Relation analyse of TSS with abundance of gastropods using Landsat Sattelite imagery in nongsa beach batam

by Suryanti Suryanti

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Relation analyse of TSS with abundance of gastropods using Landsat Sattelite imagery in nongsa beach batam

Suryanti*, Agus Hartoko, Ryan Kartika Sari

Fisheries and Marine Science Faculty, Diponegoro University, Jl. Prof. Soedarto, SH, Tembalang, Semarang, Central Java, Indonesia

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Abstract

Nongsa beach, residing in Nongsa Regency, Batam City is a territory whose economy began developing in marine tourism. These activities will certainly have a negative impact to the condition of waters in Nongsa beach. One of the consequences is the decreasing of Gastropods population which has the most important role in aquatic ecosystem and is the bio-indicator of the waters. The purpose of this research is to findout the composition and density of gastropods and to know the relation among TSS, sedimen fractions and organic matter with density of gastropods in Nongsa beach Batam. TSS and sedimen fractions contained in the bottom substrate are closely related to gastropods, because a kind of sedimen is a habitat preference for gastropods. Nutrients used by gastropods for feeding is needed to survive. TSS analysis can be used by satellite imagery procession. Landsat data was used to determine the concentration of TSS up to 25 meters deep. Using satellite imagery can simplify and accelerate of data analysis process. The statistics result of the validation test shows the coefficient of determination (R^2=0.6662), which indicates the TSS concentration extracted from satellite images data of Landsat determined 66.6% the conditions in field. This research used the descriptive method and purposive sampling method to determine the object which were suitable with the research purpose. TSS concentration is between 0,092 – 0,11 mg/l. Various kinds of gastropods were found from Famili Strombidae, Muricidae, Neritidae, Ceritidae, Potamididae, Terrebridae and Phasianellidae.

***Corresponding Author:** Suryanti ✉ suryantidr@gmail.com

Introduction

Nongsa Beach is a marine tourism area which has marine diversity such as coral reefs and seagrass ecosystems. The ecosystem is very threatened by the pressure changes in the environment such as chemical and physical parameters of the surrounding waters, especially due to the development and activities occurs around the coast. Such changes can determine the abundance of life in the waters, including gastropods. Gastropods is a group of animals of the phylum of mollusks lives on the type of substrate from rough to smooth (Suwignyo, 2005). Significant correlation between the density of macroalgae, with gastropods (Suryanti, 2008). Furthermore Effendi (2003) states that the abundance of gastropods are influenced by physical factors in waters and one of them is the TSS (Total Suspended Solid)

TSS is solids suspended in water in the form of organic materials and inorganic which can be filtered by Millipore paper berporipori 0.45 µm. The material is suspended having adverse impacts on water quality because it reduces the penetration of the sun into a body of water, increased water turbidity is causing disruption to the growth of the producer organism. (Huda, 2009)

Along with the development of technology and informatics, any changes that occur in the Earth's surface can be monitored using satellite images, one of which is by Landsat image. Barret and Curtis (1982) state that remote sensing technology has been widely applied to study water quality, one of which is to calculate the value of TSS in the waters and water transparency. The quality of water has a different light penetration in certain areas and it can be seen with multispectral technique. Management efforts can be done by knowing the locations that degrade or damage quickly and accurately. TSS is generally relatively reduced and varied in accordance with a depth profile (Siswanto A.D. 2010). TSS plays an important role in water quality management (Susiati *et al*, 2010)

The purpose of this study was to determine the TSS at the beach Nongsa Batam and the relationship between the abundance of gastropods with TSS and knowing TSS equation models which were analyzed using Landsat TM satellite imagery 8.

Material and Methods

Study site

Nongsa beach is one of the beaches located in the district of Nongsa, Batam, Riau Islands. Nongsa is located in the north of the island of Batam, Bintan Island bordering the Straits of Malacca and Singapore Straits. Batam Island has 415 km² area which is geographically located on 0°55' – 1°55' Lattitude dan 103°45' – 104°10' Longitude. The beach including a gently sloping beach with white sand bottom substrate and the waves in the medium category. However, when the sea breeze seasons between December 2016 and February 2017, waves and ocean currents are categorized with high wind speeds.

