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UTILIZATION OF IMAGE SENTINEL-1 SAR FOR IDENTIFICATION OF FLOOD DISTRIBUTION AREA In PANGKALAN KOTO BARU SUMATERA DISTRICT

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ABSTRACT: This research was conducted to determine the flood distribution area in Pangkalan Koto Baru District. Using the Normalized Difference Sigma Index (NDSI) method. By using this remote sensing method, it is possible to identify the flood distribution areas in Pangkalan Koto Baru District on March 15 2017.
In this study, the identification of flood distribution areas using Sentinel-1 satellite imagery data. The sentinel-1 image data needed is before the flood (20 February 2017) and at the time of the flood (15 March 2017). Furthermore, Sentinel-1 Image processing begins with a subset, some radiometric corrections and geometric corrections. The Normalized Difference Sigma Index (NDSI) method is used to identify the flood distribution which is then vectorized.
The results of the study have taken that based on the results of flood analysis using the GIS technique the area identified as flooding in this study is 41561.172 Ha. In Nagari Tanjuang Pauah it is ± 2454.301 Ha, Nagari Tanjuang Balik is ± 2076.138 Ha, Nagari Pangkalan is ± 14765.141 Ha, Nagari Mangilang is ± 917.724 Ha, Nagari Koto Alam is ± 8361.579 Ha, and Nagari Gunuang Manggilang is ± 917.724 Ha.

Keywords: Flood Distribution, Sentinel-1 Satellite Image, Remote Sensing..

1. INTRODUCTION

The use of remote sensing for flood monitoring dates back to the 1970s, when data from Landsat 1 helped analyze the 1973 Mississippi flood (Deutsch and Ruggles, 1974). Since then, scientists have continued to use satellite data as an additional source for several reasons, such as the detection of change, or mapping of flooded areas (Green et al. 2007).

Sentinel-1 is the first Copernicus Program satellite constellation commissioned by the European Space Agency. The mission consists of a constellation of two satellites orbiting the sky, namely Sentinel-1A and Sentinel-1B, which share the same orbital plane. Both carry a C-band synthetic aperture radar instrument that provides data collection in any weather, day or night. The instrument has a spatial resolution of up to 5 m and swaths of up to 400 km providing dual-polarization capability, very short return visit times and fast product delivery. The constellation is in a sun-synchronous orbit, near the poles (98.18°). The orbit has a repeating cycle of 12 days and completes 175 orbits per cycle. The first satellite, Sentinel-1A, was launched on 3 April 2014, and Sentinel-1B was launched on 25 April 2016. The two satellites took off from the same location in Kourou, French Guiana, and each carried a Soyuz rocket. Sentinel- 1C and 1D are in development with a launch date to be determined.

Flood disasters can cause enormous losses to settlements, the economy and the environment, and even loss of human lives. (Andersen and Marshall Shepherd, 2013). An area is said to be prone to flooding if the area is frequently flooded, usually in lowland areas, close to large rivers and has poor drainage.

Pangkalan Koto Baru is a sub-district located in Fifty Cities District, West Sumatra Province, with the capital city of Pangkalan Koto Baru village. Its area is 785.2410 km2 which means it is 23.62% of the area of Fifty Cities Regency which covers 3323.9846 km2. The boundaries of the Pangkalan District are bordered by the North with the Regency

Kampar Riau, South with Harau District, West with Pangkalan Koto Baru and Bukit Barisan Districts. This sub-district has many rivers which have been widely used by the community as a source of water for irrigation, bathing and washing, fishing, sources of C excavation and as a means of transportation using boats to bring gambier and rubber products.

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2. THE METHOD

1. Subset

Subset or image cropping is used to crop the Sentinel-1 Image, this image cropping process is carried out by selecting the area to be researched, namely Pangkalan Koto Baru District, West Sumatra.

2. ***Apply Orbit File***

Apply orbit file, this process is required to update orbit metadata on Sentinel-1 Imagery (Fernandes, 2018). Orbit state vectors contained in product metadata information, are generally inaccurate. The exact orbit of the satellite is determined after several days to several weeks after product generation.

