Study of Chlorophyll-a Distribution of Microalgae at Tasik Aman and Tasik Harapan in Penang Island Malaysia using Landsat Image

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Abstract. Environment study is vitally important in order to understand deeply about flora and fauna living in the Earth. Microalgae species has the uniqueness and specialty dominant producer in most freshwater and marine environment. Thus, microalgae are important as a principal energy base for many aquatic food webs in ecology and also have many benefits in human life such as medicine, cosmetic and food. Generally, chlorophyll-a is the pigment found in all photosynthesis plants including microalgae, and it is a very important as a parameter for estimation of lakes primary productivity in microalgae ecosystem. Chlorophyll of microalgae can be detected by using satellite remote sensing in the form of lakes colour. Variation of lakes colour reveals difference category of microalgae productive areas (i.e. distribution and where microalgae). In this study, satellite remote sensing image and dataset (i.e. Landsat 7) are used to measure the current state of chlorophyll-a distribution of microalgae at Tasik Aman and Tasik Harapan, Universiti Sains Malaysia (USM) in Penang Malaysia with the aid of PCI Geomatica software packaging. The Landsat 7 image and dataset in month May until June 2013 are used. From Landsat 7, its shows the existence of chlorophyll-a concentration of microalgae variability on that period is valid for this area. The result indicated that Landsat 7 approach is suitable used for studying chlorophyll-a concentration in this area but for mapping it is not suitable because Landsat has low resolution.

Keywords: microalgae, chlorophyll-a, remote sensing

INTRODUCTION

Optical remote sensing has been used widely in oceanography to find ocean surface estimates of chlorophyll-a concentration. It has been usually used by marine biologists as an index of algal biomass. The microalgae biomass represents a non-invasive as well as much less time consuming option in comparison to traditional analytical approaches used in marine biology. Higher spectral resolution observation, open the possibility for optical oceanographers to extract more spectral information which is related to microalgae variability. The optical variability is depends on the cell size, internal structure and specific pigment composition. However, beyond chlorophyll-a that common to all taxonomic groups of microalgae, the increasing in availability of hyperspectral technology on the remote sensing observing platforms provides the potential to map microalgae community composition in the ocean global [1].

Remote sensing is an effective technique to map coastal and inland water area through the analysis of digital images and using satellite data. There had a several investigations become interested in the application of remote sensing data to overcome limitations of traditional method [2]. The first satellite to produced maps of chlorophyll-a concentration of ocean with a satisfactory order error is Coastal Zone Color Scanner (CZCS) and [3] explained an algorithm for relationship between reflectance and sediment for CZCS data.

Chlorophyll is an important factor in photosynthesis activity and it is complex molecule found in all photosynthetic plants, including microalgae. Chlorophyll has been used to monitor vegetation stress, productivity, growth stage and nutrient cycling. There had a few types of chlorophyll identified and slightly differences in their molecular structure such as chlorophyll-a, b, c and d. Chlorophyll-a is the principal photosynthetic pigment and it is common to microalgae. Thus, the trace of chlorophyll-a will act as an important indicator to the existence of an amount of microalgae in the area. Hence, the accurate estimation of chlorophyll content is very important [4]. In addition, microalgae are microscopic plants and play an important as dominant primary producer in aquatic ecosystem.
Microalgae make up 50% of primary photosynthesis on the earth and are being used as indicator of environmental conditions caused by their populations that are sensitive to changes in nutrient level and water quality conditions [5]. Many previous scientists used Landsat data in their research, for example, [6] used Landsat data for monitoring lake water clarity and [7] used Landsat imagery for measuring chlorophyll. The objective of this paper is to study chlorophyll-a concentration of microalgae at Tasik Aman and Tasik Harapan, Universiti Sains Malaysia, Penang Malaysia using Landsat 7-ETM image (refer Figure 1).

