# Suspended_Sediment_Concerntration_Variation_in_Barito_Delta.pdf

*by*

---

**PAPER · OPEN ACCESS**

# Remote Sensing Studies of Suspended Sediment Concentration Variation in Barito Delta

To cite this article: Deasy Arisanty and Aswin Nur Saputra 2017 *IOP Conf. Ser.: Earth Environ. Sci.* **98** 012058

View the article online for updates and enhancements.

# Remote Sensing Studies of Suspended Sediment Concentration Variation in Barito Delta

**Deasy Arisanty[1*], Aswin Nur Saputra[1]**

[1]Geography Education, Faculty of Teaching and Education Science, Universitas Lambung Mangkurat, Brigjend H. Hasan Basry Banjarmasin, Indonesia

deasyarisanty@unlam.ac.id

**Abstract**. The dynamic of suspended sediment concentration in Barito Delta depend on the process in upstream. Agriculture, mining, and illegal logging in Barito River upstream has an effect for suspended sediment concentration in Barito Delta. The objective of research is to estimate the variation of suspended sediment concentration in Barito Delta. The data of research consist of Landsat 7 in year 2011 and measurement result data of suspended sediment concentration both in wet season and dry season in year 2011. Data analysis is regression analysis to estimates the variation of suspended sediment concentration in Barito Delta. The method of research compares three types of spectral transformation for suspended sediment that is Normalized Suspended Material Index (NSMI), Normalized Differences Suspended Sediment Index (NDSSI), and band ratio (green/blue). The result of the transformation is compared with the value of the field measurement. Based on the result of the comparison can be known the suitable type of transformation for the suspended sediment estimation in Barito Delta. The result of research explains that NSMI has the highest value to estimate the variation of suspended sediment concentration in Barito Delta.

**Keywords:** remote sensing, suspended sediment concentration

## 1. Introduction

Barito River is main river in Barito Delta. Barito River flows from Muller Mountain into Java Sea [1]. Barito River has the length about 900 km, width average about 800 m, and depth average about 8 m [2] [1].

Land use changes in upper part of watershed have increased the sediment in Barito Delta. Degradation has been occurred in upper part of watershed due to illegal logging, mining, forest encroachment, and forest fire [3] [1]. Land use may affect the sediment yield from the watershed [4].

Suspended sediment is transported by the river discharge. Barito River has the river discharge about 1731 $m^3$/s in wet season and 1008.75 $m^3$/s in dry season. River discharge in mouth of Barito River can transport about 17.67 mg/l in dry season. River discharge in mouth of Barito River can transport the suspended sediment about 25 mg/l in wet season [1] [5].

Variation of Suspended Sediment is the important for studying about coastal protection, management, engineering, restoration, and development. To estimate variation of suspended sediment in simultaneously and short time periods needs the satellite remote sensing [6]. Remote sensing can be

used to obtain spasio-temporal information of some water quality parameter such as suspended sediment concentration, especially in large river [7] [8].

Suspended material can be identified using remote sensing data. The interaction of light with a water-sediment mixture is complex because both materials scatter and absorb radiation. the apparent upwelling radiance measured remotely is not only a function of water and sediment properties, but also is a function of initial solar input, atmospheric transmission of the radiation, the upwelling radiance at the water surface, and specular reflection off the water surface due to both sunlight and skylight. These variables in turn are depend on the illumination geometry, atmospheric conditions, and water surface parameters such as water surface roughness [9]. If all of these variables can be accounted for, it may be possible to determine accurately the relationship between remotely sensed reflectance and sediment concentration.

The equation to identify the suspended material is Normalized Suspended Material Index (NSMI). The equation has two principles, i.e. a peak reflectance in the blues range of the visible spectrum is contained in water, and reflectance through the visible spectrum can be increased by the presence of SM. Suspended sediment can be identified using Normalized Difference Suspended Sediment Index (NDSSSI) and a Band Ratio (green/blue) [10].

## 2. Methods

The research objective is to analyze the best index for suspended material information in Barito Delta. The index to generate information about suspended material content through satellite imagery consists of Normalized Suspended Material Index (NSMI), Normalized Differences Suspended Sediment Index (NDSSI), and band ratio (green/blue) [10]. The research uses Landsat 7 image with recording time is on 12, May 2011 and 3, October 2011. In this image has been done geometric correction and atmospheric correction to the level of reflectance at surface. Recording time related to the sampling time season during wet season and dry season.