TSS processing method

Analysis of samples TSS (Total Suspended Solid) used Gravimetry method (BSN, 2004). 1 liter of sea water is filtered using Whatman filter paper AH / 934 1.5 µm. Filter paper firstly heated in an oven at a temperature of 80°C for 24 hours, then cooled in a desiccator and weighted to constant weight. Then the calculation results of the analysis carried out by the formula according to BSN (2004) :

$$TSS = \frac{(A - B) \times 1000}{V}$$

Where :

TSS = *Total Suspended Solid* (mg/l)

A = weight of filter paper + weigh of dry residue (mg)

B = weight of filter paper (mg)

V = volume samples (l)

Satellite imagery data analysis for TSS

Regression is used to analyze the model development to predict the concentration of TSS waters. Regression formula is obtained from the values combination of the digital number on satellite imagery and value of TSS in situ. The model used in the form of regression equations has the highest coefficient of determination (R^2), where y is the value of a parameter in the field

(data in situ concentration TSS) and x is a combination of digital number of bands in imagery. Form of regression used in the study is polynomial regression, using this following formula:

$$Y = b_0 + b_1X + b_2X^2 + \ldots + b_kX^k$$

Where :

Y = respone variable
b_0 = intersep
$b_1, b_2, \ldots, bk$ = regression coefficient
X = predictor variable

Satellite image data processing method

Image data processing performed to generate information of TSS in waters based on digital number by the satellite imagery. Then the digital number regressed to determine the validity of the model used. Image processing method used is as follows:

a. Image composite.
b. Atmospheric correction, Cropping and Enhancement
c. Band (Red Green Blue)
d. Image Cropping.
e. Gridding Wizard
f. Edit formula
g. Overlay and Layout

Individual abundance

Definition of individual abundance is the number of individuals or species of each station in a cubic unit. Formula to calculate the number of individual using Odum's formula (1971) :

$$KR = \frac{ni}{N} \times 100\%$$

Where :

KR = Relative density
Ni = Number of individu
N = Number of individu each station

Species diversity

Species diversity is the heterogenity of species and quantitative measure that reflects how many different types (such as species) in a ecosystem. This research used Shannon-Wiener (Krebs, 1989) formula :

$$H' = -\sum_{i=1}^{s} Pi\ lnPi$$

Where :

H' = Diversity index
Pi = ni /N
Ni = Number of individuals in species i
N = Total number of individuals in the community

Criteria of diversity index result (H') are as follow :

H' ≤ 1 : Low diversity
1 < H' < 3 : Medium diveristy
H' ≥ 3 : High diversity

Uniformity index

Uniformity index is composed of individuals of each species contained in the community. Uniformity index (Krebs, 1989) taking the following form:

$$E = \frac{H'}{Hmaks}$$

Where :

E = Uniformity index
H' = Diversity index
Hmaks = log s

Dominance index

Simpson's Dominance is a very flexible measurement that takes the entire community into account (Krebs 1989). Here is the equation of Simpson's dominance :

$$C = \sum_{i=1}^{s} (Pi)^2$$

Where :

C = Dominance index
Pi = ni/N
s = Number of species

Results and Discussion

Results

The following histogram contains of TSS values at high tide and low tide in coastal waters Nongsa,

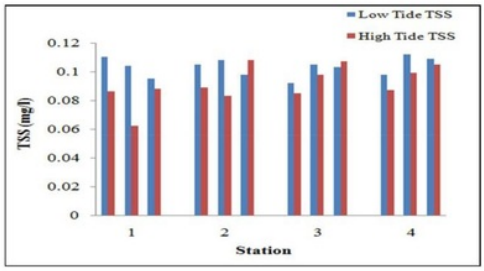

Fig. 1. Histogram of TSS in Nongsa Beach Batam.

Here is the regression equations used as a model equation for TSS process using TM Landsat 8 satellite imagery (Fig 2)

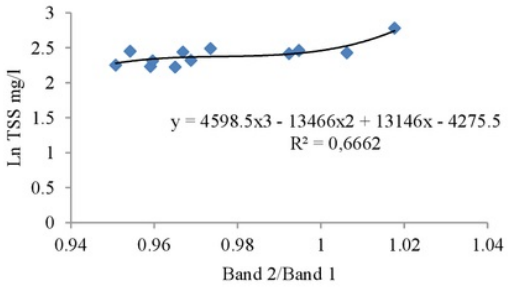

Fig. 2. The Result of Regression Between Digital Number and Number of TSS in situ

Here is a map of the distribution of TSS around the sampling point on the coast of Nongsa processed by using Landsat 8 TM (Fig 3)

