



## Optimization of Remote Sensing Data In Monitoring Morphology Change of Siak River in Pekanbaru City

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**Abstrak:** Kondisi sungai yang mengalami perubahan tidak terlepas dari pemanfaatan sempadan sungai untuk kebutuhan hidup manusia. Selain pengaruh pengembangan lahan terbangun, perubahan morfologi sungai karena pengikisan dan pengendapan. Oleh karena itu diperlukan pendeteksian perubahan morfologi sungai salah satunya dengan memanfaatkan data penginderaan jauh dengan *Modification Normalized Difference Water Index*. *Modification Normalized Difference Water Index* dapat memisahkan antara air dan daratan secara tajam hingga analisis morfologi sungai dapat lebih jelas. Penelitian ini bertujuan untuk mendeteksi perubahan morfologi Sungai Siak di Kota Pekanbaru akibat *cut bank* dan pengendapan dengan menggunakan *Modification of Normalized Difference Water Index* pada data temporal landsat tahun 2008 dan 2018. Data yang digunakan dalam penelitian ini adalah citra Landsat 7 tahun 2008 dan Landsat 8 tahun 2018. Hasil penelitian menunjukkan bahwa perubahan morfologi Sungai Siak di Kota Pekanbaru disebabkan oleh *cut bank* dan *point bar*. Luas *cut bank* mencapai 12.133 ha dan *point bar* 4.488 ha dalam kurun waktu 10 tahun.

**Abstract:** *River condition that experiences change is not apart from the utilization of river boarder for human life needs. Beside the effect of built land development, river morphology changes because of cut bank and point bar. Therefore, it needs detection of river morphology change, one of which is by utilizing remote sensing data with Modification Normalized Difference Water Index. Modification Normalized Difference Water Index can separate between water and land sharply until river morphology analysis can be clearer. This research aims to detect the change of Siak River morphology in Pekanbaru City caused by cut bank and point bar by using Modification of Normalized Difference Water Index on landsat temporal data of 2008 and 2018. Data used in this research were Landsat 7 image of 2008 and Landsat 8 year of 2018. The research results show that morphology changes of Siak River in Pekanbaru City is caused by cut bank and point bar. The cut bank area reaches 12.133 ha and point bar 4.488 ha in the period of 10 years.*

## 1. Introduction

Based on the form, river is classified into old river, adult river, and young river. First, young river is the initial form of river flow, with the flow formed in the land surface by irregular water flow and consists of some parts. Certain part is easily eroded and another part is not easily eroded. Second, adult river is the next development of young river, with traits the river's valley is quite wide, the riverbed slope is relatively flat, and the cliff formation is formed of cliff slide result upstream side. The material condition of river base is formed of graded material the result of sediment. While the third, old river is the next development of adult river. As the cause of erotion process and continuous sedimentation, the river's

valley is formed with river's width becomes wider and the riverbed slope becomes more sloping (Anggraini et al., 2017). While the river morphology is the size and form of the river as the reaction result towards hydraulics condition from the flow (Umar et al., 2017; Umar, 2019). Until the river will always adjust its size and form either geometrically or riverbed roughness.

The condition which continuously increases the population number causing river da maged and exploitation occurs towards river for the importance of human life (Giofandi et al., 2019; Giofandi et al., 2020). The effect of river morphology change has occurred since the river itself formed and continuously occur (Umar, 2018; Umar et al., 2019; Sekarrini et al., 2020). Morphology change will occur rapidly if there is change of land use with all aspects and changes in the space and time dimension (Kurniawan et al., 2017). Changes influence water activity which flows to the surface, the river that develops by itself reaches balance influenced by flow variable, sediment, and size and distribution of bed load (Umar & Dewata, 2018; Umar, Dewata, Barlian, et al., 2019).

The presence of river area is pivotal such as for building plan activity and protection of the riverside area (Umar et al., 2016; Sekarrini, 2020; Hasmita et al., 2020). One of river boarder area that mostly experiences river morphology change is Pekanbaru City, Riau Province. Therefore, more attention is required to find out the location of river boarder which experiences the river morphology change. One of which is by conducting detection by using remote sensing technology (Umar, 2017; Umar, 2018a).

