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IDENTICATION OF LOWLAND CHARACTERISTICS AT TANJUNG API-API AREA USING BY LANDSAT 8

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ABSTRACT

Tanjung Api-Api area is part of lowlands located in South Sumatera. In order to develop the lowland area into built up area, its necessary to know the physical characteristics of this region. This study aims to determine physical characteristics of lowland using landsat 8 data. The method used in this study were TCT (Tasseled Cap Transformation), NDVI (Normalized Difference Vegetation Index), NDBI (Normalized Difference Built up Index), NDWI (Normalized Difference Water Index). The results showed that using the approach of NDVI, NDBI, NDWI can be determined land use/ land cover (LULC) in the Tanjung Api-Api area. The land use / land cover dominated by vegetated area that consists of secondary mangrove forests, plantations, agriculture, shrubs and rice fields. Besides that there also settlements, industrial buildings, ponds and others. Tanjung Api-Api area has lot of vegetation (dense vegetation) areas which produce a lot of prespiration so that the moisturity at study area is higher compared to the low-vegetated areas/ built up area.

Keywords : Landsat 8, Lowland, Physical characteristics, NDVI, TCT, NDBI, NDWI.

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1. INTRODUCTION

Lowlands are areas that the soil is saturated with water, either permanent or temporal. In the lowlands there are various types of vegetation, such as freshwater swamp forest, peat swamp forest, mangrove forest, grassland and others. Conversion of lowlands to built up areas will lead to environmental degradation. Reclamation of swamp area as the settlement area, will caused to a decrease of water absorption, disrupting the hydrological balance in the lowlands (Bolun et al. 2016; Muhammad & Pedia 2012) [3,11].

Tanjung Api-Api area is part of lowland located on the downstream of Musi River Basin, bordering the East Coastal of Sumatra Island. Conversion of Tanjung Api-Api area as special economic zone will caused to high growth of settlements. The Special Economic Zone of Tanjung Api-Api have two functions as a port and industrial area, so that its necessary to conduct research on the physical characteristics of lowlands in this region. Reclamation to acquire dry land will affect environmental conditions. To prevent of environmental degradation, its necessary to know the physical character of the lowland, which includes: land use/ land cover (LULC), vegetation density level, built up area and inundation area or area which has high moisturity. The physical character of the environment can be interpreted using approach of TCT (Tasseled Cap Transformation), NDVI (Normalized Difference Vegetation Index), NDBI (Normalized Difference Built Up Index) and NDWI (Normalized Difference Water Index) (Annemarie 2012; Rayan & Diana 2016; Suwarsono et al. 2013; Zhe et al. 2015) [1, 13,16, 21].

Analysis of environmental processes, monitoring and topographic surveys, dense vegetation or other of local factors could be done with remote sensing techniques (Chen 2002; Dengsheng et al. 2007; Ebtihal 2014; Rawat 2015; Manjunatha et al. 2015) [4,5,6,9,10]. Remote sensing techniques and satellite imageries have been employed to monitor significant land disturbances, spatially and temporally. On February 11th 2013, The Landsat Data Continuity Mission has been a successful launch. LANDSAT 8 satellite has two main sensors: the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS). Advantages use of landsat 8 is a clearer view with better and greater sensitivity to brightness and color than previous (Tri & Intae 2015) [17]. Changes of the land use/ land cover can be interpretation using remote sensing technique, so that can be environmental considerations in the urban planning processes of an increasing number of governments around the world (Xu 2008; Patel et al. 2015; Ramita 2009) [7,12,14].

Classification of land use/ land cover (LULC) used combination band 6, band 5 and band 4 (Red- Green – Blue) by landsat 8 was done to analyze vegetation (Tri and Intae 2015) [17]. Vegetation analysis used Normalized Difference Vegetation Index (NDVI) give advantage of the unique shape of the reflectance curve of vegetation, and has been widely used for mapping vegetation on the global (Ebtihal 2014; Szilard et al. 2016; Vani & Venkata 2017; Youshi et al. 2009) [6,15,19,20]. TCT (Tasseled Cap Transformation) can interpretation of physical characteristics of land using by T-cap Components i.e. T-cap Brightness, T-cap Greenness (TCG), T-cap Wetness (TGW) and than compare with NDVI value (Baig et al. 2014) [2]. The classification of land use land cover (LULC) was done by using parameters NDVI, NDWI, NDBI and NDBa1. NDVI is used to determine the quality and distribution of vegetation, NDWI to know the characteristics of waters, and NDBI to know the distribution and change of open land (Suwarsono & Khomarudin, 2014) [16].