Suspended solid sampling point in Barito Delta area is 18 points of observation. Suspended sediment is measured in mouth of river and near shore. Transect method is used to measure and to collect data. Suspended load is measured in dry season and wet season. Suspended load is collected with sediment sampler [1].
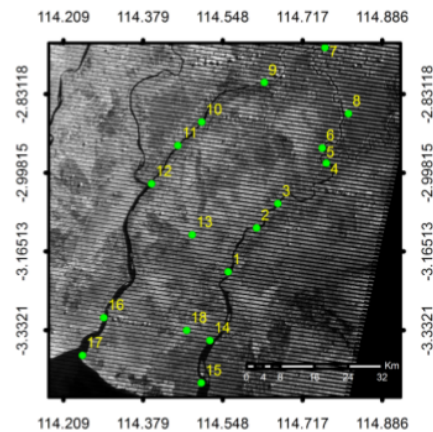


**Figure 1.** Sample area of Barito Delta

The estimation method of suspended material content in Barito delta uses spectral transformation of satellite imagery. Spectral transformations use several variations of band deletion. The types of band intercepts are NSMI, NDSSI, and Band Ratio. The result of spectral transformation based on index is done by linear regression analysis with field measurement value. The highest regression value is used as the most appropriate index for Barito Delta.

NSMI is a transformation index that exploits band delimitation between red, green, and blue bands. The result of channeling produces a range of values from -1 to +1. The higher value of transformation will be the brighter of hue. NDSSI is almost similar to the NSMI index. NDSSI is limited to the near infrared and blue bands, but NSMI is also utilizes the wavelength of green and red. The resulting range on the NDSSI index is between -1 to +1.

$$NSMI = \frac{(\rho_{red})+(\rho_{green})-(\rho_{blue})}{(\rho_{red})+(\rho_{green})+(\rho_{blue})} \qquad (1)$$

$$NDSSI = \frac{(\rho_{blue})-(\rho_{nir})}{(\rho_{blue})+(\rho_{nir})} \qquad (2)$$

The Band Ratio method is a type of band incision applied to 2 image bands. In this study, the band ratio uses green and blue bands to estimate the content of suspended materials. The result of this index is a range of values from 0 to infinity.

$$Band\ Ratio = \frac{(\rho_{green})}{(\rho_{blue})} \qquad (3)$$

### 3. Result and Discussion

Based on the result of regression test it is found that the highest value is found in the method using NSMI transformation with $R^2$ of 0.514 in wet season and $R^2$ equal to 0.700 in dry season. The result is made possible using of visible bands compared to the NDSSI method ($R^2 = 0.010$) using the infrared band. The equation uses to understand the suspended solid content in water. Visible bands more penetrating in the water surface than infrared wavelength, due to infrared wavelength tends to be absorbed, when it comes to the water surface.
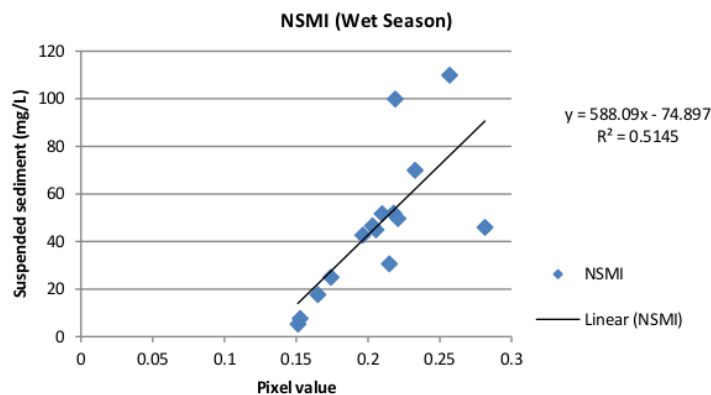


