PROCEEDING

The 2nd International Seminar of Basic Science

Natural Science For Exploration The Sea-Island Resources

Ambon, May 31st 2016

Organized by
Faculty of Mathematics and Natural Science
Pattimura University

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"Natural Science for Exploration The Sea-Island Resources"

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2nd edition

Welcoming Address By The Organizing Committee

Today, We have to thank the The Almighty Allah SWT for the implementation of this international seminar. This is the second seminar about Basic Science in The Faculty of MIPA Pattimura University. The seminar under the title "Natural Sciences for Exploration the Sea-Island Resources" will be carried out on May 31st 2016 at Rectorate Building, Pattimura University. There are 200 participants from lecturers, research institute, students, and also there are 34 papers will be presented.
My special thanks refer to the rector of Pattimura University and the Dean of MIPA Faculty, Prof. Dr. Pieter Kakissina, S.Pd., M.Si. I also would like to express my deepest gratitude to Prof. Amanda Reichelt-Brushett, M.Sc., Ph.D. ; Kazuhiko Ishikawa, Ph.D. ; Nicolas Hubert, Ph.D. ; Prof. Dr. Kirbani Sri Brotopuspito ; Prof. Dr. Marjono, M.Phil. ; Gino V. Limon, M.Sc., Ph.D. as the keynote speakers.

The last, We hope this international seminar usefull for all of us, especially Mollucas People and very sorry if any mistake. Thank you very much.

Dr. La Eddy, M.Si.
Chairman of Organizing Committee

Opening Remarks
By Dean of Mathematic and Natural Sciences Faculty

I express my deepest gratitude to The Almighty God for every single blessing He provides us especially in the process of holding the seminar until publishing the proceeding of International Seminar in celebrating the 18th anniversary of MIPA Faculty, Pattimura University. The theme of the anniversary is under the title "Natural Sciences for Exploration the Sea-Island Resources". The reason of choosing this theme is that Maluku is one of five areas in Techno Park Marine in Indonesia. Furthermore, it is expected that this development can be means where the process of innovation, it is the conversion of science and technology into economic value can be worthwhile for public welfare especially coastal communities.

Having the second big variety of biological resources in the world, Indonesia is rich of its marine flora and fauna. These potential resources can be treated as high value products that demand by international market. Basic science of MIPA plays important role in developing the management of sustainable marine biological resources.

The scientific articles in this proceeding are the results of research and they are analyzed scientifically. It is expected that this proceeding can be valuable information in terms of developing science and technology for public welfare, especially people in Maluku.

My special thanks refer to all researchers and reviewers for your brilliant ideas in completing and publishing this proceeding. I also would like to express my gratefulness to the dies committee-anniversary of MIPA Faculty for your creativity and hard working in finishing this proceeding, God Bless you all.

Prof. Dr. Pieter Kakisina, S.Pd., M.Si.
Dean of Mathematic and Natural Sciences Faculty

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"The 2nd International Seminar of Basic Science 2016"

Hotel Mutiara Ambon

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DEVELOPMENT OF ALGORITHM MODEL FOR ESTIMATING CHLOROPHYLL-a CONCENTRATION USING *IN SITU* DATA AND ATMOSPHERICALLY CORRECTED LANDSAT-8 IMAGE BY 6SV CASE STUDY: GILI IYANG'S WATERS

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ABSTRACT

Chlorophyll-a (Chl-a) is an important parameter for monitoring the quality of seawater. By implementing a high accuracy of algorithm model, the concentrations of chl-a could be estimated from satellite remote sensing data. In this research, algorithm models for estimating the concentration of chl-a over Gili Iyang's waters were developed. For the development purposes, the *in situ* data of chl-a were taken on October 15, 2015 at 08:53 to 10:37 am (6 stations) and Landsat-8 data that has been atmospherically corrected using *Second Simulation of Satellite Signal in the Solar Spectrum Vector* (6SV). The regression model for estimating chl-a produced a high with determination coefficient of 0.697. By applying the developed algorithm, the estimated of chl-a ranged from 114.158 to 147.379 mg/m^3.

Keywords**:** Chl-a, 6SV, Landsat, Algorithm Model

INTRODUCTION

Monitoring parameters quality of seawater became a hot topic discussed because the marine ecosystem depends on the quality of sea water parameters. One biological parameter which has an important role and be an indicator of waters fertility is phytoplankton.