2. MATERIALS & METHODS

2.1. Study Area

The study area is Tanjung Api-Api, Banyuasin district, South Sumatera. In order to develop Tanjung Api-Api area as Special Economic Zone, the Government plans to build infrastructure that could support the potential of the area. Geographically located at coordinates between 104^{o} 45’ to 104^{o} 55’ E Longitude and 2^{o} $17^{'}$ to 2^{o} $24^{'}$ S Latitude (Figure 1). This study area has a wet tropical climate with an average rainfall of 2,723 mm/ year. Topographic conditions are dominated by areas that are relatively flat in the form of coastal areas, tidal swamps and lebak. This area is suitable to be developed as a residential and agricultural area because the slope is 0 - 2% , but the area has flood potential (Banyuasin dalam Angka, 2012).

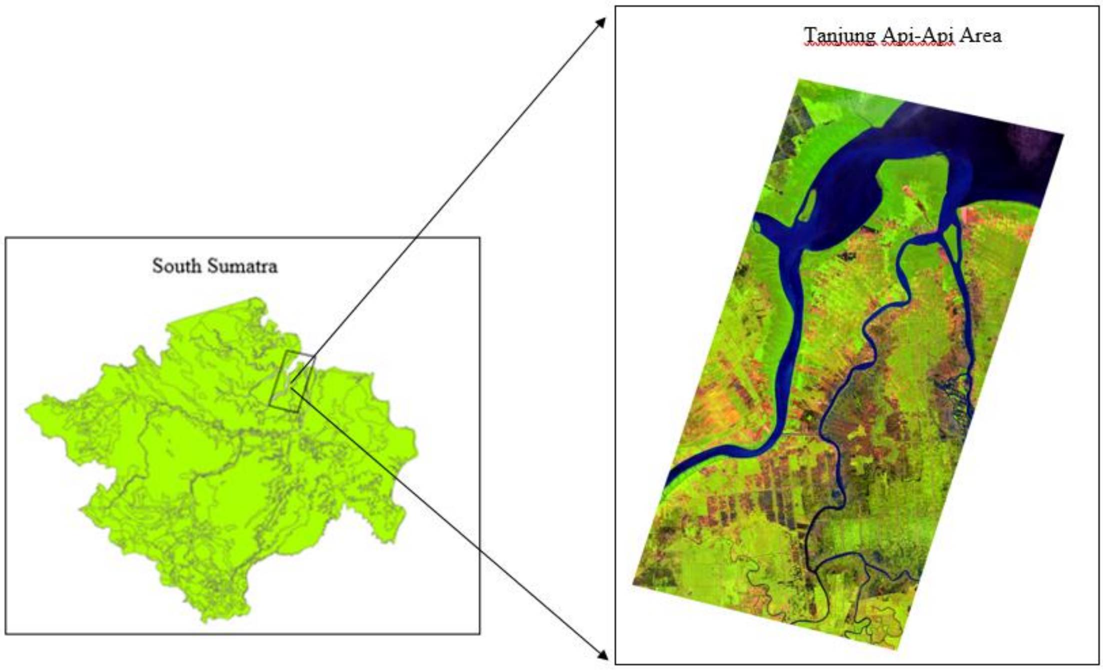


Figure 1. Location of the study area (Landsat WRS Path 124/Row 062)

2.2. Description of The Data

The study involved various activities including data acquisition, data processing and data analysis and interpretation. The remotely sensed data used in this study are data of Landsat 8 that cover area is contained within the Landsat Path/Row 124/062 acquired on 16 December 2016 (resolution 30 m and Satellite imageries were downloaded from United States Geological Survey site). The data has already georeferenced to the UTM coordinate system WGS 1984 (Zone 48 S). On this period was rainy session so that had more precipitation than dry session and resulting in relatively high water content in soils.