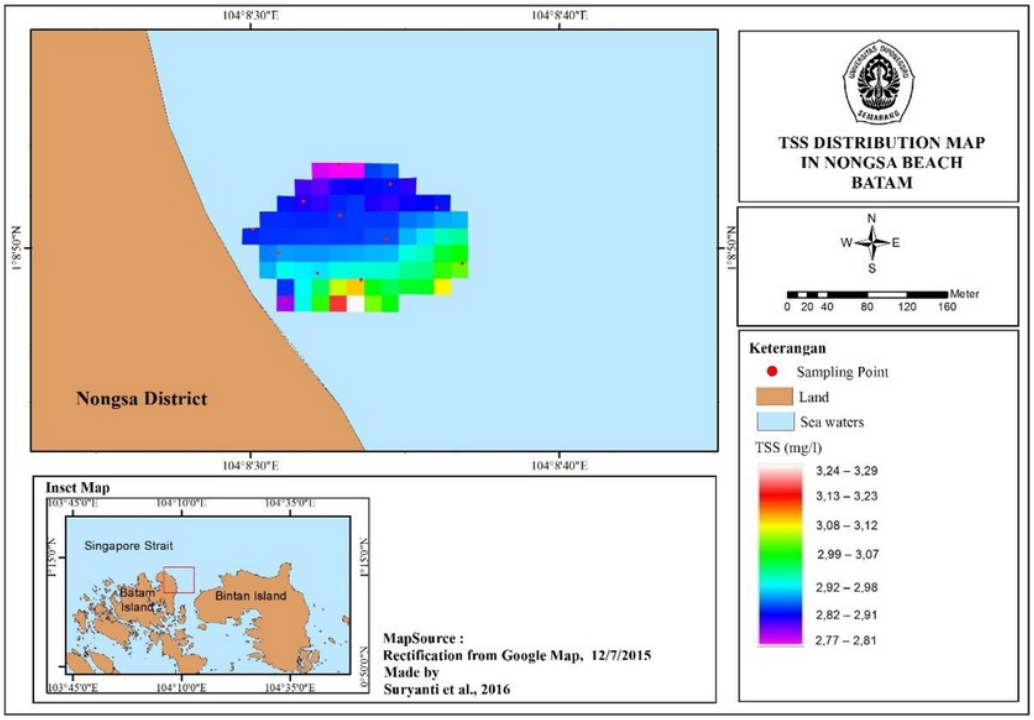

Fig. 3. TSS's distribution map in Nongsa Beach Batam.

The following table contains of abundance and community structure data of gastropods at four stations on the Nongsa Beach (Table 1),

Table 1. Abundance, Diversity Index, Unifomity Index and Dominance Index of Gastropodsin Nongsa Beach Batam.

No	Species	Station 1				Station 2				Station 3				Station 4			
		A	b	c	KI	a	b	C	KI	a	B	c	KI	a	B	c	KI
1	*Strombusurceus*	1	0	1	2	1	1	3	5	2	1	3	6	0	1	1	2
2	*Strombusturturella*	0	2	1	3	0	2	1	3	2	0	1	3	1	0	1	2
3	*Parpura panama*	1	0	0	1	0	2	0	2	0	1	0	1	1	2	0	3
4	*Neritasquamata*	5	2	1	8	6	8	8	22	8	5	6	19	6	5	10	21
5	*Rhinocdavissinensis*	2	3	2	7	5	2	2	9	2	2	3	7	5	2	3	10
6	*Cerithidea cingulate*	62	47	81	190	62	73	102	237	55	92	102	249	97	134	167	398
7	*Hastulahectica*	0	0	2	2	0	1	1	2	0	1	2	3	0	0	0	0
8	*Phasianellidae*	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	1
	total	71	55	88	214	74	89	117	280	69	102	117	288	111	144	182	437
	Abundance	214				280				288				437			
	H`	0.53				0.64				0.60				0.41			
	E	0.26				0.31				0.28				0.20			
	C	0.79				0.72				0.78				0.83			

Source: Research Data 2016.

Here are the results of the regression relationship between levels of TSS and the abundance of gastropods on the Nongsa beach (Fig. 4).

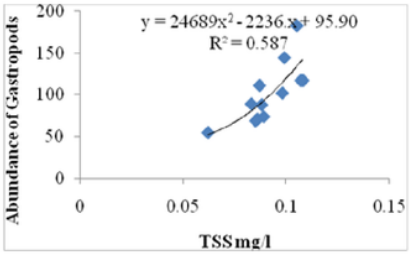

Fig. 4. Result of Regression Between TSS Concentrate and Abundance of Gastropods

Discussion

Based on the research results at low tide on the TSS values ranging between 0.092 mg/L up to 0.11 mg/L while the TSS value at the time of high tide ranges between 0.062 mg/L up to 0.108 mg/L . TSS value at the time of low tide and high tide on the beach included in the category of low levels, i.e. no more than 50 mg/L . This is because the condition of coastal waters there has not been a major pollutiondone directly by human activity, so that the condition of coastal waters based on TSS safe for the existence of Gastropods. This was confirmed by Setiawan (2008) state the value of TSS 25 mg/L has no effect, 25-80 mg/L has little effect, 81-400 mg/L is less good, and > 400 mg/L is not good. The next the content of TSS largely determines fertility conditions a body of water (Helfinalis, 2008).

