CAPABILITY BETWEEN HYPERSPECTRAL AND MULTISPECTRAL IMAGE FOR WATER QUALITY ESTIMATION

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ABSTRACT: Chlorophyll-a, total nitrogen (TN), and total phosphorus (TP) are water quality parameters which are periodically measured by point based field measurements. Many studies tried estimation of water quality parameters using multispectral (MS) imagery those shown limitations due to broad band width of MS data. Some satellite images have narrow band for ocean water quality monitoring although they have low spatial resolution for in-land water. Hyperspectral (HS) image is consisted with narrow and contiguous bands which is more suitable for in-land water quality estimation than MS image. In this study, we compared capability between MS and HS image to estimate the in-land water quality parameters. MS (ALI) and HS (Hyperion) image were acquired at same time for overlapped area and field data were collected in a week of image acquisition at some points. Correlation coefficients were calculated among field measured parameters, MS, and HS image, respectively. Results show much higher correlation coefficients for some HS bands than MS bands. The high correlation coefficients of HS bands are well known as wavelength of chlorophyll absorption. Therefore, HS image has higher capability to estimate in-land water quality than MS image.

1. INTRODUCTION

Chlorophyll-a, total nitrogen (TN), and total phosphorus (TP) are primary water quality parameters which are periodically measured by point based field measurements. Many studies tried estimation of water quality parameters using multispectral (MS) imagery those shown limitations due to broad band width of MS data (Harma et al., 2001; Hellweger et al., 2004; Keiner and Yan, 1998). Therefore some ocean color satellite imagery includes narrow bands in visible region to estimate ocean water quality such as chlorophyll concentration because some narrow wavelength regions have shown high sensitivity to concentration of algae (Van Der Meer, 2003; Yacobi et al., 1995). However ocean color imagery has low spatial resolution to monitor in-land water quality such as AVHRR, SeaWiFS, and MODIS those have over than 500m resolution (Hellweger et al., 2004; Dekker et al., 1991).

Hyperspectral (HS) image is consisted with narrow and contiguous bands which is more suitable for in-land water quality estimation than MS image. Some studies presented good result of chlorophyll estimation using HS image those were build experimental regression models between image and field measurements (Ostlund et al., 2001, Thiemann and Kaufmann, 2002; Lubac et al., 2008) although HS image cannot acquire data for wide area and frequently.

In this study, we compared capability between MS and HS image to estimate the in-land water quality parameters such as chlorophyll-a, TN, and TP.

2. DATA AND STUDY AREA

EO-1 Hyperion HS image and ALI MS image were used to compare of capability for estimation of water quality parameters which were obtain image simultaneously for overlapped area. Two HS and MS image were acquired on June 3, 2001 for Seoul city area. Hyperion image is consisted 242 contiguous bands with 10nm band width in 350-2500nm and it has 7.5km swath width with 30m resolution. ALI image has 9 bands within 400-2500nm with 30m resolution and 40km swath width. In this study, 50 Hyperion bands and 4 ALI bands were used respectively which are bands in 400-900nm region. Figure 1 shows Hyperion and ALI image for overlapped area in Seoul city area and 6 yellow circles are water quality measuring points (station) by Ministry of Environment (ME), Korea.

Water quality data were acquired within a week from image acquisition date and there were no precipitation therefore water quality would be similar between field measuring date and image acquisition date. Chlorophyll concentration was from 1.2 mg/L to 70.8 mg/L and TN was from 2.059 mg/L to 36.695 mg/L and TP was from 0.079 mg/L to 2.597 mg/L.

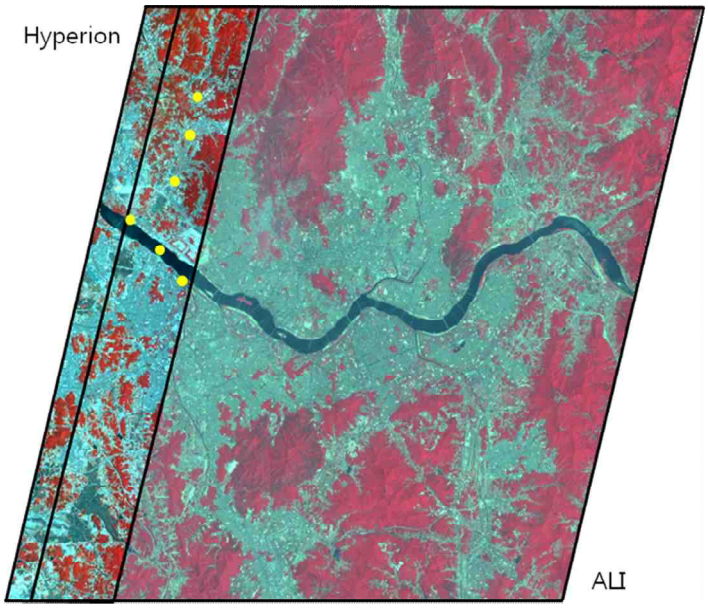

Figure 1. EO-1 Hyperion HS image and ALI MS image for overlapped area and yellow circles are water quality monitoring stations within overlapped area.