2.3. Methods

Classification of land use and land cover (LULC) using multispectral composite bands. In this study used composite band; RGB (Red=6; Green=5 and Blue=4). Selection of RGB (6-5-4) because most of the lowland at study area has dense vegetated but the built up area has low density. Maximum likelihood classifier (MLC) was used to classification land use and land cover (LULC), taking into account the spectral characteristics of the satellite images and existing knowledge of land use of the study area. To ensure that the results achieved were accurate, ground checking at study area was done. Table 1 provides detailed spectral characteristics of Landsat OLI/ TIRS Spectral Bands. The Landsat 8 image has a red band (R) and near infrared (NIR) that look narrower than the ETM + image. The information on the density of vegetation and its changes, the area of land, and the state of the field can be detected from the remote sensing technique using satellite imagery. Landsat 8 has a different range of frequencies along the color electromagnetic spectrum, though not always the color seen by the human eye . Each range is called a band, and Landsat 8 has 11 bands.

Table 1 Multispectral bands of landsat 8

	Landsat 8 OLI	**Spectral Range (μm)**	**Spatial Resolution (m)**
Coastal/ Aerosol	Band 1	0.433-0.453	30
Blue	Band 2	0.450-0.515	30
Green	Band 3	0.525-0.600	30
Red	Band 4	0.630-0.680	30
Ner-IR	Band 5	0.845-0.885	30
SWIR-1	Band 6	1.560-1.660	30
SWIR-2	Band 7	2.100-2.300	30
Pancromatic	Band 8	0.500-0.680	30
Cirrus	Band 9	1.360-1.390	15
LWIR-1	Band 10	10.30-11.30	30
LWIR-2	Band 11	11.50-12.50	30

Source : USGS (United State Geological Survey) landsat 8 product, 2013 [18]

To understand the vegetation performance as one of the objectives NDVI surfaces were generated from the imageries and their values analyzed on a Gis platform. Tasseled Cap Transformation (TCT) is done to know the brightness, wetness and greeness at study area which have relation with land use/ land cover (LULC). Furthermore, to know the density of vegetation done by using NDVI, analyze of NDBI to know the built up area , whereas NDWI is used to know area having high moisturity and inundation area. Next, calculation of four spectral indices i.e. Tasseled Caps Transformation (TCT), Normalized Difference Vegetation Index (NDVI), Normalized Difference Built up Index (NDBI) and Normalized Difference Water Index (NDWI). TCT were calculated according Table 2, while NDVI, NDBI and NDWI were calculated according to equations (1), (2) and (3). Geographic Information System (GIS) operations were performed with ArcGis 10.2.

Tabel 2 Tasseled Caps Transformation (TCT) for landsat 8 at satellite reflectance

TCT	Blue Band 2	Green Band 3	Red Band 4	NIR Band 5	SWIR 1 Band 6	SWIR2 Band 7
Brightness	0.3029	0.2786	0.4733	0.5599	0.5080	0.1872
Greeness	-0.2941	-0.2430	-0.5424	0.7276	0.0713	-0.1608
Wetness	0.1511	0.1973	0.3283	0.3407	-0.7117	-0.4559

Source : Baig et.al., 2014 [2]

Formula for calculate NDVI, NDBI and NDWI on Landsat - 8 OLI.

$$NDVI = \frac{NIR - RED}{NIR + RED} = \frac{B5 - B4}{B5 + B4} \quad (1)$$

$$NDBI = \frac{SWIR - NIR}{SWIR + NIR} = \frac{B6 - B5}{B6 + B5} \quad (2)$$

$$NDWI = \frac{GREEN - SWIR}{GREEN + SWIR} = \frac{B3 - B6}{B3 + B6} \quad (3)$$

3. RESULT AND DISCUSSION

3.1. Interpretation of Land Use/ Land Cover (LULC) with composite band, NDVI and NDBI

RGB of Landsat 8 (band 6, 5, 4) color composite contains the same 3 bands as the previous, because vegetation reflects higher in the near infrared than the other two bands, the green color dominates. So this combination will makes the vegetation look more natural. The composite band 654 (Red=6; Green = 5 and Blue= 4) was chosen at this study because Tanjung Api-Api area is an area that has high vegetation. Figure 2a showed the composite band with unsupervised classification, while Figure. 2b showed the composite band that has been classified in a supervised maximum likelihod. The land use / land cover dominated by vegetated area that consists of secondary mangrove forests, plantations, agriculture, shrubs and rice fields. Land use such as settlements, industrial buildings and ponds is least. Tanjung Api-Api area has lot of vegetation areas which produce a lot of prespiration so that the moisturity at study area is higher compared to the low vegetated areas/ built up area. Interpretation of land use/ land cover (LULC) can be using NDVI, because it can be known the level of density and greenness of vegetation. Table 3 showed the spectral values of NDVI based on vegetation density levels.

