Variation in the Spectral Reflectance Characteristics of Water with Different Amounts of Suspended Solids

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Abstract: Variation in spectral reflectance values in the near-infrared band manifests different amounts of suspended solids and colloids. The study aims to characterize the near-infrared reflectance values of the different amounts of suspended solids and colloids. Water samples of different locations with variation in qualities in terms of their turbidity were collected to analyze total solids (TS), total suspended solids (TSS), Fe content and total dissolve solids (TDS). Significant difference in the reflectance of the difference in water body quality was evident. The water body containing Fe and suspended solids is capable of reflecting significant amounts of the Near-infrared band. The obtained results enable the water body qualities to be monitored using satellite imagery.

INTRODUCTION

Surface water depends on different physical and chemical characteristic such as environmental, biological, and physical etc. It is useful for utilization, consumption, agriculture, and industry etc. Satellite image is recorded by digital image data consist of pixel that is reflectance values from various objects on the Earth's surface. Environmental Remote Sensing (1999) reported that characteristics of water from satellite image are different on mix components which are categorized into three categories: physical, chemical and biotic component. Nowadays, these data are used to evaluate the quality of water for decreasing limitation of data and analysis in the field (Sudheer et al., 2006) base on the relation between water quality in the field and reflectance values. Due to the Water quality in field is limited (Ming-Der Yang et al., 1999) especially in terms of time and space area, the relationship between the parameter of water quality and the reflected power measurements are more complex (Yuanzhi Zhang et al., 2003). Due to the interaction between the various components of the physical properties of water such as water color and turbidity, the effect of dissolved solids in water or colloidal suspension in water information can be detected by satellite imagery (Gerald K. Moore, 1980).

The objective in the research is to analyze the tendency quality of water by physical characteristic which is affected on satellite image SMMS reflected energy in infrared wave. Because it is one component that measure by satellite image, parameters consist of Total suspended Solids, Total Dissolve Solid, Fe, color, turbidity, comparison between relative statistics and reflected energy in infrared wave, recording image data between reflected energy in infrared wave around Khon Kean province, determination the sample size of water for representative 10 Pixel. All parameters create a multiple regression equation for prediction of reflectance values in the near-infrared spectral.

STUDY AREA

Khon Kaen province located in the middle of the northeast between 15-17 degree north latitude and 101-103 degree east longitude, 10,880 square kilometers (Fig. 1). In this study, ground water sample in Khon Kaen province and tendency on some quality water that affected on reflectance values in the near-infrared spectral were collected.

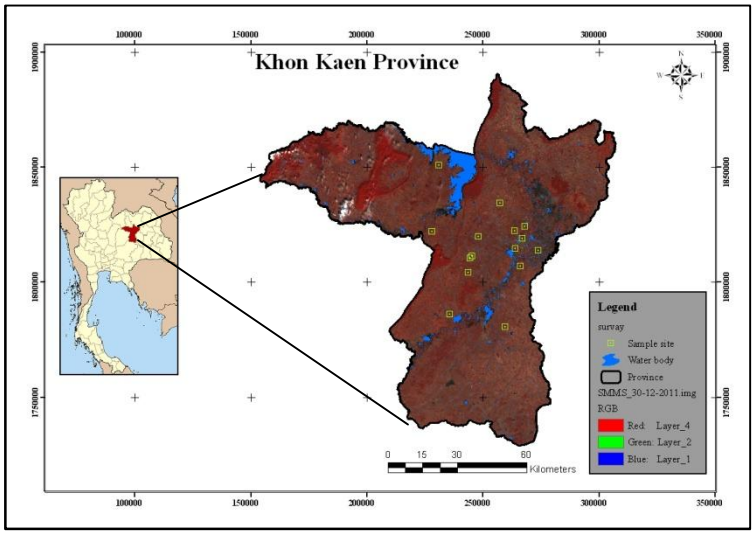

Fig.1 Khon Kaen province

METHODS AND EQUATION

This research measures reflectance values in the near-infrared spectral of sample site and sampling in the water. Parameters are evaluated by laboratory and relative between the statistic and reflectance values. The method of the research are shown in Fig. 2 for the systematic research.