3. ***Thermal Noise Removal***

Sentinel-1 image intensity is disturbed by thermal noise, especially in cross-polarized channels. The thermal noise removal function reduces the effect of noise in textures between sub-plots, in particular, and normalizes the backscattering signal in the entire Sentinel-1 scene. Sentinel-1 product level-1 provides a look-up noise table (LUT), for each measurement data set, which is provided in linear power used to obtain product noise calibrated according to GRD data (Filipponi, 2019).

4. Calibrate

The Calibrate function to get good data, SAR data needs to be calibrated. Calibration is the procedure used for radiometric correction of Sentinel-1 images, by correcting pixel values that truly represent radar backscattering from the reflected surface. A calibration vector is included as an annotation in the product which allows simple conversion of image intensity values into sigma-naught, gamma-naught or beta-naught values (Fernandes, 2018).

5. Speckle Filtering

Speckle Filtering is a process to improve image quality by eliminating speckles. To improve Sentinel-1 Image quality several speckle filter methods can be used, namely Boxcar, Median, Frost, Lee, Refined Lee, Gamma-MAP, Lee Sigma and IDAN. This study uses the speckle filter Lee method. Lee's method is based on Minimum Mean Square Error (MMSE) and geometric aspects.

6. ***Terrain Corrections***

Terrain Correction or geometric correction used in this study is the Range Doppler Terrain Correction method. Range Doppler Terrain geometric correction implements this orthorectification method for SAR geocoding of radar geometry so that projected results are obtained. Geocoding converts images from Slant Range or Ground Range Geometry into a map coordinate system. Geocoding Terrain involves using a Digital Elevation Model (DEM) to correct built-in SAR geometry effects such as foreshortening, layover, and shadows (Veci, 2019).

$$\mathrm{NDSI} = \frac{\sigma_0^m - \sigma_0^s}{\sigma_0^m + \sigma_0^s}$$

Information :
σ0 is sigma naught

m is the master and
s are slaves.
After that the formula was applied using SNAP software with the Band Maths toolbox.

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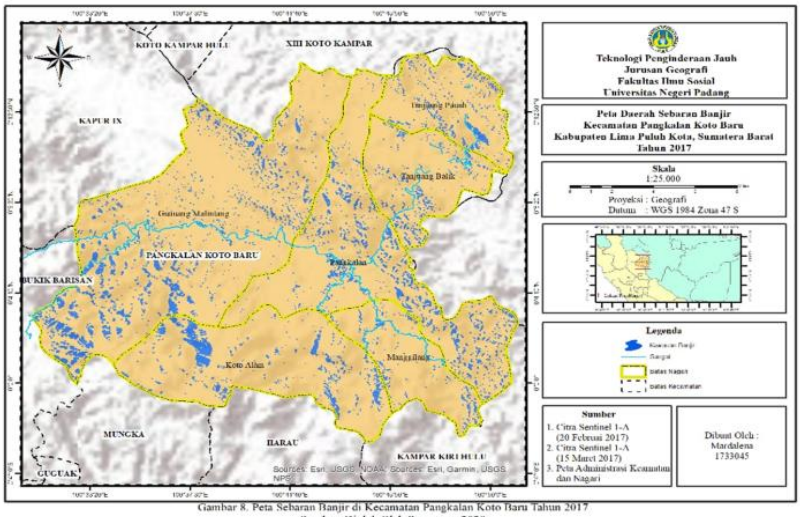
3. DISCUSSION RESULT

1. Map of Flood Distribution in Pangkalan Koto Baru District

The following is a map of the distribution of floods in Pangkalan Koto Baru District, Fifty City District on March 15 2017.



