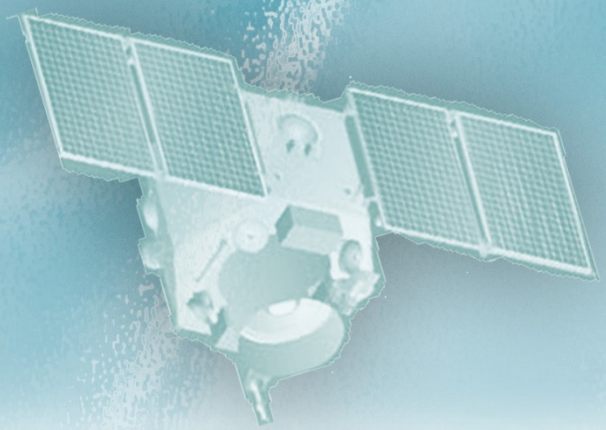

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MAPPING COLORED DISSOVED ORGANIC MATTER DISTRIBUTION IN BERAU DELTA, EAST KALIMANTAN FROM REMOTE SENSING

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ABSTRACT

Colored Dissolved Organic Matter (CDOM) is a product of plant and animal decomposition processes. Information of CDOM distribution is needed to determine water quality condition. The paper describes CDOM distribution in the Berau Delta coastal waters derived from *in situ* measurements and Medium Resolution Imaging Spectrometer (MERIS). Field measurements of CDOM absorption was carried out in January 2009. Three MERIS data: August 28, September 15 and September 30, 2007 were used in this study. Case-2 regional algorithm in BEAM VISAT software was used to process the MERIS data. The result indicated that the CDOM absorption in the Berau Delta coastal waters ranged from 1.67 m^{-1} in the river to 0.091 m^{-1} in clear open seawater.

Keywords: CDOM, absorption, MERIS, Berau Delta,

INTRODUCTION

The location of Berau Delta in East Kalimantan Province, Indonesia, contributes to the fresh water discharge in the region. The water discharge carried sediment load from the land. The land within the Berau catchment still covered by 50-60% of rainforest (Ekadinata et al., 2010) and the sediment yield is considerably small (Buschman et al., 2011). However, Buschman et al (2011) believed that the anticipated land cover changes in the region will increased the supply of sediment 10-100 times. The increase of sediments fluxes could have an effect on the adjacent Berau reef system.

The water discharge from the Berau River also contains dissolve material in the water. Colored Dissolved Organic Mater (CDOM) together with particulate material, in the form of suspended sediment, contribute to the color of the coastal water in the Berau delta. High concentrations of CDOM correspond to brown or yellowish color in the water (Coble et al., 2003). Colored Dissolved Organic Matter (CDOM) is a product of plant and animal decomposition processes, and also come from organic materials leached from soils (Coble et al., 2003). Changes in the concentration and properties of CDOM in coastal regions can be used to trace physical circulation and water-mass history. Information of CDOM distribution can be useful to track river-borne components impact on water quality condition (Coble et al., 2003). This situation should be monitored continuously, and one example to monitor CDOM distribution in such a vast area is using remote sensing, as already been done in several studies (Belanger et al., 2008; Chen et. al., 2004; Kutser et al., 2005; Shanmugam, 2011; Swan et al., 2012).

The objective of this study is to map the distribution of CDOM in Berau Delta waters, East Kalimantan, Indonesia from remote sensing. This information is useful for monitoring the distribution of CDOM to the Berau continental shelf, especially due to the existence of a barrier reef system adjacent to the Berau Delta.

MATERIALS AND METHODS

The Berau Delta is located between 01°45′ to 02°35′ North and 117°20′ to 118°45′ East on the coast of East Kalimantan, Indonesia (Figure 1). The Berau coral barrier reef system adjacent to the Berau Delta, has a diverse coral community. Slight changes in the reef environment may effect on the health of coral reefs. Therefore, it is important to monitor the distribution of turbid water from the Berau River system into the Berau continental shelf. This study was focused in CDOM distribution of the turbid water.

