Chapter 6

ASSESSMENT OF THE CAPABILITY OF TiungSAT-1 SATELLITE DATA FOR MAPPING CHLOROPHYLL DISTRIBUTION

Mohd. Ibrahim Seeni Mohd and Lim Chee Ming
Faculty of Geoinformation Science and Engineering
Universiti Teknologi Malaysia.

ABSTRACT

The capability of TiungSAT-1 Multispectral Earth Imaging System (MSEIS) satellite data for mapping chlorophyll distribution was assessed for the coastal areas of Muar, Johor by using the green band 3 (0.50–0.59 μm), acquired on 29 July 2001. Sea-viewing Wide Field of view Sensor (SeaWiFS) data using the SeaWiFS default chlorophyll-a algorithm (OC4V4) was used to derive chlorophyll-a in the study area. The bands used are band 2 (443nm), band 3 (490nm), band 4 (510nm) and band 5 (555nm). The digital numbers (DN) of TiungSAT-1 data were converted to reflectance values by using internal average relative reflectance (IARR). A plot of SeaWiFS chlorophyll-a versus reflectance values from TiungSAT-1 data was made. The plots show that there is no correlation between reflectance values from TiungSAT-1 data and chlorophyll-a values from SeaWiFS data.

This is due to the unavailability of the blue band and the stripping effects in the TiungSAT-1 data. This indicates that the TiungSAT-1 satellite data is not useful in ocean colour studies to derive chlorophyll data.

Keywords: *Chlorophyll-a, SeaWiFS and TiungSAT-1*

INTRODUCTION

The importance of satellites for coastal and offshore water colour patterns showing the spatial and temporal variability of primary productivity has now been recognised (Gower 2001). Maps of chlorophyll concentrations are useful in the fishing industry to identify fish breeding areas. Since monitoring at global scale is of such importance for both the scientific and commercial domain, earth observation data, in particular satellite ocean colour data, plays a key role in providing information for fishery applications.

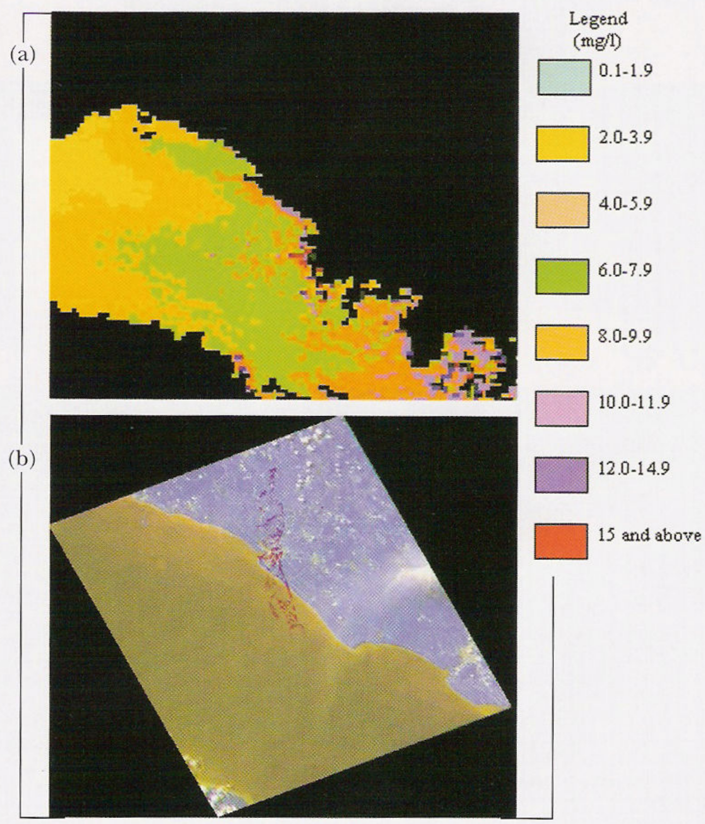

Figure 1. (a) SeaWiFS image showing chlorophyll distribution near Muar, Johor and (b) TiungSAT-1 image near Muar, Johor.

The visible wavelength, i.e. the blue and green region, is useful for ocean colour study. In this study, TiungSAT-1 Multispectral Earth Imaging System (MSEIS) data was tested in deriving chlorophyll information. Simple statistical relationships between digital number (DN), reflectance values and chlorophyll concentration were carried out using TiungSAT-1 and SeaWiFS satellite data near the coastal area of Muar, Johor (Figure 1).

SATELLITE DATA

A subset of TiungSAT-1 image on the green band (0.50-0.59 μm) was used. In the study, Internal Average Relative Reflectance (IARR) (ERDAS IMAGINE 1999) was applied to convert raw DN values to reflectance. The SeaWiFS L1A data used was downloaded from the Distributed Active Archive Center (DAAC) NASA homepage (NASA website 2002). Details of the SeaWiFS and TiungSAT-1 wavelengths and applications are given in Tables 1 (a) and (b).