Gambar 8. Peta Sebaran Banjir di Kecamatan Pangkalan Koto Baru Tahun 2017
Sumber: Diolah Oleh Penyusun, 2020

Fig. 1. distribution of floods in Pangkalan Koto Baru District,

Based on indicators that can be indicators of the causes of flooding that can be detected by Sentinel-1 satellite imagery are as follows:

a. River Flow Density

In the sentinel-1 image that has been processed it is very clear the shape of the watershed in the image is. River flow density describes the water storage capacity of a watershed.

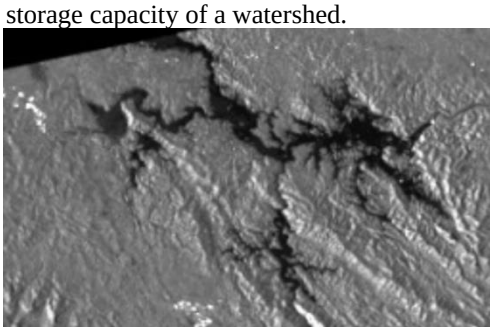


Fig. 2 sentinel-1 image

b. elevation

In the Sentinel-1 image that has been processed it is very clear the shape of the elevation or the size of the location's height is above sea level. Altitude influences the occurrence of floods. The following is the shape of the elevation on the processed Sentinel-1 image.

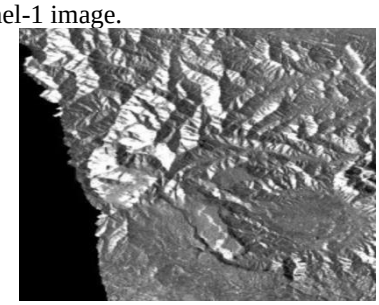


Fig. 3 sentinel-1 image process

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c. Structural landform (S)
Is a large group of landform units that occur due to the strong influence of geological structure. Shaped hills or layered. For example hills, folds, and faults.

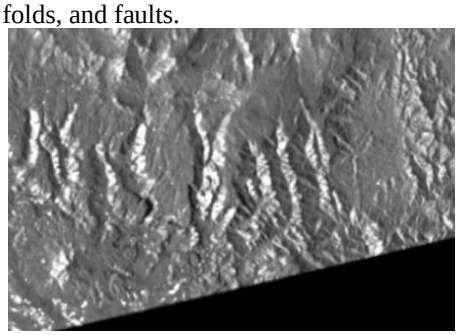

Fig. 3 sentinel-1 image landform

d. Fluvial landform (F)
In the processed Sentinel-1 image, the fluvial landform is very clear. Fluvial landforms are a large group of landform units that occur as a result of river activity. Has an elongated pattern, and irregular shape.

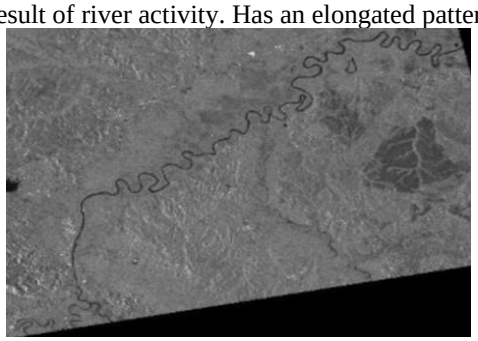

Fig. 4 sentinel-1 image Fluvial landform

e. Denudational landform (D)
Is a large group of landform units that occur as a result of degradation processes such as landslides and erosion. Examples of these landform units include remnant hills and river valleys.

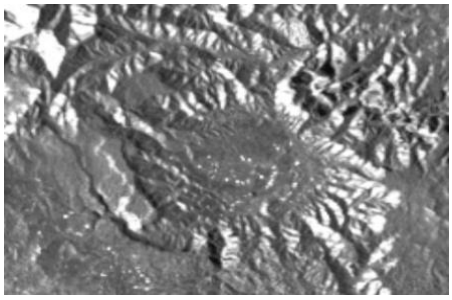

Fig. 5 sentinel-1 image Denudasional landform

2. Flood Distribution Area

Identification of the location of the flood using the area calculation method using the calculate geometry menu. Area calculation method using calculate geometry by utilizing attribute data in Arcgis 10.3.1 (Use the Coordinate System according to the data, namely WGS 1984 UTM Zone 47S, and in Units use Hectare (ha) Hectare). The following is the area of flooding in the Pangkalan Koto Baru sub-district on March 15 2017