**Figure 2.** NSMI in Wet Season

**Table 1.** Suspended sediment during wet season

| No. | Location | Suspended Sediment (mg/l) |
|---|---|---|
| 1 | Barito River 1 | 45 |
| 2 | Barito River 2 | 7.67 |
| 3 | Barito River 3 | 17.67 |
| 4 | Barito River 4 | 30.67 |
| 5 | Barito River 5 | 49.67 |
| 6 | Barito River 6 | 60 |
| 7 | Barito River 7 | 46 |
| 8 | Barito River 8 | 99.97 |
| 9 | Barito River 9 | 25 |
| 10 | Pulau Petak River 1 | 46.67 |
| 11 | Pulau Petak River 2 | 51.67 |
| 12 | Pulau Petak River 3 | 30.67 |
| 13 | Pulau Petak River 4 | 25.33 |
| 14 | Kapuas Murung River 1 | 5.33 |
| 15 | Kapuas Murung River 2 | 70 |
| 16 | Kapuas Murung River 3 | 42.67 |
| 17 | Talaran Channel | 110 |
| 18 | Serapat Channel | 52 |

Source: Arisanty (2013)

**Table 2.** Suspended sediment during dry season

| No. | Location | Suspended sediment (mg/l) |
|---|---|---|
| 1 | Barito River 1 | 25 |
| 2 | Barito River 2 | 14 |
| 3 | Barito River 3 | 15.33 |
| 4 | Barito River 4 | 12 |
| 5 | Barito River 5 | 55 |
| 6 | Barito River 6 | 45.67 |
| 7 | Barito River 7 | 53.67 |
| 8 | Barito River 8 | 66.33 |
| 9 | Barito River 9 | 36 |
| 10 | Pulau Petak River 1 | 56.33 |
| 11 | Pulau Petak River 2 | 130 |
| 12 | Pulau Petak River 3 | 60 |
| 13 | Pulau Petak River 4 | 82 |
| 14 | Kapuas Murung River 1 | 71 |
| 15 | Kapuas Murung River 2 | 13.67 |
| 16 | Kapuas Murung River 3 | 17.67 |
| 17 | Talaran Channel | 95 |
| 18 | Serapat Channel | 66.67 |

Source: Arisanty (2013)

**NSMI (Dry Season)**

$y = 1007.6x - 201.34$
$R^2 = 0.7008$

♦ NSMI

— Linear (NSMI)
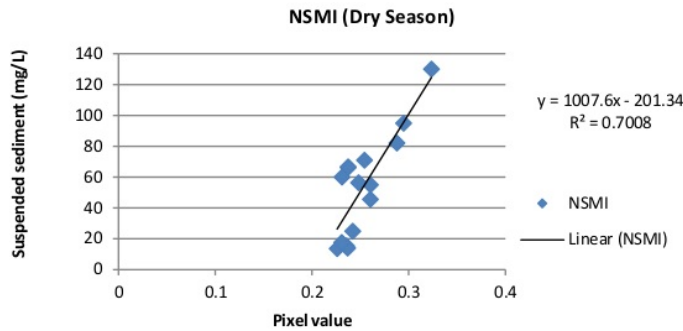
**Figure 3.** NSMI in Dry Season

Band Ratio between green and blue has a lower value ($R^2 = 0.05$) when compared with the other two methods, due to the absence of red band. The red band is a band with a fairly sensitive wavelength. Red band has a higher reflection to the ground when compared to a blue or green band.