TSS value at each station at high tide to rise between point A, point B and point C. TSS value at station 1 point A of 0.086 mg/L, point B of 0.062 mg/L and point C of 0.088 mg/L . A point located close to the shoreline while the point c was located about 15 meters from the shoreline or in the area of breaking waves (surf zone). It can be said that the value of suspended solids increasingly leading to higher sea levels value. It is thought to be caused by the movement of water occuring at low tide and the tide heading towards downs caused sediment transport at the base, causing a shift in the sediment at high tide and low tide. This can be explained at high tide, the tide would spread to the waterfront area, which is accompanied by a mass transport sea water in a very large number, so did the opposite at low tide. This was confirmed by Firdaus and Aryawati (2015), Banyuasin estuary quality condition of water include temperature and salinity varies in each layer depths and more dominant in the surface layer of water. TSS concentration increases at low tide. The next Parwati *et al*, (2014), Analyze the pattern of increase or decrease in value TSS of the selected region shows a very typical pattern in accordance with the cover/land use in the vicinity.

Species of gastropods were found at Nongsa Beach Batam consisting of six families that Strombidae family consists of *Strombusurceus* and *Strombusturturella*, family Muricidae consists of species *Parpura panama*, family Neritidae consists of *Neritasquamata*, family Ceritidae consists of species *Rhinoclavissinensis*, family Potaminidae consists of *species Cerithideacingulata*, Terrebridae family consists of *Hastulahectica* and family Phasianellidae. Dominance Index in this study was obtained by 0.79 at station 1, station 2 obtained a value of 0.72, the third station obtained a value of 0.78, and station 4 obtained a value of 0.83.Species of gastropods dominating on the Nongsa beach is *Cerithideacingulata*. *Cerithideacingulata* is a gastropod that lives on argillaceous sand substrate. *Cerithideacingulata* generally live in the intertidal zone, especially muddy, sandy beaches, and mangroves (Hinton 1972: 4; Roberts et al.1982: 28; Sriaroon *et al.* 2006: 108 in Laksmana, 2011). Gastropod majority prefers substrates of fine sand and even mud to live as smooth substrates contain more nutrients than the coarse substrate (Madah *et al,* 2015). Gastropod is a unitary motile animals that can move locations appropriate habitat (Retno, 2002)

Diversity index were spread about 0.41 to 0.64. The index value of diversity included in the low category because it is smaller than 1. This is reinforced by the Shannon-Wiener (1963) in Fachrul (2007), where states that H '< 1 is a low biodiversity value with the number of individual was not uniform and had one of the dominant species. Low value diversity index is suspected that these ecosystem are under pressure. The pressure that occur in an ecosystem is usually influenced by many factors such as the changing patterns of currents and waves on the beach due to changes in the earth's temperature (global warming). Changes in currents and waves which become firmer can lead to coastal erosion and loss of balance in the sediment transport along the coast.

The current velocity was quite high, ranging from 0.2 to 0.5 m/s. Based on data from BMKG Batam, Nongsa coast wind speed in February was quite high. The wind blowing in the Riau Islands was primarily from the north to northeast with blowing speed were 5-15 m/sec (about 10-40 km/h) (BMKG Batam, 2016)

Results of regression analysis of the relationship between TSS value at high tide with abundance of Gastropods are obtained using this following equation polynomial regression y = 24689 x 2 - 2236.4x + 95 904 with a value of R ² = 0.5874 . The linear equation indicates that the positive relationship between TSS and with an abundance of gastropods with the coefficient of determination (R^2) 0.5874.This means that the effect of TSS in the waters to abundance of gastropods around the station 59% while the other 41% were influenced by other factors. Value of correlation (r) in the regression is 0.766. This shows that there is a strong relationship between the abundance of gastropods with TSS value (> 0.5).

Conclusion

This study attempts to identify the TSS in Nongsa beach using satellite remote sensing data based on regression model from digital number and TSS concentration in the waters. We found that this regression algorithm can be successfully used to identify the TSS concentration over Nongsa beach.The regression algorithm for estimating the concentration of TSS is $y = 4598.5x^3 - 13466 x^2 + 13146 x - 4275.5$. Abundance of gastropods at station 1 was 214 ind/m^2, at station 2 was 280 ind/m^2, the third station spread was 288 ind/m^2 and at station 4 was 437 ind/m^2. The concentration of TSS in Nongsa Beach Batam has a relationship with abundance of gastropods with a high correlation coefficient is equal to 0.766

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