Phytoplanktons play a critical role in the cycling of biogeochemical properties, and are responsible for presenting oxygen in the Earth's atmosphere through a process known as photosynthesis (Morel and Prieur, 1977). The concentration of chl-a, which can be found in every phytoplankton species (Zhang and Han, 2015). The concentration of chl-a may be obtained by taking sea water samples and tested in the laboratory, but the conventional method of sampling is expensive and time consuming. The remote sensing technique is an efficient and accurate method for extracting water physical parameters (Jaelani et al. 2016).

The chlorophyll concentration in the water can be detected through remote sensing techniques since the changes in its spectral absorption and scattering coefficients affect water color (Maycira Pereira, 1991).

Remote sensing techniques have been applied to measure chl-a by researchers (Han and Jordan, 2005). Many studies have proposed algorithms between Landsat data and *in situ* water quality parameters using simple regression models (Bonansea et al. 2015). The accuracy of estimated data derived from remote sensing depends on an accurate atmospheric correction algorithm and physical parameter retrieval algorithms (Jaelani et al. 2015).

Consequently, the main purpose of this paper is to develop more accurate algorithm to estimate the concentration of chl-a in the waters of Gili Iyang, Sumenep, East Java Province. The development of models algorithm used remote sensing reflectance of Landsat-8 has been corrected by 6SV.

MATERIALS AND METHODS

Study Area and Data Collection

The research location is in the waters of Gili Iyang that administratively includes the District Dungkek, Sumenep, East Java Province, with the geographical location of 6^{o}59'7.07 "S and 114^{o}10'32.22" E. Gili Iyang has a surface area of 9.15 km^2.

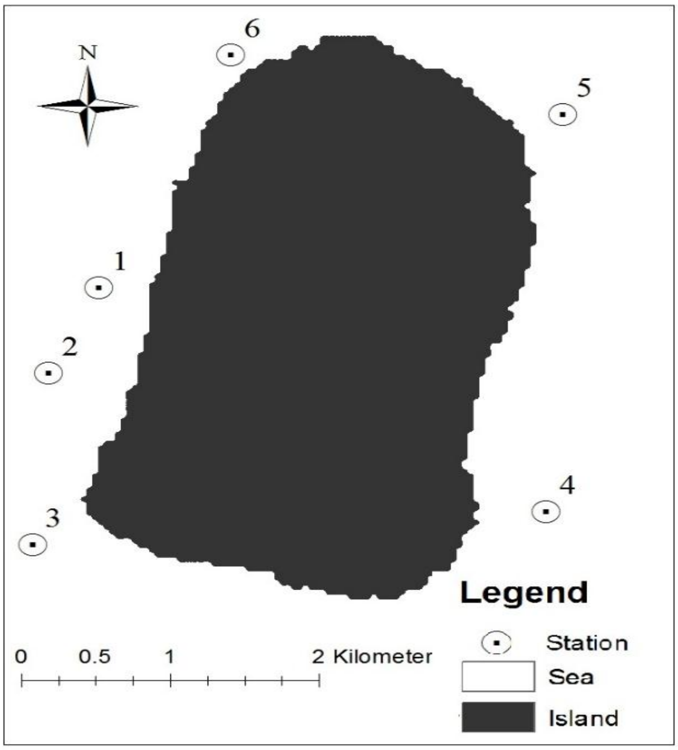

Figure 1. Area Study

The data used in this study consisted of two : the *in situ* data of chl-a and Landsat-8 OLI level 1T. *In situ* data of chl-a was collected on October 15, 2015 at 08:53 to 10:37 pm (6 stations) at Gili Iyang waters. Samples of water were taken at a maximum depth of 0.5 m at each observation station. Data chl-a was then tested using spectrophotometric analysis in the laboratory. Landsat-8 data were taken on 15 October 2015 with file name LC81170652015288LGN00 and path/row: 117/65. This data was obtained from http://earthexplorer.usgs.gov.