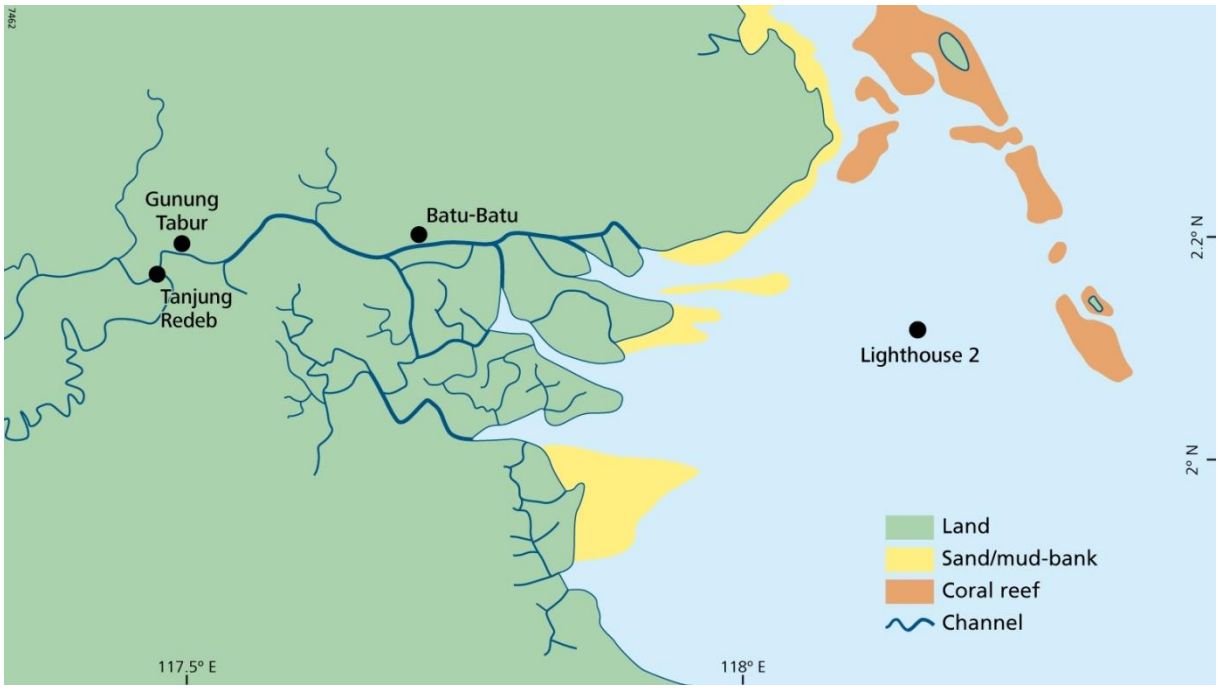

Figure 1. Map of the Berau delta and its channels in East Kalimantan, Indonesia with the coral barrier reef islands in the east (http://www.coastalresearch.nl).

The information of CDOM distribution was derived from Medium Resolution Imaging Spectrometer (MERIS) and *in situ* measurements. Three MERIS reduced resolution (RR) L1b data: August 28, September 15 and September 30, 2007 were used in this study. Case-2 regional algorithm in BEAM VISAT software was used to process the MERIS data. BEAM VISAT (http://www.brockmann-consult.de/cms/web/beam/) is an open-source toolbox and development platform for viewing, analyzing and processing of remote sensing raster data. Case-2 regional (C2R) algorithm derives the inherent optical properties (IOPs) based on a neural network (NN), which relates the bi-directional water leaving radiance reflectance with the IOPs (Doerffer and Schiller, 2008). Input to the algorithms is the water leaving radiance reflectance of 8 MERIS bands after atmospheric correction. The full description of the C2R algorithm can be found in Doerffer & Schiller (2007).

