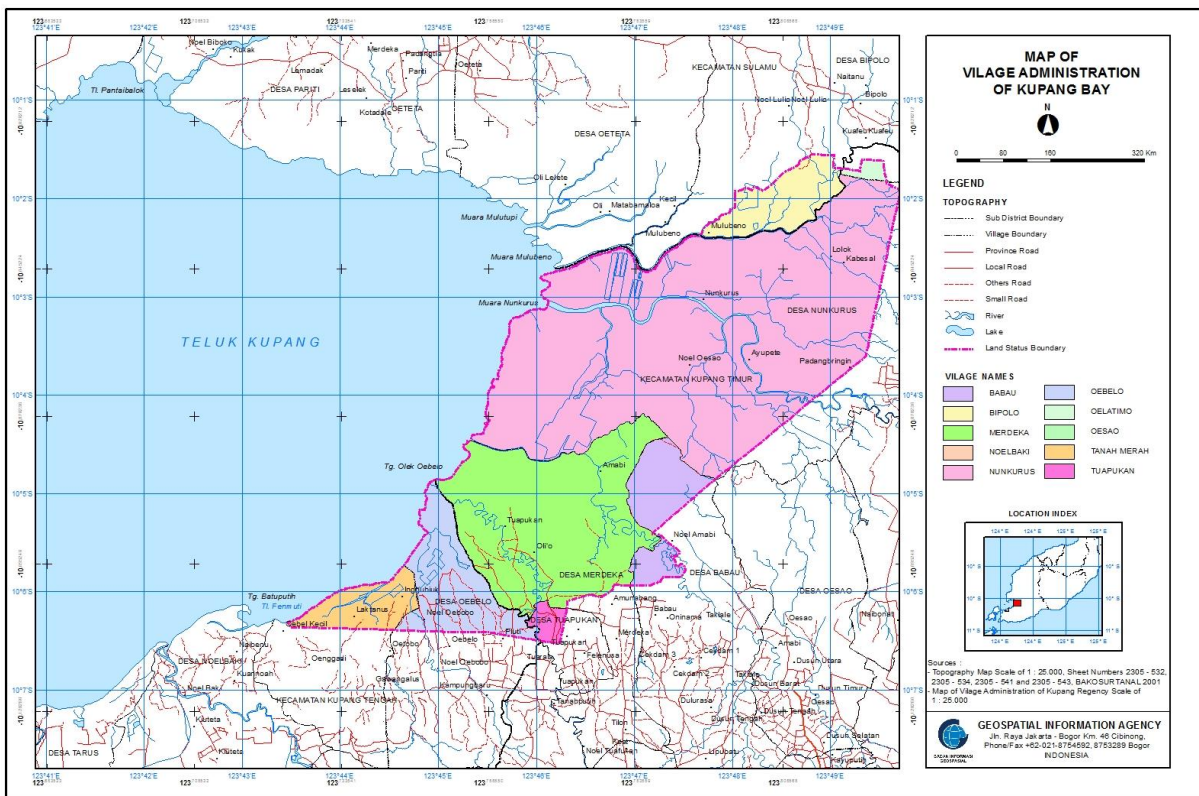


Figure 3. Map of Kupang Bay Administration

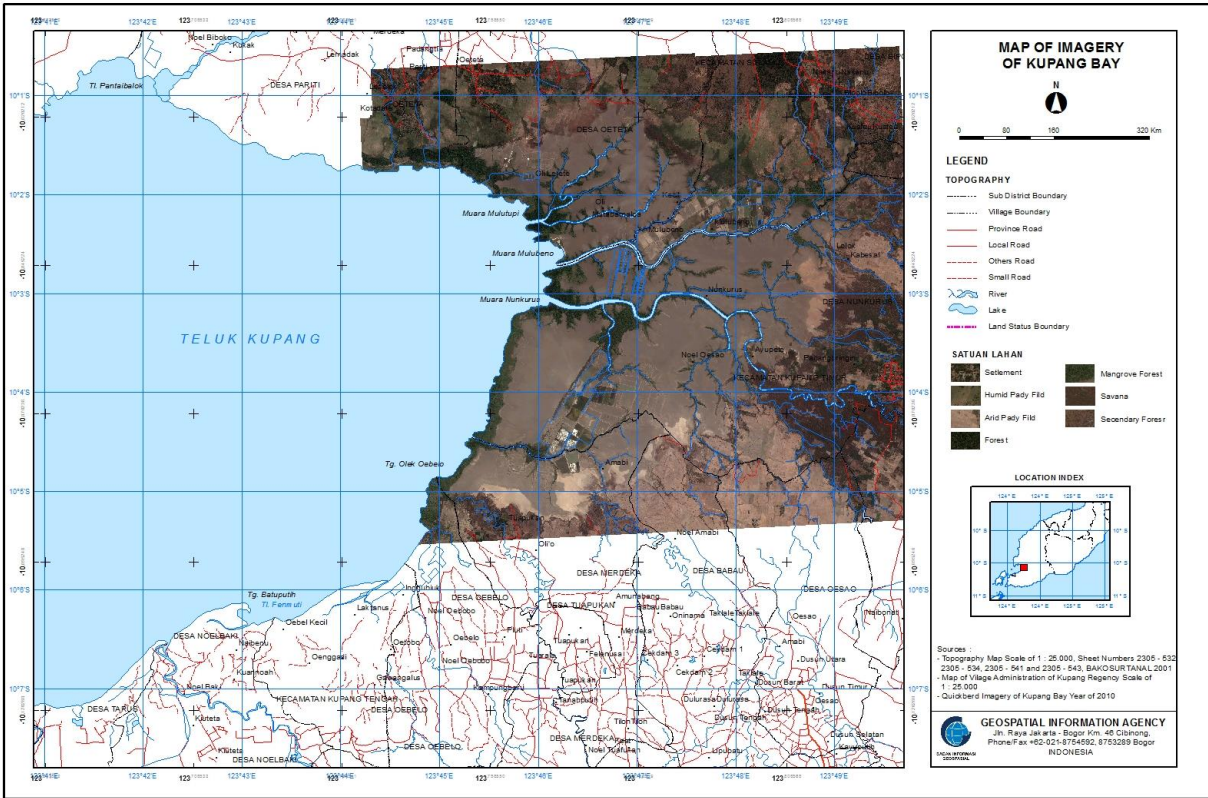