Plotting the location of sampling in the field on the right images is in the striping line at Barito River 6, Kapuas Murung River 1 and 2 on the image of wet season. While on dry season the sample points overlap with striping line at Barito River 6 and 9. Striping line is still present in Landsat 7 ETM + image and has not done striping line correction so that in some locations the pixel value can't be used. Another problem is the existence of measurements made in small channel areas such as in Talaran and Serapat are relatively not too large. It becomes unrepresentative to compare the value in the field with the index value through the utilization of Landsat-7 ETM + image which has a spatial resolution of 30m on the visible band. Based on the results obtained by applying the algorithm obtained through Band Math gets the description of the distribution of suspended material in Delta Barito. In the resulting image looks suspended material content is higher in the dry season with a content of more than 70 mg/l. This is possible because of the low flow of river water, so that the suspended material content is more clearly visible from the surface [5].
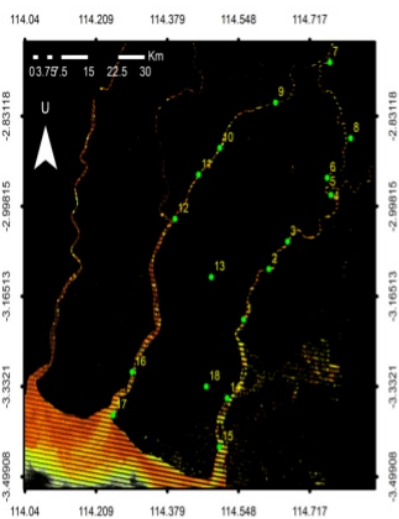
**Figure 4.** Distribution of dry season Suspended Material
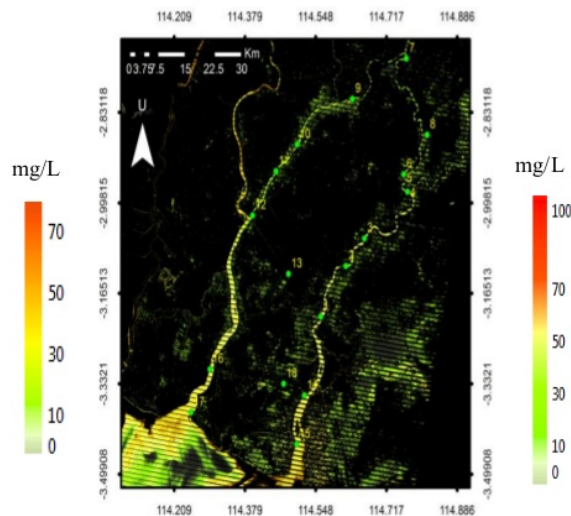
**Figure 5.** Distribution of wet season Suspended Material

5

## 4. Conclusions

The result of research shows that NSMI has the highest value to estimate the variation of suspended sediment concentration in Barito Delta. NSMI value in wet season is 0.514 and 0.700 in dry season. NDSSI and Band Ratio has the lower value of regression than NSMI. NSMI has the higest value due to visible bands wavelenght more penetrating in the water surface than infrared wavelength.

## References

[1]  Arisanty D 2013 *Morphodynamic of Barito Delta, Southern Kalimantan (*Yogyakarta: Faculty of Geography Universitas Gadjah Mada)

[2]  Mulyahadi 2010 Accessibility Assessment of Road Infrastructure for Support of River Transportation in Kalimantan *Jurnal Transportasi Darat* **12**(4) pp 155-175

[3]  Ministry of Environment *Study and Implementation of Barito Watershed Integrated Management* 25 September 2010. [Online]. Available: http://www.menlh.go.id/kajian-dan-implementasi-penanganan-das-barito-terpadu-national-side-event/. [Diakses 20 October 2010]

[4]  Rovira A and C Ibanez 2007 Sediment Management Options for the Lower Ebro River and Its Delta *Journal of Soil Sediment* **7**(5) pp 285-295

[5]  Arisanty D, J Sartohadi, M A Marfai and D S Hadmoko 2014 Sediment Dynamic of Barito Delta, Southern Kalimantan, Indonesia *Journal of Environment* **1**(1) pp 30-37

[6]  Li Y, C Li and X Li 2017 Remote Sensing Studies of Suspended Sediment Concentration Variations in a Coastal Bay during the Passages of Atmospheric Cold Fronts *IEEE Journal of Selected Tropics in Applied Earth Observations and Remote Sensing* **10**(6)

[7]  Cui L, Y Q T Fei, Y Liu and G Wu 2013 Using Remotely Sensed Suspended Sediment Concentration Variation to Improve Management of Poyang Lake, China *Lake and Reservoir Management Journal* **29**(1)

[8]  Wang J J, X X Lu, S C Liew and Y Zhou 2010 Remote Sensing of Suspended Sediment Concentration of Large Rivers Using Multi-temporal MODIS Image: an Example in the Middle and Lower Yangtze River, China *International Journal of Remote Sensing* **31**(4)

[9]  Mertens L A, M O Smith and J B Adams 1993 Estimating Suspended Sediment Concentration in Surface Waters of the Amazon River Wetlands from Landsat Images *Remote Sensing of Environment* **43**(3) pp 281-301

[10] Montalvo 2010 *Spectral Analysis of Suspended Material in Coastal Waters: A Comparison between Band Math Equations* (Mayaguez: Departement of Geology University of Puerto Rico)

# Suspended_Sediment_Concerntration_Variation_in_Barito_Delta.