3. CORRELATION ANALYSIS

Correlation coefficients were calculated among bands of Hyperion, ALI image and field measured water quality parameters which were chlorophyll-a, TN, and TP. Table 1 and 2 shows the correlation coefficients for some bands of Hyperion and ALI image respectively. Green and NIR bands of Hyperion (band 21 and 42) and ALI (band 3 and 5) image show stronger correlation than other bands for chlorophyll-a although the correlation coefficients are not very high. For TN and TP, blue and red bands of Hyperion (band 9 and 34) and ALI (band 2 and 4) shows strong correlation. Moreover Hyperion bands show stronger correlation for every parameter due to narrow band width. Therefore Hyperion could be better image data to estimate water quality parameters although some bands of Hyperion is not agreed well know chlorophyll-a sensitive wavelength such as 440nm, 550nm, 675nm, and 700nm. Because just 6 field samples were used that has limitation to statistical significance.

Table 1. Correlation coefficients between Hyperion bands and field measured water quality parameters

Band	Wavelength	Corr. with Chl-a	Corr. with TN	Corr. with TP
Band 9	436nm	0.36	0.80	0.78
Band 21	559nm	-0.43	0.22	0.21
Band 34	691nm	-0.09	0.52	0.54
Band 42	772nm	-0.47	0.13	0.14

Table 2. Correlation coefficients between ALI bands and field measured water quality parameters

Band	Wavelength	Corr. with Chl-a	Corr. with TN	Corr. with TP
Band 2	509nm	0.06	0.64	0.61
Band 3	596nm	-0.31	0.34	0.36
Band 4	683nm	-0.05	0.59	0.62
Band 5	779nm	-0.37	0.28	0.30

Figure 2 shows correlation coefficients for chlorophyll-a, TN, and TP with Hyperion radiance image. Chlorophyll-a shows negative correlation for overall wavelength and correlation is stronger from 550nm than shorter wavelength. TN and TP shows similar correlation with Hyperion image and correlation coefficients are higher in blue wavelength (400-500nm) than the other wavelength.

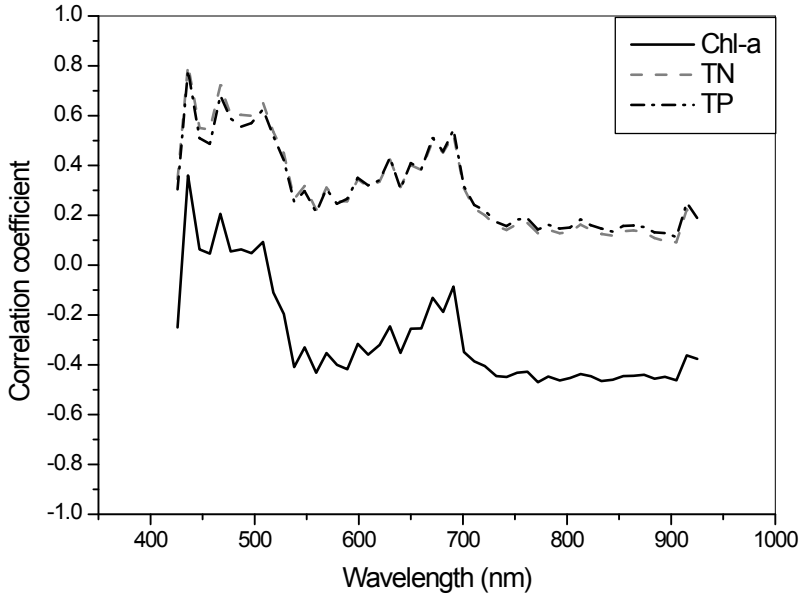

Figure 2. correlation coefficients for chlorophyll-a, TN, and TP with Hyperion radiance respectively.

4. CONCLUSIONS

In this study, we compared capability between HS and MS image to estimate water quality parameters using correlation analysis. The results shown higher correlation coefficients for certain HS bands for water quality parameters although number of field measured sample were limited. Consequently HS image would have more capability than MS image for in-land water quality monitoring. In further study, correlation analysis is needed with sufficient number of field measured data for wide area using HS image.

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