Figure 4. Quickbird imagery of Kupang Bay

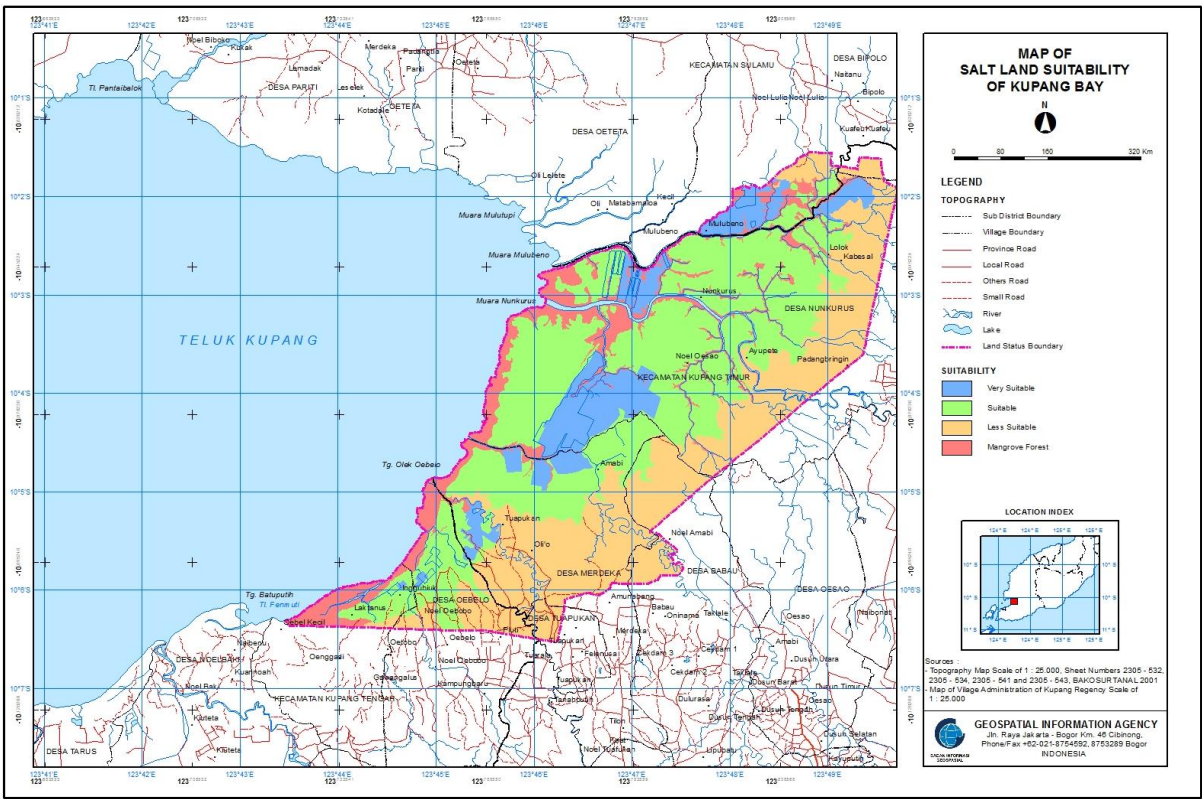


Figure 5. Map of Salt Land Suitability of Kupang Bay