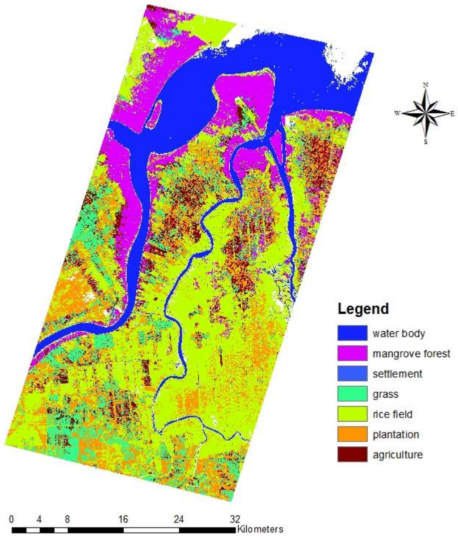
Table 3 Spectral values of NDVI based on vegetation density level at study area

NDVI Value	Vegetation Density	Land Use/ Land Cover (LULC)
-0.803–0.0842	Non vegetation	Water body, river and pond
0.0842- 0.214	Non vegetation	Settlement area, industry building and bare soil.
0.214 – 0.453	Rarely vegetation	shrubs
0.453 – 0.710	Medium vegetation	Rice fields and dry farms mixed with shrubs
0.710 – 0.883	Dense vegetation	Mangrove forests and plantations

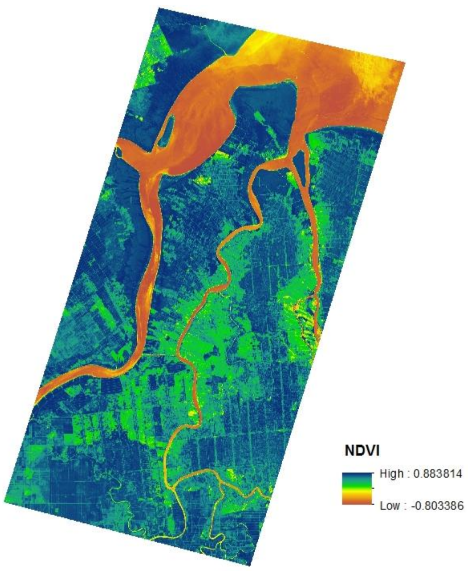
NDVI values obtained by calculated of near infrared with visible light reflected by the plant. Based on NDVI calculations, most of Tanjung Api-Api areas are vegetated areas with high density.

Figure 2 (c) showed dense vegetation predominantly on coastal areas, this area is mangrove forest and coconut plantation area. Medium density areas are characterized by greenish colour, dominated by agricultural areas of rice fields and agriculture of mixed shrubs, whereas rarely density was dominated by shrubs and non-vegetated areas were waters/ water bodies, settlements and open land areas.

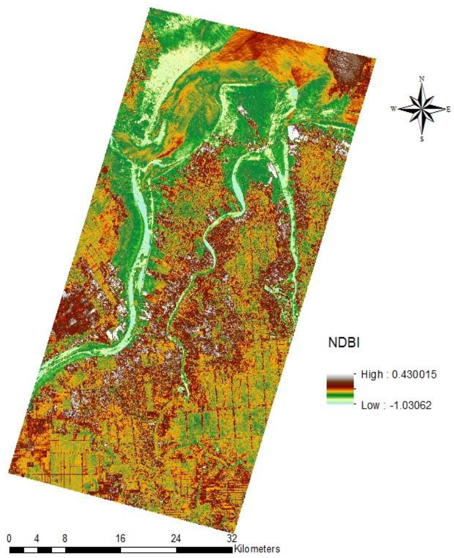
(2a) Composite Band (RGB = 6-5-4), before classification



(2b) Composite Band (RGB = 6-5-4), after Supervised Maximum Likelihood classification.