One of satellite images which can be used to detect morphology change or landscape of earth surface is Landsat satellite. The Landsat satellites that are still available such as Landsat 5, Landsat 7, and Landsat 8 (Giofandi & Nizam, 2018; Safitri & Giofandi, 2019). One of remote sensing usages is for monitoring the change of coastline similar to monitoring the change of river morphology as conducted by (Arief et al., 2011) who made coastline of Kendal Regency by using Landsat temporal data through the method used namely RGB visual and on screen digitizing; (Anggraini et al., 2017) conducted the research related to monitoring Ujung Pangkah coastline on Landsat 7 and Landsat 8 data through visual interpretation, Edge Detection, Normalized Difference Water Index, and overlay analysis; (Daim et al., 2015) monitored the speed of Kampar River morphology change by using some methods namely visual interpretation, on screen digitizing, composite image, and overlay analysis. This research focuses on discussing the aspect of Siak River morphology change and the interpretation method of remote sensing until from these backgrounds then this research aims to find out the distribution of cut bank and point bar through applied of geographic information systems with the methods of Modification of Normalized Difference Water Index transformation for the period of 10 years.

## **2. Materials and Methods**

The Main data used in this research method were Landsat 5 image path 127 and row 60 recording 8th of April 2008 and Landsat 8 image path 127 and row 60 recording of August 26, 2018. Data obtained were free of charge by downloading them at December 13th 2021 through United States Geological Survey (USGS) site namely [www.earthexplorer.usgs.gov](http://www.earthexplorer.usgs.gov). To analyze the river morphology change, Modification of Normalized Difference Water Index (MNDWI) based management technique was used then on screen digitizing and analysis of image overlapping were conducted on the image of 2008 and 2018.

### **2.1 Modification of Normalized Difference Water Index**

MNDWI method is the modification result of Normalized Difference Water Index (NDWI) method. This method used MIR band wavelength (1565-1655  $\mu\text{m}$ ) more as the substitute of NIR band wavelength (785-900  $\mu\text{m}$ ) in the previous method. The water reflection will have bigger positive value than in NDWI because of absorbing more MIR light than NIR, the built land will have negative value as mentioned above; and the land and vegetation will remain having negative value because the land reflects more MIR light than NIR (Jensen, 2015).

Contrast between water and built land will strongly be enlarged because of the increasing value from water feature and decrease of build land value from positive to negative, the water increase is bigger than MNDWI image will result more accurate extraction of open water feature as the build land, soil, and

vegetation all negative values and therefore they were pressed and omitted (Xu, 2006). The formula used to detect the water body is:

$$MNDWI = \frac{G - MIR}{G + MIR} \quad (1)$$

Description:

MNDWI = Vegetation Index

G = Band Green

MIR = Band Middle Infra Red

Sumber (Xu, 2006)

### 3. Result and Discussion

Based on the result of data processing of Landsat 5 and 8 image, it clearly shows the area of Pekanbaru City, mainly related to the city development is seen rapid through the visual appearance in a true colour image is the combination of the red, green, and blue bands. This is also in line with the findings by (Giofandi & Sekarjati, 2020) The city existence with buildings in the city center makes effect towards its surrounding mainly when found the presence of puddle then the water will dry and evaporate quickly.

Figure 2 explains the information related to MNDWI result started from year of 2008 and 2018 which displays the appearance of Siak river in administration Pekanbaru City. The cloud condition was thick it can minimize its appearance which displays sharper information related to the appearance in the cloud. At the east part of Siak River flow in 2008 covered half of flow surface which makes the information extract process of river surface was not optimal. If seen from the visual display either true color display or identified transformation result, it cannot eliminate the cloud thickness thoroughly. In the appearance of year of 2018 with minimum satellite image condition then the cloud displays more detail information, seen the information related to the water and land is clearly seen different. The value of mndwi spectral wave in 2008 obtained higher value namely 0,469 with lowest value around -0,450, then in 2018 resulted lower value with peak value 0,430 until -0,488. The appearance of Siak river area is seen clearly at the river bank with its left and right without being closed by the land usage on it, while for the area of Danau Buatan (Artificial Lake), it can be seen sharply and clearly.

The information related to figure 3 explains the river flow in the form of meander which has arch length, the river that has regular bend (more or less) forming sinus function in its plain field. This causes river flow moves horizontally because there is river cut bank by the main water flow on the outer side of bend and point bar. If this condition continuously occur, it will cause the river flow getting crooked and makes meander will experience changes and movement. Certain bend condition on the river meander is disconnected and will become puddle of former river which forms oxbow lake (Sutikno et al., 2016).