Processing Landsat-8 Data

Radiometric calibration

The downloaded Landsat-8 data need a radiometric calibration since the data was stored in digital number (*DN*) format. Radiometric calibration is used to change the digital number (*DN*) to the value of radian TOA (Top Of Atmospheric) using the equation:

$$L_\lambda = M_L * Q_{cal} + A_L \qquad (1)$$

L_λ is TOA spectral radiance (Watts/(m^2*srad*μm)), M_L is band specific multiplicative rescaling factor from metadata (Radiance muti band), A_L is band specific additive rescaling factor from metadata (Radiance add band), Q_{cal} is Quantized and calibrated standard product pixel values (DN)

Atmospheric correction

Having calibrated by radiometric, Landsat-8 was corrected from atmospheric effects. Atmospheric correction was performed to remove the atmospheric effects of the signal recorded by the sensor. The process converted the value of radian TOA to reflectance values of BOA (Bottom Of Atmospheric). The Atmospheric correction in this study used correction parameters of the simulation results using *a Second Simulation of Satellite Signal in the Solar Spectrum Vector* (6SV) (Vermote, et al. 1997). It parameters can be obtained by running web-based software of 6SV that could be accessed through http://6s.ltdri.org/. The correction parameters generated from 6SV then were used to convert the value of radian TOA to reflectance values of BOA using the following equation :

$$y = x_a * (L_\lambda) - x_b \qquad (2)$$

$$acr = \frac{y}{(1. + x_c * y)} \qquad (3)$$

$$Rrs(\lambda) = \frac{acr}{\pi} \qquad (4)$$

x_a, x_b, and x_c is the coefficient of atmospheric correction parameters, *acr* is the result of atmospheric correction reflectance, L_λ is radian value TOA, *Rrs (λ)* is the remote sensing reflectance. The atmospheric corrected data *Rrs (λ)* was used to create the model algorithm for estimating the concentration of chl-a.

Regression

In this study, the regression model was used to develop model algorithm for estimating chl-a. The regression model follows the equation:

$$y = ax + b \qquad (5)$$

Where, *y* is the *in situ* concentration of chl-a, *x* is the value of *Rrs (λ)* of a single band, the band ratio or combination of bands, *a* is the slope of the regression line, and *b* is the y-intercept. To find the value of *a* and *b* were used least square method. Furthermore, the coefficient of determination (R^2) between *in situ* and estimated concentration of chl-a were calculated using the equation:

$$R^2 = \left(\frac{n\sum xy - \left(\sum x\right)\left(\sum y\right)}{\sqrt{n\left(\sum x^2\right) - \left(\sum x\right)^2}\sqrt{n\left(\sum y^2\right) - \left(\sum y\right)^2}} \right)^2 \quad (6)$$

Where, x is the measuremet value of the chl-a, y is the estimated value of chl-a concentration that have been made by model algorithms in the previous stage and n is the number of data used.

RESULTS AND DISCUSSION

In situ data of chl-a and coefficient of atmospheric correction parameters

Table 1. In situ data of chl-a

Station	Latitude	Longitude	Local Time	*Chl-a* (mg/m^3)
1	-6.98161	114.16104	8.53	140
2	-6.98829	114.15758	9.02	138
3	-7.00091	114.15722	9.25	156
4	-6.99848	114.18797	10.02	130
5	-6.96921	114.18852	10.2	121
6	-6.96484	114.16923	10.37	112

Table 1 shows the concentration of chl-a were taken at six stations in the waters of Gili Iyang. Chl-a concentration was highest at station 3 with value of 156 mg/m^3 while the lowest at station 6 of 112 mg/m^3.

The coefficients of atmospheric correction parameters using 6SV simulation results were shown in Table 2 below :

Table 2. The coefficient of atmospheric correction parameters

Band	Coefficient of atmospheric correction parameters		
	x_a	x_b	x_c
1	0.00256	0.172	0.23561
2	0.00229	0.12723	0.20185
3	0.00236	0.08007	0.1567
4	0.00263	0.05615	0.12863
5	0.00388	0.03656	0.10086

The results in table 2 will obtain the value of *Rrs (λ)* for each observation stations as shown in table 3 and figure 2 below:

Table 3. Value of remote sensing reflectance (*Rrs (λ)*) Landsat-8

Station	Remote Sensing Reflectance Values (*Rrs (λ)*) (sr^{-1})						
	Latitude	Longitude	Band				
			1	2	3	4	5
1	-6.98161	114.16104	0.017	0.018	0.015	0.004	0.002
2	-6.98829	114.15758	0.018	0.021	0.018	0.006	0.002
3	-7.00091	114.15722	0.017	0.018	0.015	0.004	0.000
4	-6.99848	114.18797	0.020	0.022	0.018	0.006	0.004
5	-6.96921	114.18852	0.018	0.019	0.014	0.004	0.003
6	-6.96484	114.16923	0.017	0.018	0.013	0.003	0.002

