Mapping the Distribution of Potential Land Drought in Batam Island Using the Integration of Remote Sensing and Geographic Information Systems (GIS)

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Abstract. Potential land drought mapping on Batam is needed to determine the distribution of areas that are very potential to the physical drought of the land. It is because the drought is always threatening on the long dry season. This research integrates remote sensing science with Geographic Information System (GIS). This research aims to map the distribution of land drought potential in Batam Island. The parameters used in this research are land use, Land Surface Temperature (LST), Potential dryness of land on the Batam island. The resulting map indicates the existence of five potential drought classes on the island of Batam. The area of very low drought potential is 2629.45 ha, mostly located in the Sungai Beduk sub-district. High drought potential with an area of 7081.39 ha is located in Sekupang sub-district. The distribution of very high land drought potential is in Batam city and Nongsa sub-district with area of 15600.12 ha. The coefficient of determination (R^2) is 0.6279. This indicates a strong positive relationship between field LST and modelled LST.

Keywords: Land Drought, Land Surface Temperature, Remote Sensing, GIS

1. Introduction

Geographically, Batam island has a very strategic location, namely in international shipping line. Batam City based is located between: - 0º 25' 29 "N - 1º 15' 00" N and 103º 34' 35" E - 104 º 26' 04"E. Today, drought is increasingly common annually under normal climate conditions. Drought is the availability of water far below the water requirement for the necessities of life, agriculture, economic and environmental activities (Law number 24 year 2007 in disaster management). The problem of water existence in the earth is divided into two main categories, namely the advantages and lack of water [1]. Previous research related to drought potential has been done by [2], by utilizing remote sensing and Geographic Information Systems (GIS) technique. The variables used were vegetation index, brightness index, wetness index, rainfall, hydrogeology and land use map. Next research was done by [3] on integrating remote sensing technique and GIS for potential identification of drought, and revealed that clay rock is one example of rock that has high porosity, but have low permeability, so that the clay rocks have high humidity, but the wells in the rock has 4 low potentials.

Mapping the distribution of land drought potential using Landsat-8 OLI remote sensing imagery with Temperature Vegetation Dryness Index (TVDI) method. The main parameter used to find the potential of land drought is NDVI (Normalized Difference Vegetation Index) which is used to get the level of vegetation density in the research area and LST (Land Surface Temperature) to know the amount of temperature contained in the land is very good to determine the distribution of drought in a region [4,5]. The key elements of drought monitoring and forecasting system using GIS and remote sensing techniques can also be made by providing real-time water cycling of near-terrestrial water and assessment of drought conditions in the field [6,7]. The combination of multi-temporal remote sensing data for drought monitoring for different months in a year or a month in different years, shows significantly varying locations of drought areas, indicating seasonal and seasonal fluctuations, and the use of remote sensing and GIS techniques [8-10] continues to be sustainable, and further enhances the level of accuracy of multispectral data [11]. This research aims to map the distribution of land drought potential in Batam Island, and assess the relationship between land surface temperature of Land Surface Temperature (LST) measured in the field and modelled LST value from Landsat-8 OLI. The parameters used in this research are land use, and LST.

2. Methods

2.1. Research location

This research location was on Batam Island (1º05' N 104º02' E) using Landsat-8 OLI recorded on April 2016, the image was obtained by downloading through the www.earthexplorer.usgs.gov. Stages of digital image processing were image cropping, radiometric correction, geometric correction, image composite and image transformation. While the parameter processing was done by scoring, and layout was done using ArcGIS 10.2 software, that produced a map of potential drought in Batam Island. The research location map, produced by Development Planning Agency at Sub-National Level (BAPPEDA), can be seen in Figure 1, and the research flow chart can be seen in Figure 2.