Field measurements of CDOM absorption was carried out in January 2009 and it was part of East Kalimantan Programme (Ambarwulan, 2010). CDOM absorption was defined as the absorption at 440 nm of all water constituents which pass a Millipore filter with a pore size of 0.2 µm. The slope of the quasi exponential decrease of absorption with increasing wavelength was determined as

$$S_{CDOM} = 0.016 \pm 0.0015 nm^{-1} \quad (1)$$

RESULTS AND DISCUSSION

In situ measurements shows that the CDOM absorption in the Berau river (mean = 1.35 m^{-1}) was higher than the open sea (mean = 0.19 m^{-1}). The CDOM absorption ranged from 1.67 m^{-1} in the river to 0.091 m^{-1} in clear open seawater. More CDOM were produced in the Berau River than in the

seawater. This result indicated that decomposition process was highly occurred in the river. Table 1 shows the statistical analysis of CDOM absorption in the Berau Delta (Ambarwulan, 2010).

Table 1. The statistical analysis of CDOM absorption in The Berau Delta (Ambarwulan, 2010).

Parameters	Min	Max	Mean	SD
$a_{CDOM}440$ [m^{-1}]	0.140	1.666	0.672	0.583
Slope S [nm^{-1}]	-0.015	-0.011	-0.012	0.002

The result of CDOM distribution derived from MERIS RR image shows in figure 2. Three different time acquisition of MERIS images shows different CDOM absorption. CDOM absorption on September 15th 2007 was lower compare to other results, while CDOM absorption on September 31st 2007 was the highest. MERIS image on August 28th 2007 show quite high CDOM absorption. MERIS images show CDOM absorption fluctuation from August 8th 2007 until September 31st 2007. The fluctuation can be caused by a lot of things such as the tide condition in the area and the rainfall condition. Unfortunately, we did not have the information of tide and rainfall which is coincide with the time of MERIS acquisition date.

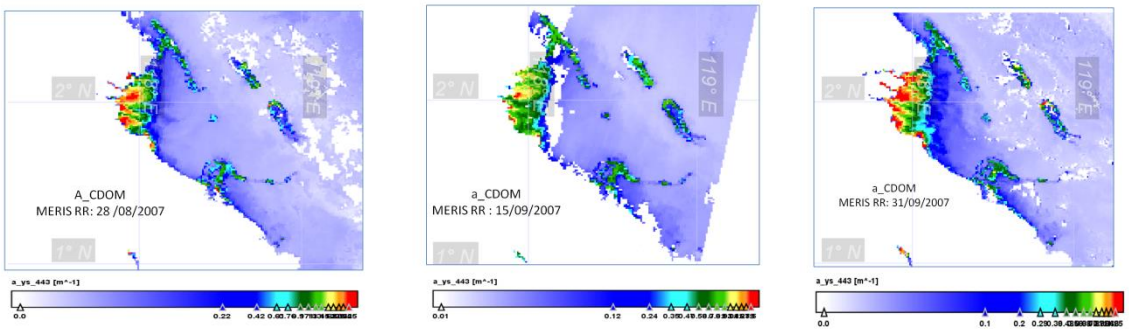

Figure 2. CDOM distribution derived from MERIS RR images.

The result might contain some incorrect information. The information of CDOM absorption was the result of C2R algorithm in BEAM VISAT software. One of the set up for the algorithm is the assumption of no bottom reflectance (IOCCG, 2006). This assumption could lead to incorrect results in the coral reef area in the eastern of Berau delta waters. The information should be validated with in situ measurements in the coral reef area.

Figure 2 also shows that the CDOM distribution to the open sea waters is not reach the coral reef area. The CDOM distribution appear limited at several km from the mouth of the Berau river. Tarya et al (2010) shows the influence of tidal and subtidal water motion at the Berau coastal shelf, which might be the reason of the CDOM distribution limit to the coral reef area.

CONCLUSION

In this paper we estimated the CDOM distribution from MERIS RR images using C2R algorithm in BEAM VISAT software. Although we have some *in situ* information related with CDOM absorption, unfortunately we cannot use it to validate the results from MERIS images because the time difference between in situ measurements and Image data acquisition. The image processing results shows CDOM distribution in the Berau delta. Some incorrect information might still exist, especially in the coral reef area, since the algorithm used no bottom reflectance assumption. The result also indicated that the CDOM absorption in the Berau Delta coastal waters ranged from 1.67 m^{-1} in the river to 0.091 m^{-1} in clear open seawater. The distribution to open seawater is restricted by tidal condition.

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