Table 1 Identification of the location of the flood

No	Nagari Name	Area (Ha)	Area Affected (Ha)	Percentage of Affected
1.	Tanjuang Pauah	6421,472	2454,301	38,22 %
2.	Tanjung Balik	6960,453	2076,138	29,82 %
3.	Pangkalan	16513,677	14765,141	89,41 %
4.	Manggilang	5845,177	917,724	15,70 %
5.	Koto Alam	13381,028	8361,579	62,48 %

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6.	Gunuang Malintang	29402,295	12986,289	44,16 %
	Total	78524,102	41561 ,172	52,92%

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Based on the research of this final project, the Pangkalan Koto Baru sub-districts that were most widely affected by the floods on March 15 2017 were Nagari Pangkalan, Nagari Koto Alam, Nagari Gunuang Malintang, Nagari Tanjuang Pauah, Nagari Tanjuang Balik and Nagari Mangilang.

The results of image processing in SNAP were previously inputted into the ArcGIS 10.3.1 software. Then processing is carried out to change the file format to a vector shapefile to calculate the area of the attribute that each image classifies as the area of a puddle in that image. The results are obtained as follows:

a. Body of Water Date 20 February 2017

The results of the extraction of flood inundation in the image on February 20 2017 show that the extracted water body vector pattern only appears to follow the flow pattern of the river which does not overflow and is by the river network. The area for water bodies on February 20 in the research focus area is 26.18 Ha.

Fig. 6 Date Permanent Water Body Appearance
20 February 2017

b. Body of Water March 15, 2017

The results of the extraction of flood inundation in the image on March 15 2017 show that the vector pattern of water bodies extracted from the river flow is very visible, overflow or inundation which is identified as a flood inundation. The area for water bodies on March 15 in the research focus area is 76.22 Ha.

Fig. 7 The appearance of a Body of Water During a Flood March 15, 2017

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The validation related to the flood disaster in Pangkalan Koto Baru District obtained is as follows:

1. Base Police

Fig. 8 The Appearance of the Base Police in a Flood

Fig. 9 The appearance of the Base Police in 2020

4. CONCLUSION

Based on the results of a study on the flood distribution area in Pangkalan Koto Baru District, Fifty Cities District, several things can be concluded, including the following:

1. Two Sentinel-1 Image data are needed to perform this method as a comparison, one time when there was no flood on February 20 2017 and one time when a flood occurred on March 15 2017. The data processing on Sentinel-1 Image in SNAP Software, namely Subset, Apply Orbit File, Thermal Noise Removal, Calibrate, Speckle Filtering, Terrain Correction, and Coregistration. Using the Normalized Difference Sigma Index (NDSI) method with a change index value in the math band of 0.69 which is the middle value.
2. The area identified as flooding in Pangkalan Koto Baru District on March 15 2017 in this study was 41561.172 Ha. In Nagari Tanjuang Pauah it is ± 2454.301 Ha, Nagari Tanjuang Balik is ± 2076.138 Ha, Nagari Pangkalan is ± 14765.141 Ha, Nagari Mangilang is ± 917.724 Ha, Nagari Koto Alam is ± 8361.579 Ha, and Nagari Gunuang Malintang of ± 12986.289 Ha
3. The most extensive flood-affected areas were Nagari Pangkalan (89.41% of the area of the village), Nagari Koto Alam (62.48% of the area of the village), Nagari Gunuang Malintang (44.16% of the area of the village), Nagari Tanjung Pauah is (38.22% of the Nagari area), Tanjung Balik Nagari is (29.82% of the nagari area), and Nagari Manggalang is (15.70% of the nagari area)..

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