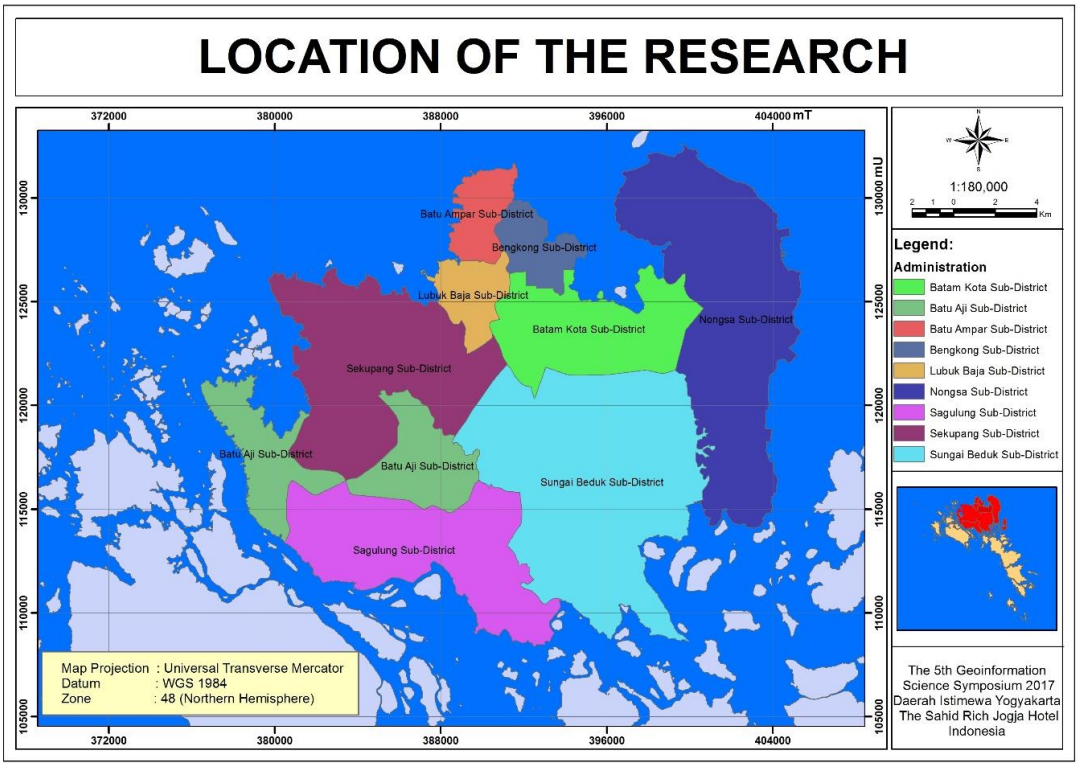

Figure 1. Research location in Batam island, Indonesia

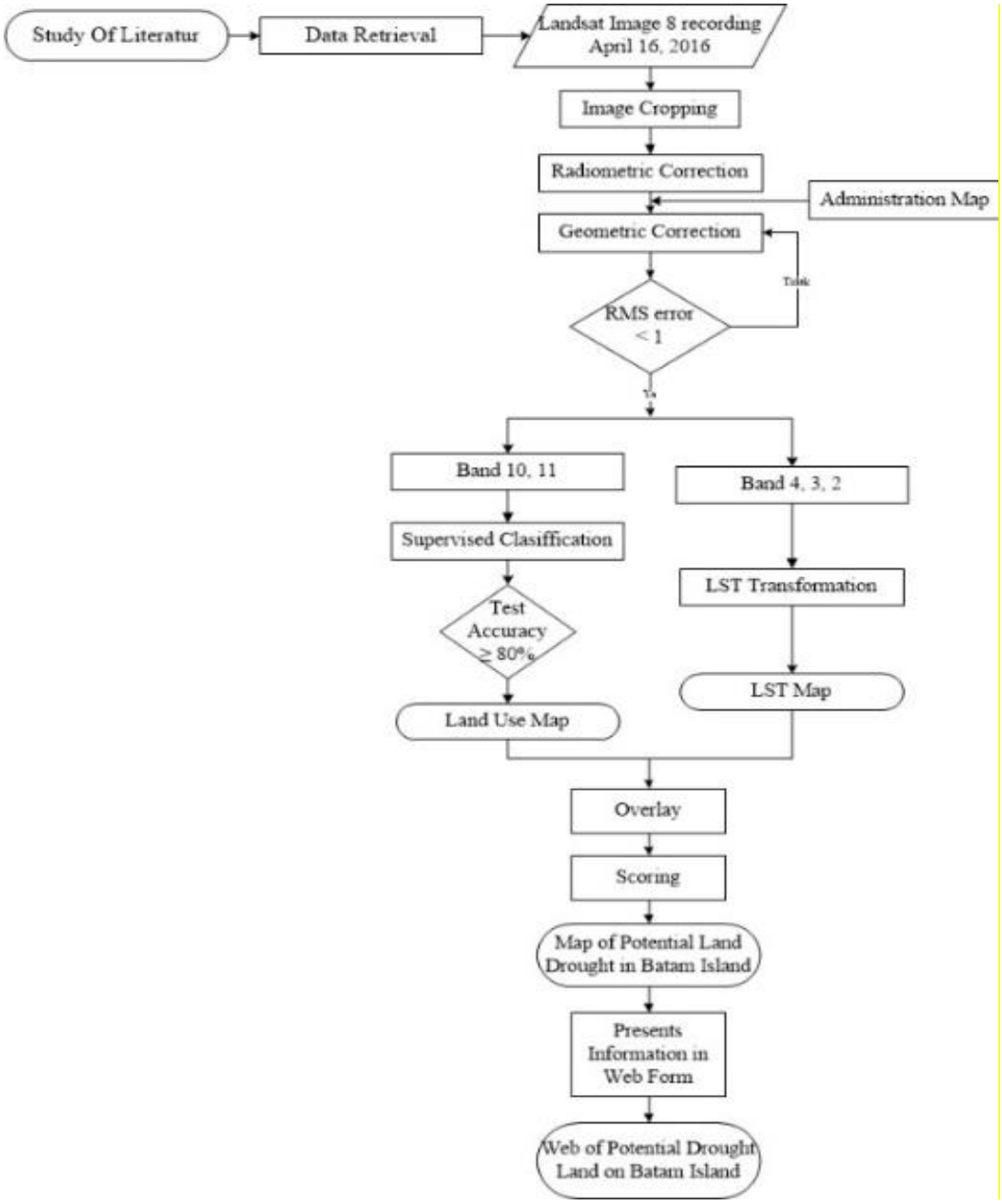

Figure 2. Flow Diagram of Research

2.2. Land Surface Temperature (LST)

Image processing of Landsat-8 OLI to obtain LST value was done using the following steps (Figure 3):

1. Converts the Digital Number (DN) of bands 10 and 11 into the spectral radiance via radiometric calibration.
2. Converts spectral radiance to brightness temperature in Kelvin unit.
3. Change the brightness temperature unit from K to Celcius.

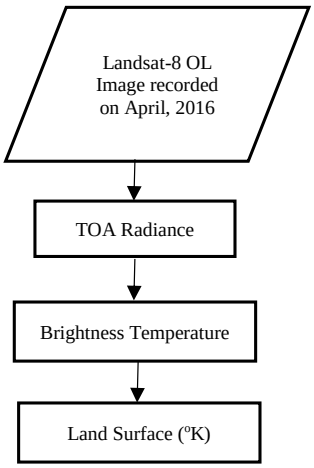

Figure 3. Flowchart of obtaining LST using Landsat-8 OLI

2.3. Land Use Map

The processing of land use map started by collecting data from the related institutions. Then, the data or map was digitized to produce the shapefile (vector data), performed attributes editing, and performed the scoring process. The map that has been scored on the basis of the impact of land use on land drought was selected as final map. Flowchart of land used data processing can be seen in Figure 4.

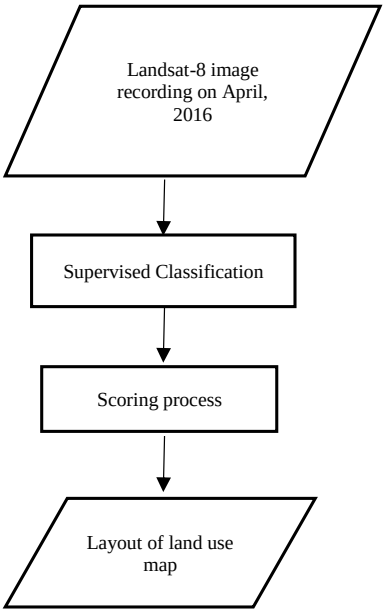

Figure 4. Flowchart of land use processing

3. Results and Discussion

Map of potential land drought is a map derived from the processing of data/parameters that affect the drought of the land. Parameters used in processing drought potential maps are land use map, and surface temperature map/LST [12-14]. The weight and scoring process of each parameter is different.

Based on the accumulated score of the parameters that affecting the drought, the categories for potential land drought class were obtained as shown in Table 1.