Table 1. (a) Wavelength of TiungSAT-1 data (Source: ATSB website 2002)

(a) Wavelength of TiungSAT-1 data		
Band	Wavelength	Colour
1	810-890 nm	Near Infra-red
2	610-690 nm	Red
3	500-590 nm	Green

Table 1. (b) Wavelength and applications of SeaWiFS data (Source: Dundee website 2002)

(b) Wavelength and applications of SeaWiFS data				
Band	Wavelength	Bandwidth	Colour	Applications
1	412 nm	20 nm	Violet	Dissolved organic matter (violet absorption)
2	443 nm	20 nm	Blue	Chlorophyll (blue absorption)
3	490 nm	20 nm	Blue/green	Chlorophyll (blue/green absorption)
4	510 nm	20 nm	Green	Chlorophyll (green absorption)
5	555 nm	20 nm	Green/yellow	Chlorophyll (green reflection)
6	670 nm	20 nm	Red	Atmospheric aerosols
7	765 nm	20 nm	Near infra-red	Atmospheric aerosols
8	865 nm	20 nm	Near infra-red	Atmospheric aerosols

DATA PROCESSING

The TiungSAT-1 image was registered with the SeaWiFS image by using image-to-image registration giving a root mean square error of 0.056 pixel (Figure 2). The SeaWiFS Data Analysis System (SeaDAS) (Monirul Islam and Chan 2001) image-processing software was used to process the raw SeaWiFS L1A data to extract chlorophyll-a by using the SeaWiFS default chlorophyll-a algorithm (OC4V4) as given below.

Figure 2. Geometrically corrected TiungSAT-1 image registered with SeaWiFS image.

$$C_a = 10^{(0.366 - 3.067 R_{4s} + 1.930 R_{4s}^2 + 0.649 R_{4s}^3 - 1.532 R_{4s}^4)} \quad (1)$$

where,

$$R_{4s} = \log_{10}(R_{555}^{443} > R_{555}^{490} > R_{555}^{510}) \quad (2)$$

R_b^a is the largest ratio value for water-leaving radiance between the two bands used.

Statistical analysis was carried out using the 13 June 2001 data to obtain the correlation between ground truth chl-a and SeaWiFS derived chl-a which gave a high correlation value of 0.85 (Figure 3). Since the correlation is high, statistical analysis was also carried out to obtain a correlation between TiungSAT-1 satellite data and the SeaWiFS satellite data which were acquired on the same date, i.e. 29 July 2001. Two types of correlation, (i) mean of SeaWiFS band 4 and band 5 DN values versus TiungSAT-1 band 3 DN values (Figure 4(a)) and (ii) SeaWiFS chl-a from OC4V4 versus TiungSAT-1 band 3 reflectance values (Figure 4(b)) were obtained.

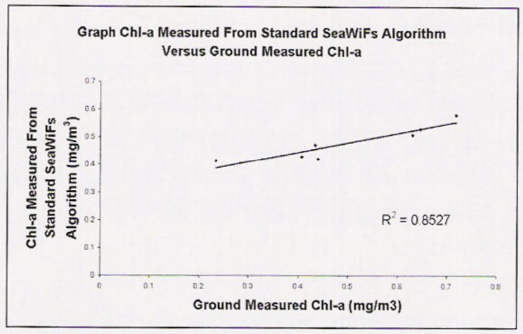

Figure 3. Correlation between chlorophyll-a measured from standard SeaWiFS algorithm OC4V4 versus chlorophyll-a from ground truth measurements.

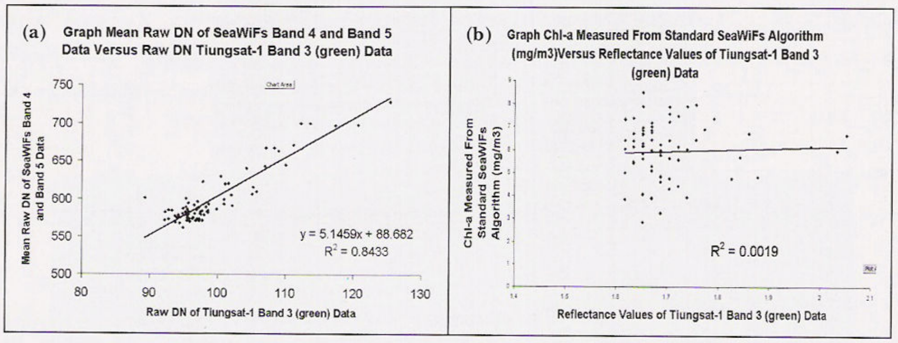

Figure 4. (a) Correlation between mean band 4 and band 5 DN of SeaWiFS data and band 3 DN of TiungSAT-1 data. (b) Correlation between Chlorophyll-a calculated from SeaWiFS OC4V4 algorithm and reflectance values of TiungSAT-1 band 3 data.

RESULTS AND DISCUSSION

The regression analysis carried out between SeaWiFS mean band 4 and band 5 DN and TiungSAT-1 band 3 DN gives a correlation of 0.84. Linear regression between SeaWiFS chl-a from OC4V4 and reflectance values from TiungSAT-1 band 3 give a correlation of 0.0019.

Figure 4(a) shows a good correlation between SeaWiFS mean of band 4 and band 5 and TiungSAT-1 in the green band 3 but Figure 4(b) shows a poor correlation between SeaWiFS chl-a derived using OC4V4 algorithm and TiungSAT-1 reflectance values. This shows that TiungSAT-1 data is not that useful for ocean colour studies for deriving chlorophyll information. This is due to the lack of the blue band that is usually used in chlorophyll algorithms which is available in the SeaWiFS data. For future TiungSAT-1 satellites the blue band (433-453 nm) should be included together with the existing green band to make it useful for chlorophyll studies. In addition, the TiungSAT-1 data has stripping effects which may also affect the results.

CONCLUSION

The study carried out shows that the TiungSAT-1 MSEIS data is not useful for ocean colour studies in deriving chlorophyll information. The inclusion of a blue band in future TiungSAT-1 satellites would make it more useful for future studies.

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