Figure 4 explains the information related to the presence of location distribution point bar and cut bank for 10 years, data of year 2008 and 2018 in the last overlay was analyzed until the above information obtained. In conducting the cut bank analysis was at the bend of river flow that was dissolved will be carried and deposited at lower place such as river valley, estuary, and other lower places. Big or small cut bank, strong or weak cut bank is highly affected by some natural factors such as the slope of vegetation condition or the plant volume and water speed. The cut bank process can cause the decrease of land productivity, land support, and quality of living environment. The distribution of cut bank occurrence is divided into 5 segments signed by red color and to see the large of cut bank is in table 1 in which it reaches 12.133 ha.

Then in the analysis, point bar is at river bend flow. This is accumulated from the material the result of river flow transportation progressively carried in the riverbed or in other river body. The point bar speed is affected by some variables namely material dimension, item distribution, mass, form, water viscosity, point bar speed, and endurance towards cut bank. Table 1 gives information related to the point bar large for the period of 10 years reaching 4.488 ha, point bar land is getting dense and large causing the increase of riverbed, then causing high water surface making the river wider even it can cause flood.

#### 4. Conclusion

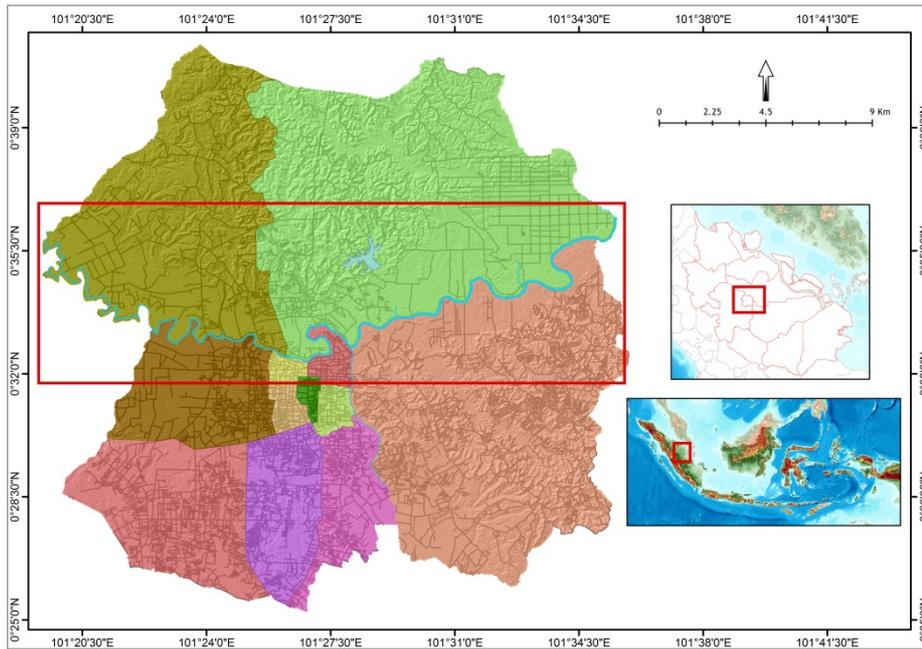
The result of processing remote sensing data shows the presence of significant river morphology change. The filter of Modification of Normalized Difference Water Index can be used to detect the dynamics either river morphology change, besides it experiences cut bank reaching 12.133 ha and point bar 4.488 ha in the period of 10 years. Condition strong or weak cut bank is highly affected by some factors such as the slope of vegetation condition or the plant volume and water speed. The cut bank process can cause the decrease of land productivity, land support, and quality of living environment. While point bar speed is affected material dimension, item distribution, mass, form, water viscosity, and point bar speed which is getting dense causing high water surface.