Table 1. Category of potential land drought

Map	Category	Score	Area (Ha)	Percentage (%)
Land Drought Potential	Very Low Drought Potential	30 – 40	2629.45	5.92
	Low Drought Potential	41 – 51	9585.52	21.59
	Medium Drought Potential	52 – 62	9507.12	21.41
	High Drought Potential	63 – 73	7081.39	15.95
	Very High Drought Potential	74 – 84	15600.12	35.13

Based on Table 1 the percentage of each class of potential land drought can be seen. The area of very low drought potential class 2629.45 ha, distributed mainly in Sungai Beduk, Sekupang, and Batu Aji district. Low drought potential class has an area of 9585.52 ha, mostly distributed in Sekupang sub-district. Medium drought potential class has an area of 9507.12 ha, with the dominant location in Sekupang District. High drought potential class have the area of 7081.39 ha, distributed in Sekupang, Sagulung, and Nongsa Sub-district, and. very high drought potential class has an area of 15600.12 ha, with located mostly in Batam City and Nongsa sub-district. Based on the analysis of land use scoring and LST, a map consisting of five drought potential classes was generated. Map of Potential Land Drought in Batam Island 2016 can be seen in Figure 5.

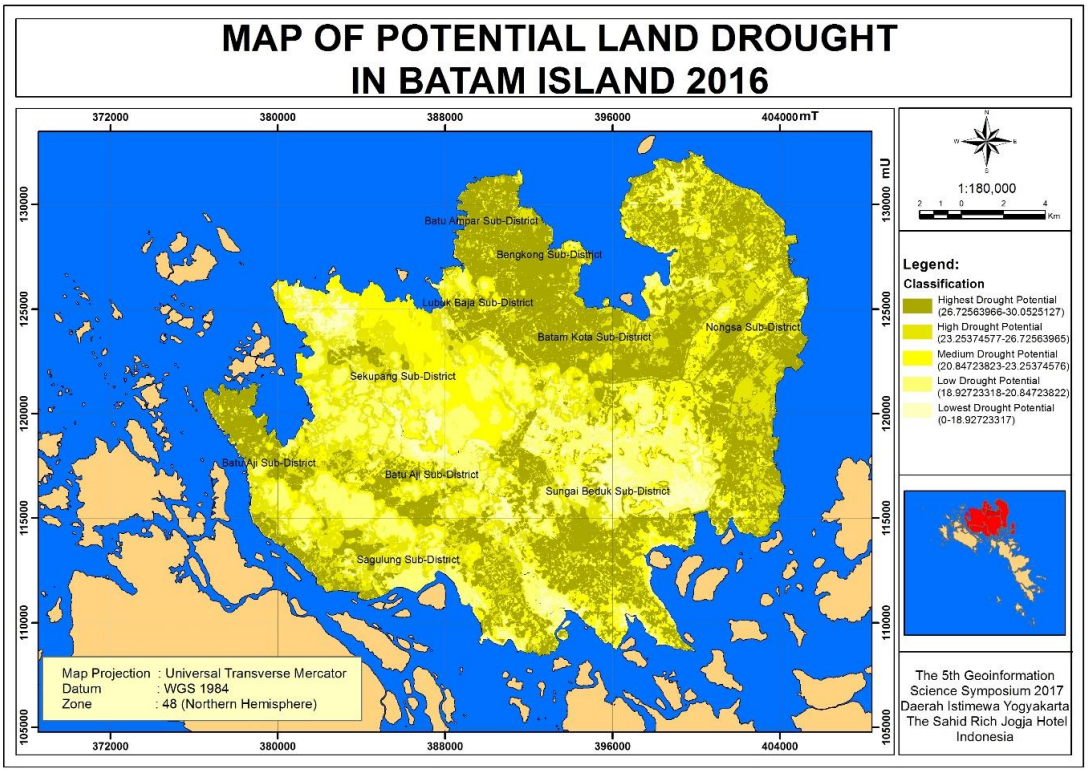

Figure 5. Map of Potential Land Drought in Batam Island 2016

Figure 5 gives information on the distribution of the potential land drought in Batam Island 2016. The map has five classes with different areas. In general, the Batam Island has a very high drought

potential, as characterized by the red colour. The potential of land drought is similar to previous research conducted in Natuna, Riau Islands (Put the source here). In this research, field validation was also done to find out the relationship of LST from the Landsat-8 OLI with field LST. Sampling points were randomly taken, which represented each of the existing drought potential class. The sample collected in the field is 30, and it can already represent the variation of the entire Batam Island. The distribution of sample point for validation of field temperature can be seen in Figure 6, and scatter plot between field LST and LST value from Landsat-8 OLI image can be seen in Figure 7. Coefficient of determination (R^2) is 0.6279 and indicates a positive strong relationship between field and modelled LST. If indicates a positive relationship between LST image with temperature in the field, it will affect the value of surface temperature is very perpendicular and real to the research location using remote sensing techniques, as a parameter to determine the distribution of drought distribution, settlement and vegetation of land in a region [15-19].