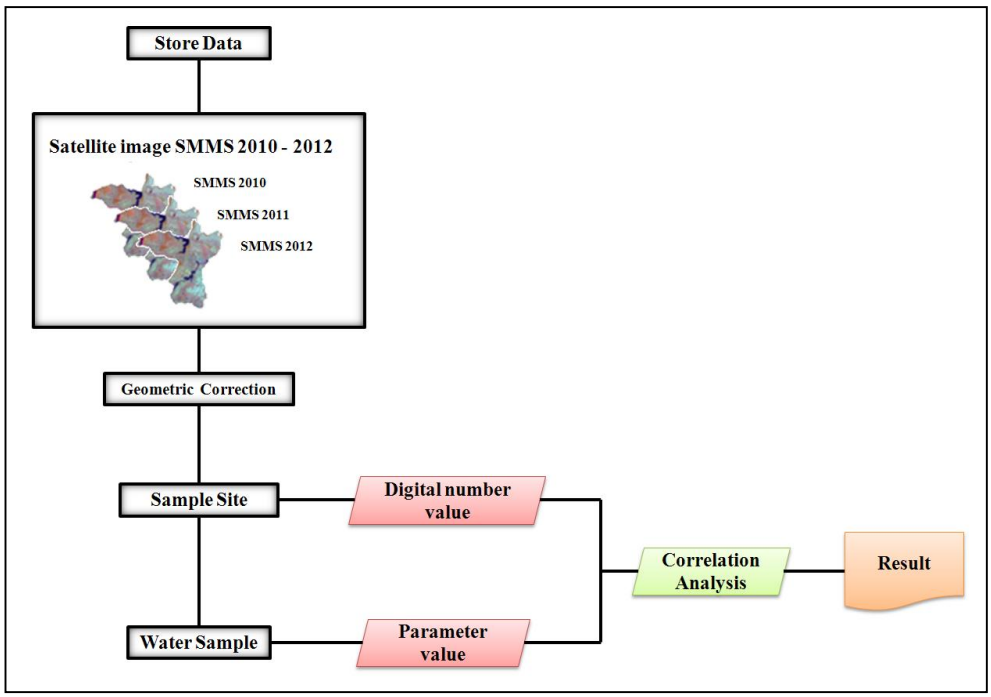

Fig. 2 Flow chart showing the main implementation methodology

STORAGE DATA

The Satellite image SMMS were collected between 2010-2012 A.D. and rearranged in geometry for determination of GPS reference by aerial photograph scale 1:4000. The 15 samples of GPS were collected from middle of surface water, stored in the freezer for preservation of water and later evaluation of parameter in laboratory.

CLASSIFICATIONEvaluation reflectance value from satellite image, classified the surface water by mix False color composite satellite image. Use band 4,2 and 1 R, G and B respectively classified easily. So color are classified three main groups : Black , Blue and Blue-green. In each group, different reflective data from minimum to maximum in Fig 3. Evaluation the wave reflective data in each ground water compare with other parameter. The average 10 pixel for representative surface water.

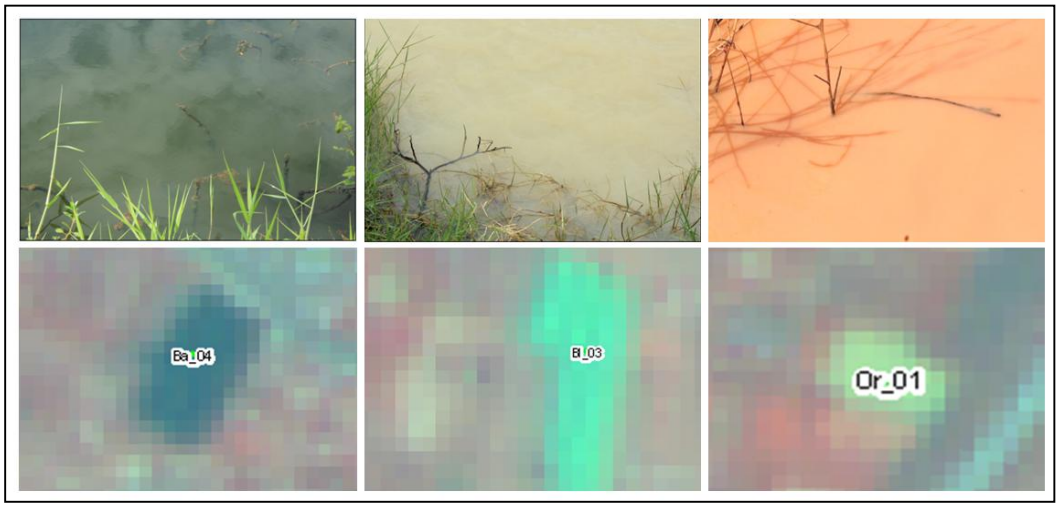

Fig. 3 Show a difference of the characteristic of water and color from satellite image.