(2c) Classification of LULC using NDVI



(2d) Classification of LULC using NDBI

Figure 2. Classification of Land Use/ Land Cover (LULC)

The NDBI index will focus on highlighting urban areas or built areas where there is usually a higher reflection in the Shortwave Infrared (SWIR) area, when compared to Near-Infrared (NIR) areas. This application is very useful for monitoring and planning of land use/land cover (LULC). Figure 2(d) showed, in Tanjung Api-Api area there are little areas that are built and the area is still dominated by vegetation. In general, area conversion is used for plantation and agriculture, and a small part is for residential areas and industrial buildings. Built-up areas exhibit higher heat conductivity than bare soil areas, resulting in the higher emissivity and albedo values of thermal infrared waves in built-up areas relative to bare soil areas. The region with spectral value greater than 0.1 are plantation and agriculture area whereas the region having spectral value greater than 0.3 are settlement area and spectral value smaller than -1.0 are water body and vegetation area.

3.2. Interpreation of Lowland Characteristic with Tasseled Caps Transformation (TCT)

Brightness and Greenness bands are the important components mostly used to interpretation the land use/ landcover. Figure 3 showed high of brightness value at built-up areas, man-made features, roads and bare soil, its caused by high reflectance. Brightness responds to the physical properties that affect the total reflection. The brightness value indicates the built up area, the result of the interpretation indicates that in the Tanjung Api- Api area has occured conversion of lowlands used for agriculture and plantation, while for the settlement is lower than vegetation area. Figure 3(a) showed brightness and built up areas, roads, concrete structure and soil without vegetation are shown as red or approximately purple. Figure 3(b) showed interpretation of vegetation at study area. Greenness value is responsive to the characteristic of healthy vegetation, higher of value greenness showed dense of vegetation. The greenness value indicated health and density of plant, in this research the highest of greenness value obtained by mangrove forest and plantation (spectral value between 0.167 to 0.367), rice field and shrub have spectral value between 0.07 to 0.163 while the spectral value for settlements, industrial buildings and water bodies are negative.

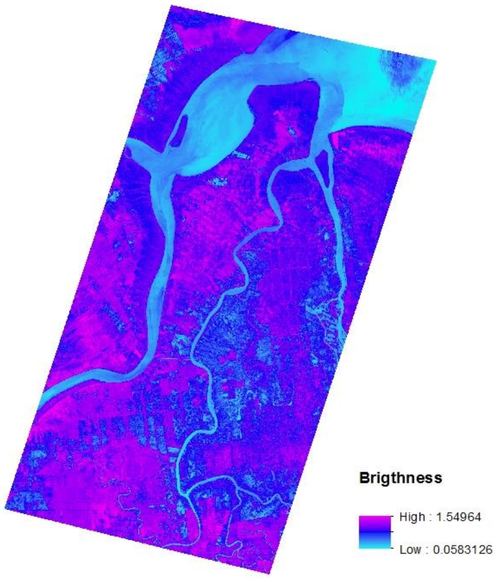
3.3. Interpretation of Lowland Characteristic with Tasseled Caps Wetness and NDWI (Normalized Difference Water Index)

NDWI can effectively distinguish water and vegetation and extract water bodies. With combining ratio two different bands, the NDWI index enhances water spectral signals,in the NIR range, water has a strong absorption capacity, unlike vegetation**.** By using NDWI (Normalized Difference Water Index) and TCW (Tasseled Cap Wetness) could be interpreted areas that have high moisturity and waterlogged/ inundation areas.

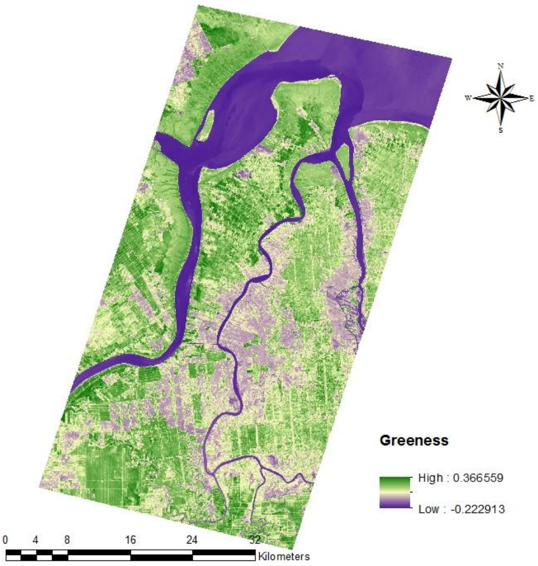
The Areas that have a dense vegetation is an area that has a high moisturity. Figure 3c and 3d, showed that Tanjung Api-Api area has high moisturity level especially in area of mangrove forest, plantation and agriculture. The areas that have dense vegetation will have high moisture value and otherwise areas with low vegetation will have low moisturity values. Table 4 showed the spectral values of NDWI to interpretation of land use/ land cover (LULC).