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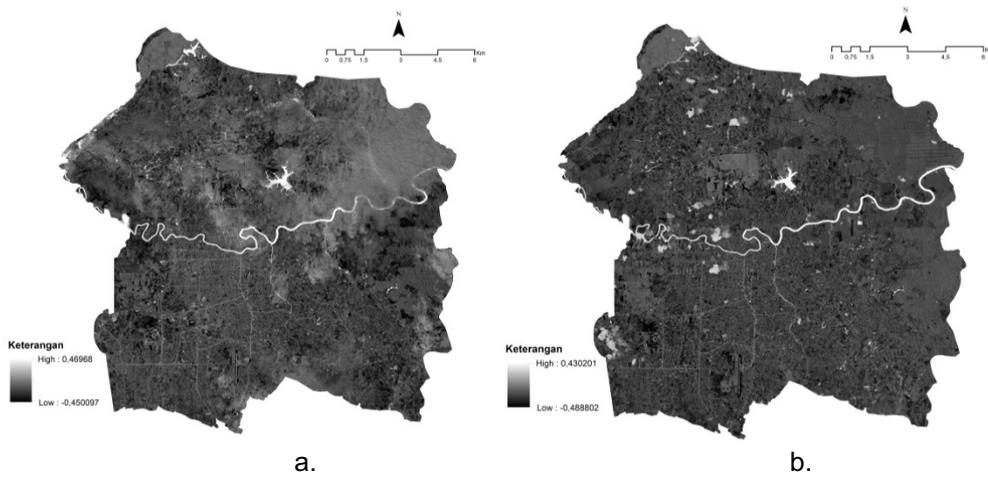
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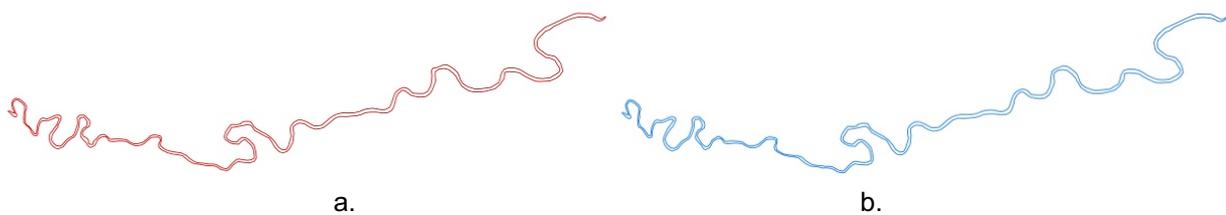
**Figures and Tables used in the article**



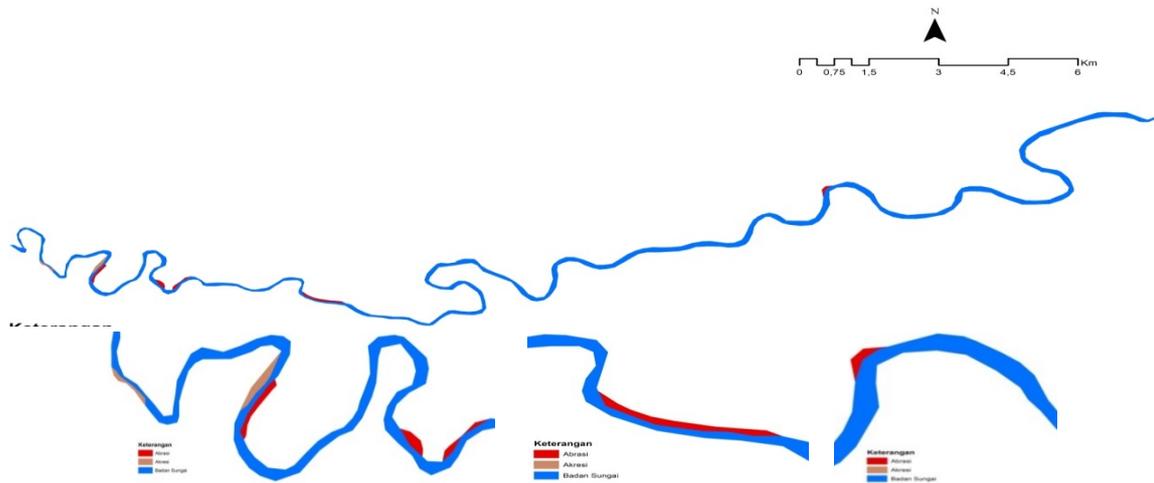
**Figure 1.** Research site



**Figure 2.** a.MNDWI year of 2008 b.MNDWI year of 2018  
(Source: Analysis, 2021)



**Figure 3.** a. River shape of year 2018 b. River shape of year 2008  
(Source: Analysis, 2021)



**Figure 4.** The distribution map of point bar and cut bank for 10 years  
(Source: Analysis, 2021)

**Table 1.** The large of point bar and cut bank of Siak River

Period	Cut bank	Point bar
2008 – 2018	12.133 ha	4.488 ha

Source: Analysis, 2021