Evaluation the parameter of water sample

The component of sample surface water are evaluated by interesting five parameters for Total suspended Solids, Total Dissolve Solid, Fe, color and Turbidity. In each parameter are different evaluated by laboratory. Reported all of data in mg/l unit except turbidity data in NTU unit and color data in unit. In each parameter are different measurement in Table 1.

Table. 1 show a detail of parameter

NO	Parameter (Unit)	Test Method	Interval of reporting
1	TSS (mg/l)	TS - TDS	≥25
2	TDS (mg/l)	Dried at 103 - 105 °c	≥25
3	Fe (mg/l)	In-house method Flame AAS	≥0.05
4	Color (Unit)	Visual Comparison Method	≥5
5	Turbidity (NTU)	Nephelometric Method	≥2.0

STATISTICAL ANALYSIS

Correlation coefficient for relation between reflectance value and water parameter were statistical analyze using Bivariate correlation test which P< 0.05 presented as significance different and test multiple regression by stepwise for some parameter effective to reflectance value.

RESULTS

The result on reflectance values of sampling from SMMS satellite between the years 2010-2012 are shown in Fig. 4. It was revealed that measurement of four waves reflective in three groups of surface water between the years 2010-2012 tended to reflect in the same direction. In addition, the clear water showed that all wave reflection was quite low; however, reflection increased in turbidity water. Moreover, Fig. 4 shows that reflection tended to be increased by characteristic water. Clear (Ba), turbidity (Bl) and red turbidity water from Fig. 3 show that reflection was clearly increased in red and closed infrared spectral.

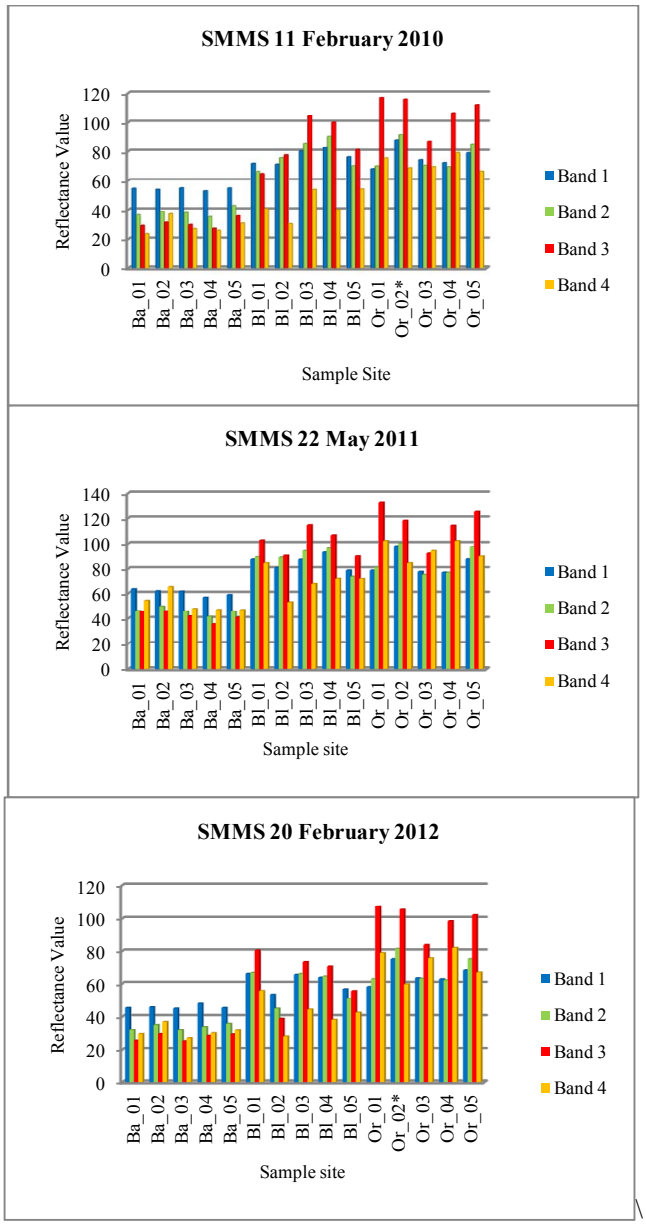

Fig. 4 This picture is show reflectance values of sampling from SMMS satellite between 2010-2012 A.D.