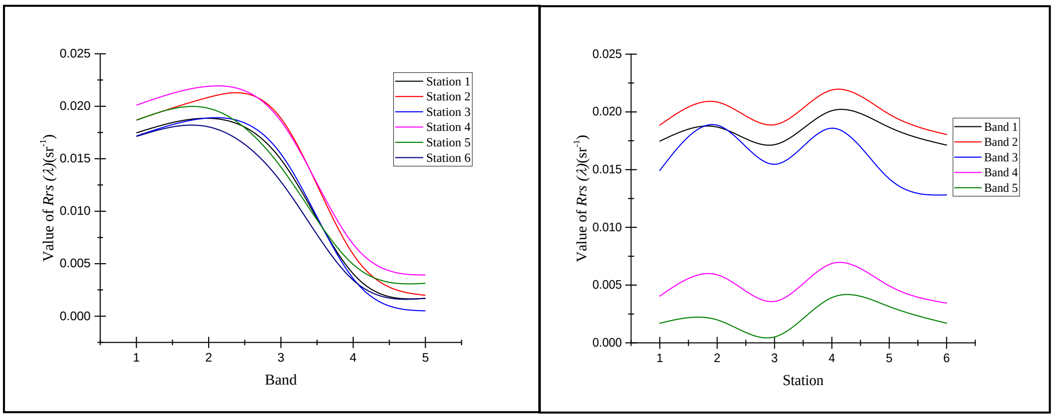

Figure 2. Graph value of remote sensing reflectance (*Rrs (λ)*) at 6 stations

Table 3 and figure 2 above show the values of *Rrs (λ)* of atmospheric correction results at six observation stations in the waters of Gili Iyang. It can be seen at figures and table above that the values of *Rrs (λ)* on each band were between in range of 0.000-0.022 sr^{-1}.

Development of algorithm model for estimating chl-a concentration

The development of algorithm models to estimate the concentration of chl-a in this study only uses three bands of Landsat-8. They are band 2 (blue), band 3 (green) and band 4 (red). Three bands have been selected because they have more sensitivity to chl-a.

The development of this algorithms used the data of *in situ* chl-a and *Rrs (λ)* data, which have been corrected from atmospheric effects. *In situ* data concentration of chl-a was used as the dependent variable meanwhile the data of *Rrs (λ)* were used as independent variables. From these data, the correlation and the highest value of determination (R^2) used regression models were determined. The highest correlation and determination value that will serve as a model algorithm to estimate the concentration of chl-a in the waters of Gili Iyang. The results of the development model algorithm was shown in table 4 below :

Table 4. Determination (R^2) values for single band

Regression Model	Band 2	Band 3	Band 4
Chl-a = a*(bi) + b	0.005	0.159	0.004
Chl-a = a*log(bi) + b	0.007	0.192	0.003
Log (Chl-a) = a*(bi) + b	0.013	0.188	0.000
Log (Chl-a) = a*log(bi) + b	0.015	0.224	0.000

Table 5. Determination values (R^2) for bands ratio

Regression Model	Band 2	Band 2	Band 3
	Band 3	Band 4	Band 4
Chl-a = a*(bi/bj) + b	0.433	0.013	0.254
Chl-a = a*log(bi/bj) + b	0.409	0.012	0.226
Chl-a = a*(log(bi)/log(bj)) + b	0.406	0.018	0.396
Log (Chl-a) = a*(bi/bj) + b	0.467	0.004	0.214
Log (Chl-a) = a*log(bi/bj) + b	0.442	0.004	0.189
Log (Chl-a) = a*(log(bi)/log(bj)) + b	0.438	0.008	0.354

Table 6. Determination values (R^2) of combination bands ratio

Regression Model	Band 2 - Band 3	Band 2 – Band 4	Band 3 - Band 4
	Band 4	Band 3	Band 2
Chl-a = a*((bi-bj)/bk) + b	0.217	0.166	**0.697**
Chl-a = a*log((bi-bj)/bk) + b	0.118	0.138	0.680
Chl-a = a*(log(bi-bj))/log (bk) + b	0.103	0.125	0.653
Chl-a = a*((log(bi)-log(bj))/log(bk)) + b	0.448	0.076	0.288
Log (Chl-a) = a*((bi-bj)/bk) + b	0.254	0.198	0.689
Log (Chl-a) = a*log((bi-bj)/bk) + b	0.144	0.167	0.672
Log Chl-a = a*(log(bi-bj))/log (bk) + b	0.128	0.153	0.640
Log(Chl-a) = a*((log(bi)-log(bj))/log(bk))+b	0.477	0.053	0.248