Table 4 Spectral values of NDWI to Interpretation Land Use/ Land Cover (LULC)

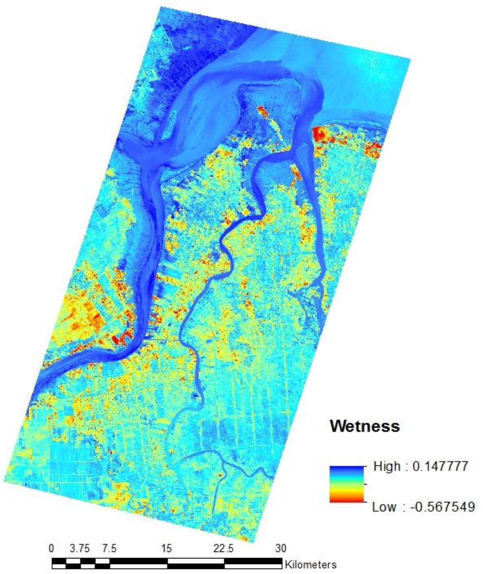
NDWI Value	Land Use/ Land Cover (LULC)
-0.695 to -0.399	Plantation and dry farms mixed with shrubs
-0.400 to-0.204	Mangrove forests
-0.205 to 0.153	Rice fields
0.154 to 0.589	Inundation area
0.590 to 1.00	Water body and river



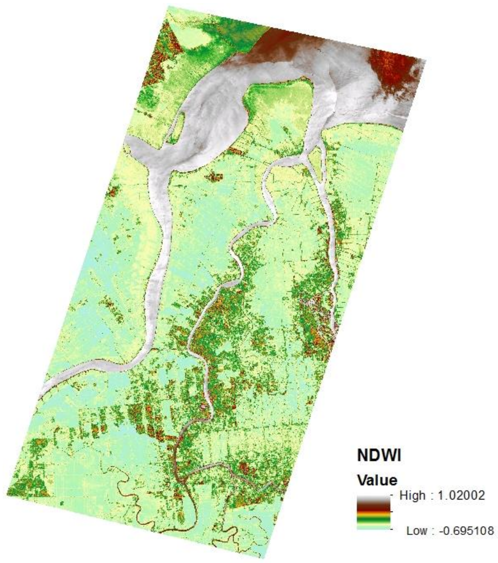
(3a) Tasseled Cap Brightness



(3b) Tasseled Cap Greeness



(3c) Tasseled Cap Wetness



(3d) NDWI value

Figure 3. Interpretation characteristic of Lowland using TCT and NDWI

4. CONCLUSION

Remote sensing techniques can be used to interpreted lowland characteristics. Lowland characteristics are strongly influenced by the presence of water, to determined the moisturity of the lowland area could be done by using the approach value of NDWI and TCW. Areas with high density (NDVI values is high) will have high moisturity (NDWI value is high) but areas with low vegetation densities will have NDWI values is low.

NDVI values for vegetated areas have spectral values between 0.214 and 0.883, while residential and industrial areas have a spectral value of 0.0842 to 0.214, and aquatic area has a spectral value between -0.803 to 0.0842. The settlement area has a NDBI greater than 0.3. While the innudation area and river have NDWI values between 0.154 to 1.00. Analysis by TCT (Tasseled Caps Transformation) showed the brightness value indicates the built up area, the result of the interpretation indicates that in the Tanjung Api- Api area has occured conversion of wetlands used for agriculture and plantation, while for the settlement is lower than vegetation area

Land use/ Land Cover (LULC) in Tanjung Api-Api area is dominated by vegetation consist of mangrove forest, plantation, rice field, agriculture and shrubland. Tanjung Api-Api areas have high vegetation density but the built up areas is low, so the area has high of moisturity.

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