![FIGURE 1. Study area map](image)

**METHODOLGY**

In this study, the data and images source from LANDSAT. The LANDSAT images of May until June 2013 have been downloading from U.S Geological Survey (USGS) website. Data of band 1, 2 and 3 were used to get chlorophyll-a concentration. This study was carried out according a few methodology steps (refer Figure 2. The atmospheric correction was applied using PCI Geometrical software. Chlorophyll-a concentration can be obtained using equation below (refer equation 1 and 2). This equation is used to related reflectance value from bands to observed chlorophyll-a concentration [7].

![FIGURE 2: Methodological steps](image)
\[ P = e_0 + e_1R_1 + e_2R_2 + e_3R_3 \]  

(1)

\[ C_a = 80.914 \, (R_1) + 38.7 \, (R_2) + 137.845 \, (R_3) + 11.53 \]  

(2)

where,

- \( C_a \) = Chlorophyll-a concentration
- \( R_1, R_2, R_3 \) = reflectance of three band 1, 2 and 3

**RESULT AND DISCUSSION**

The result and discussion of remote sensing data and method were used to investigate of chlorophyll-a concentration at Tasik Aman and Tasik Harapan, Universiti Sains Malaysia Penang Malaysia using LANDSAT 7 image. Table 1 was shown the result of chlorophyll-a concentration on May and June 2013.

<table>
<thead>
<tr>
<th>Location</th>
<th>Chlorophyll-a concentration on May 2013 (mg/m³)</th>
<th>Chlorophyll-a concentration on June 2013 (mg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>38.56</td>
<td>38.57</td>
</tr>
<tr>
<td>2</td>
<td>39.99</td>
<td>40.07</td>
</tr>
<tr>
<td>3</td>
<td>38.08</td>
<td>38.50</td>
</tr>
<tr>
<td>4</td>
<td>38.56</td>
<td>39.71</td>
</tr>
<tr>
<td>5</td>
<td>40.74</td>
<td>41.21</td>
</tr>
<tr>
<td>6</td>
<td>35.71</td>
<td>38.79</td>
</tr>
</tbody>
</table>

Result in table 1 is shown that the range value of chlorophyll-a concentration on May 2013 between 38.5 mg/m³ until 40.7 mg/m³ and on June 2013 data is 38.5 mg/m³ until 41.2 mg/m³. On May 2013, the highest value of chlorophyll-a concentration is 40.74 mg/m³ and the lowest value of chlorophyll-a concentration is 38.56 mg/m³. The different of highest data and lowest data for chlorophyll-a concentration on 23 May 2013 is 2.18 mg/m³ about 5.5%. These different values are not much bigger. Meanwhile, on 8 June 2013 the highest value of chlorophyll-a concentration is 41.21 mg/m³ and the lowest chlorophyll-a concentration is 38.50 mg/m³. The different of these two data is 2.71 mg/m³ about 6.8%.

The factor that can be affected the value of chlorophyll-a concentration is raining. It can be disturbed the photosynthesis occur and chlorophyll-a concentration of microalgae also was changed. Canopy and cloudy also can be affected the satellite data reading. Figure 3 and 4 shows the raw image of study area. In this study, the atmospheric correction and cloud and haze masking were applied using PCI Geomatica version 2013 software for all image-processing. Digital number (DN) for each location was determined for each band. The extracted DN value were converted into radiance and then converted into reflectance values to find concentration chlorophyll-a using equation (2).

From the result, chlorophyll-a concentration of microalgae has been trace that quite highest on June 2013 compared to May 2013 with total average 39.48 mg/m³ respectively which is considerably high. Refer graph 1 to see the different of chlorophyll-a concentration between months May and June 2013. In this paper, the mapping of the study area is not conducted because the two lakes are small and it does not match to LANDSAT resolution. LANDSAT has low resolution and it cannot map a small area.
CONCLUSION

In this study, LANDSAT dataset can be successfully used to trace chlorophyll-a concentration at Tasik Aman and Tasik Harapan, Universiti Sains Malaysia, Penang Malaysia on May and June 2013 although, the mapping at this area cannot carry on. The study also shown that chlorophyll-a content between these two months May and June 2013 in the same range. There is only slight different between these two months. However, In future research, we can apply this for bigger a lake which is according to LANDSAT resolution to trace and map out chlorophyll-a distribution of microalgae.
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REFERENCES