From table 5 above, the highest value of determination (R^2>0.5) was shown in a combination bands ratio of 3, 4 and 2. The ratio combination of these bands was (*Rrs* (λ_3)-*Rrs* (λ_4))/*Rrs* (λ_2). The value of determination (R^2) equal to 0.697. The regression model could be seen in equation (7) and figure (3) below:

$$Chl-a = a*\left(\frac{(b_i - b_j)}{b_k}\right) + b \qquad (7)$$

Where, Chl-a is the concentration of chl-a (mg/m^3), b_i, b_j, b_k are the remote sensing reflectance bands 3, 4 and 2. The value of *a* is 207.305 and the value of *b* is 17.068.

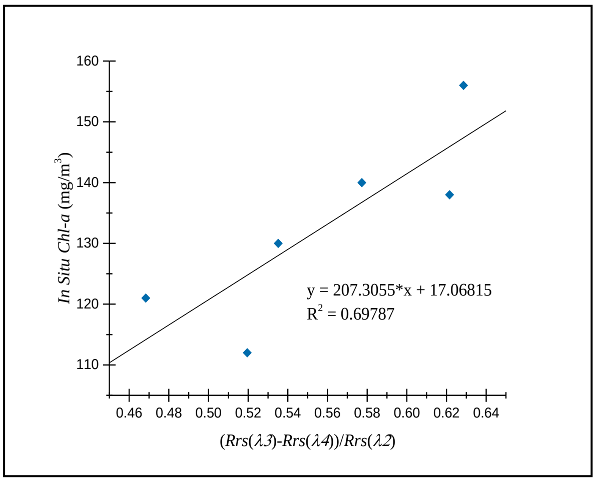

Figure 3. Regression model between *in situ* chl-a with combination bands ratio

The regression model with the highest value of determination (R^2) was then used to Gili Iyang. The estimation results of chl-a were shown in Table 7 and Figure 4.

Table 7. Estimation of the chl-a concentration based on model algorithm that has been developed

Station	Measured Chl-a (mg/m^3)	Estimated Chl-a (mg/m^3)
1	140	136.752
2	138	145.923
3	156	147.379
4	130	128.011
5	121	114.158
6	112	124.774

It could be seen in Table 7 that the estimation of chl-a concentration reach the highest value at station 3 (147.379 mg/m^3) and the lowest at station 5 (114.158 mg/m^3). At the *in situ* data, the lowest concentration of measurement results of chl-a concentration was found at the station 6 and the highest one was at station 3.

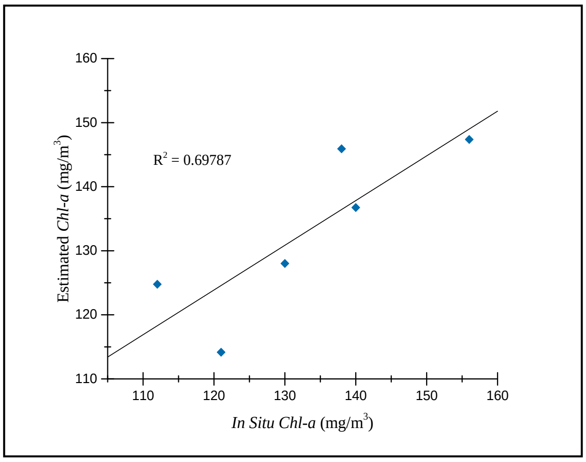

Figure 4. Relationship between estimated of chl-a and *in situ* chl-a

Figure 4 shows the correlation between the estimation results of chl-a concentration calculated by the algorithm model built on the previous stage and the concentration of chl-a *in situ*. From the figure it can be seen that both have a good correlation with R^2 = 0.697.

CONCLUSION

The development of model algorithm for estimating concentration of chl-a in the waters of Gili Iyang has been done. The development of this model algorithms used the *in situ* data of chl-a and remote sensing reflectance (*Rrs (λ)*), which have been corrected from atmospheric effects with 6SV. The developed algorithm was the combination band ratio of Landsat-8. The bands combination was band 2 (blue), band 3 (green) and band 4 (red). The regression model to estimate concentrations of chl-a produced the highest determination coefficient of 0.697. By applying the algorithm model that has been developed, was obtained the estimation of chl-a concentration in range from 114.158 to 147.379 mg/m^3.

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