The result of water sampling (TSS, TDS, Turbidity, Fe and Color) showed in Table 1 revealed that all parameters tended to increase as reflection value was increased while TDS tended to decrease. Measurement parameters show that clear water has higher TDS than clearly water but turbidity water has increased Fe while TDS was decreased. On the other hand, while TSS was increased, color of water data varies turbidity water.

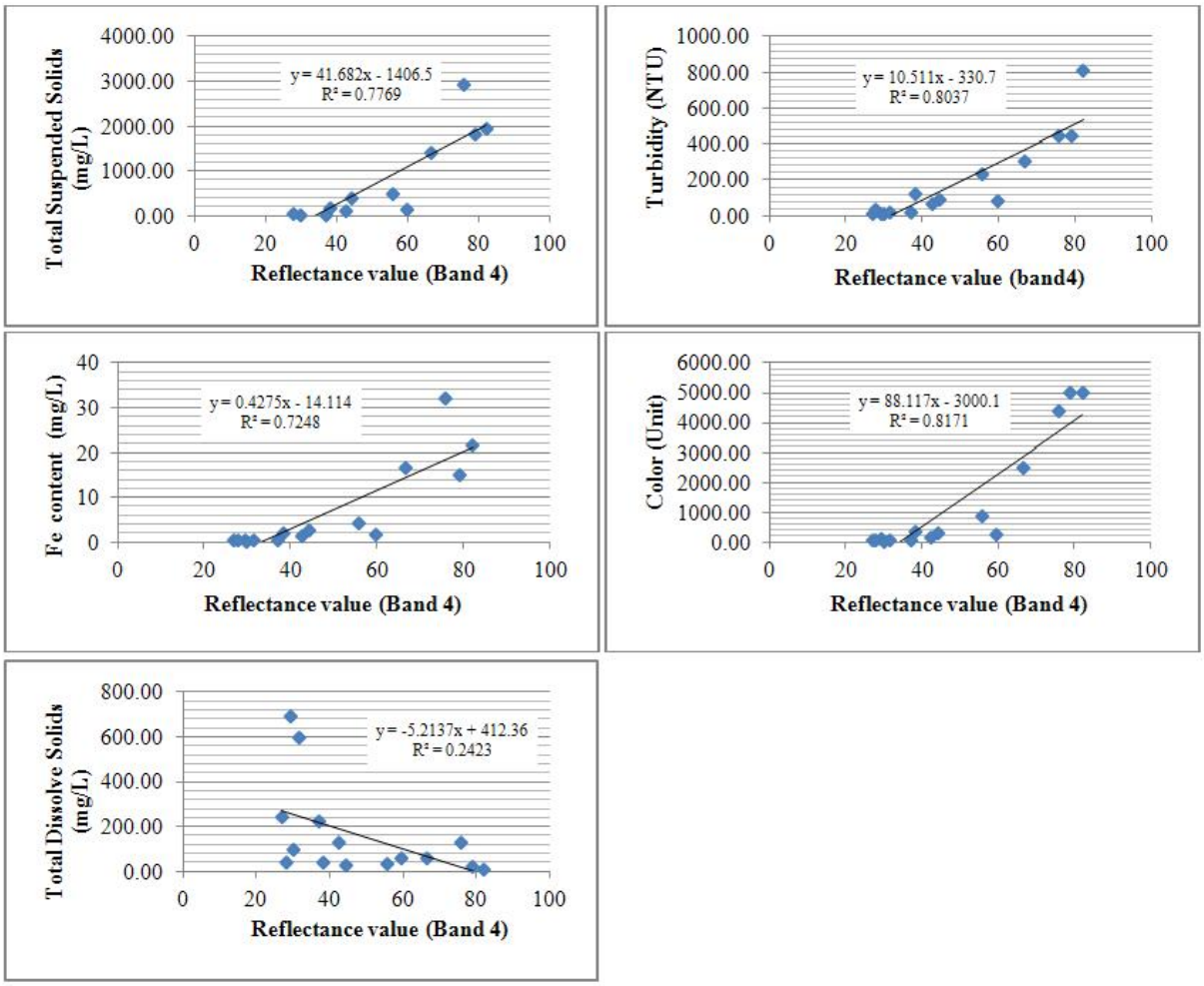

Fig. 5 Show analysis of the relationship between the reflectance Value (Band 4) and parameters of Water**.**