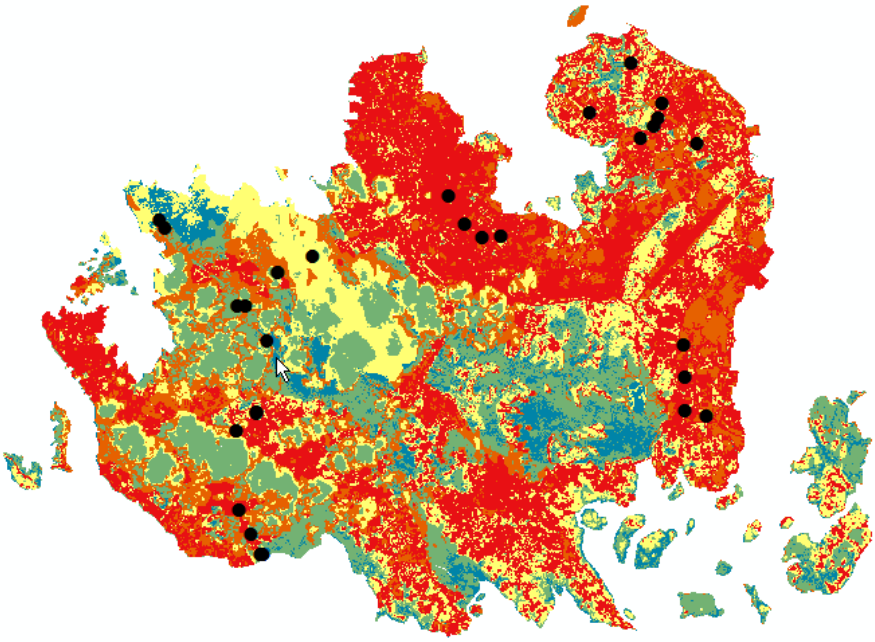

Figure 6. The distribution of sample points for validation of field temperature in Batam Island 2016

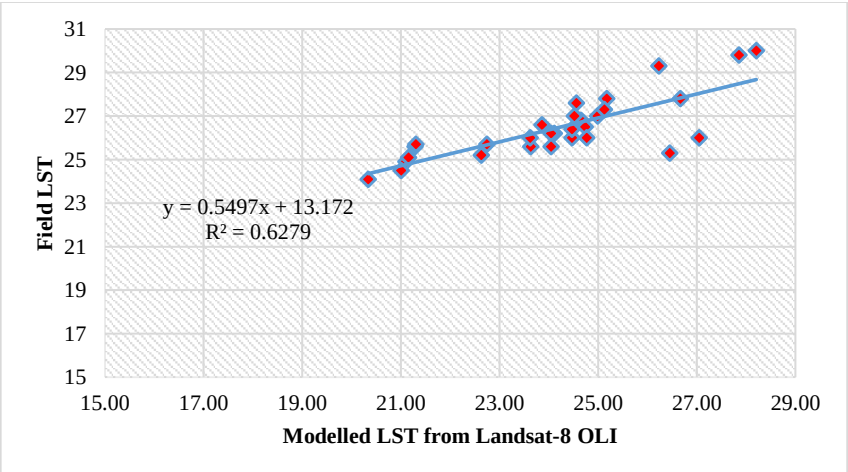

Figure 7. Scatter plot between field LST and LST values from Landsat-8 OLI image

4. Conclusions

Research on mapping the potential of drought on the island of batam resulted in five classes of potential drought lands from highest drought potential, high drought potential, medium drought potential, low drought potential and lowest drought potential. The highest drought potential was located on Batam City and Nongsa Sub-District.

Acknowledgments

We would like thank to Development Planning Agency at Sub-National Level (BAPPEDA) who has been willing to provide shapefile data and administration map of Batam City, Indonesia.

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