Reflectance value and water parameter were evaluated for relative data by correlation coefficient. Closed infrared wave and parameters (TSS, Turbidity, Fe and color) was the highest relation at 0.877, 0.896, 0.851 and 0.904, respectively (P=0.01). While red spectral, Fe and TDS were related at -0.633 and 0.629, respectively (P=0.05), TSS, Turbidity and Color were related at 0.659, 0.711 and 0.688, respectively (P=0.01). Statistic shows that water parameter relative reflection wave means increasing of reflection as well as water parameter (Table 3).

Table 3 Show analysis of the relationship between the reflectance Value and parameters of Water.

Correlations

		TSS	TDS	Turbidity	Fe	colour	Band 1	Band 2	Band 3	Band 4
TSS	Pearson Correlation	1	-.336	.866**	.991**	.946**	.407	.472	.659**	.877**
	Sig. (2-tailed)		.221	.000	.000	.000	.132	.075	.008	.000
TDS	Pearson Correlation	-.336	1	-.417	-.309	-.353	-.664**	-.652**	-.633*	-.492
	Sig. (2-tailed)	.221		.122	.262	.197	.007	.008	.011	.062
Turbidity	Pearson Correlation	.866**	-.417	1	.855**	.937**	.445	.498	.711**	.896**
	Sig. (2-tailed)	.000	.122		.000	.000	.096	.059	.003	.000
Fe	Pearson Correlation	.991**	-.309	.855**	1	.913**	.410	.463	.629*	.851**
	Sig. (2-tailed)	.000	.262	.000		.000	.129	.083	.012	.000
colour	Pearson Correlation	.946**	-.353	.937**	.913**	1	.351	.438	.688**	.904**
	Sig. (2-tailed)	.000	.197	.000	.000		.199	.103	.005	.000
Band 1	Pearson Correlation	.407	-.664**	.445	.410	.351	1	.985**	.891**	.664**
	Sig. (2-tailed)	.132	.007	.096	.129	.199		.000	.000	.007
Band 2	Pearson Correlation	.472	-.652**	.498	.463	.438	.985**	1	.941**	.729**
	Sig. (2-tailed)	.075	.008	.059	.083	.103	.000		.000	.002
Band 3	Pearson Correlation	.659**	-.633*	.711**	.629*	.688**	.891**	.941**	1	.898**
	Sig. (2-tailed)	.008	.011	.00	.012	.005	.000	.000		.000
Band 4	Pearson Correlation	.877**	-.492	.896**	.851**	.904**	.664**	.729**	.898**	1
	Sig. (2-tailed)	.000	.062	.000	.000	.000	.007	.002	.000	

N = 15

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Our results show that the energy of the reflected waves from the satellite record is associated with the characteristic of water body. The effects of different water element will affect on the reflected energy varies as well. By the turbidity of the water is clear, the main factors that affect water resource that is the water parameters are measured very small except for the TDS and the reflector of a satellite by the fall as well. When the water has a turbidity increase due to various reasons it makes such parameters. The turbidity suspended solids in water. The value of the iron and the color of the water increasing the turbidity level of the water. Water turbidity and color red the highest value of iron than other types of water are expected as a result of the emptying of ground water resources in the area.

CONCLUSION

Based on the present finding, it could be concluded that the introduction of satellite images data SMMS can be used to track and monitor water resources more efficiently than monitoring the red spectral. With near-infrared spectral as compared to the total solids in the water which has a Fe elements, and can also be a reflectance value is compared with the turbidity and color of the water. This allows Users can to use the results to decide on the interpretation satellite images data or other areas of study based on data from satellite images. The areas in the province that the water will have a different appearance of the landscape. The water is turbid

red color is found on areas with high and low to find a way to crystal clear up the water. So, the use of satellite images is another option in the management of water resources for the benefit of the consumers of the public charger.

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