Development of Agriculture-related Data Inventories Using IKONOS Images

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Abstract: This paper explores the use of IKONOS imagery of 1 m resolution panchromatic (PAN) band and 4 m resolution multi-spectral (MS) band in the development of agriculture-related data inventories. Three images (May 25, 2001, December 25, 2001, October 23, 2003) were used to obtain temporal distributions in crop cover characteristics such as rice, pear, grape, red pepper, corn, barley, garlic and surface water cover of reservoir with field investigations. The availability and cost problems are expected to solve by KOMPSAT-2 that is scheduled to launch in 2005. The capability of KOMPSAT-2 image for crop and rural water resources management will increase by accumulating temporal data inventories as a database.

Keywords: IKONOS, KOMPSAT-2, Agriculture, Land use, Classification system.

1. Introduction

In South Korea, even though satellite images have been recognized to have a potential for practical use in the field of agriculture, there have been many constraints in obtaining, designing, and analyzing images because of high prices, little images of temporal series, and coarse spatial resolutions for our agricultural applications. Fortunately, the government perceived the importance of earth remote sensing satellite of our own, KOMPSAT-1 (KOrea Multi-Purpose SATellite-1) launched at 1999 is in operation with 6.6 m spatial resolution of EOC (Electro-Optic Camera) and KOMPSAT-2 of 1 m resolution panchromatic (PAN) band and 4 m resolution multi-spectral (MS) band is scheduled to be launched in 2005. Thus, it is expected that a lot of agriculture-related information can be obtained from the images of KOMPSAT-2, and furthermore the images will play a role to update rural GIS data and to activate data use in the field of agriculture.

The very high satellite resolution imagery KOMPSAT-2 has a potential opportunity for farm and crop management To provide operational crop information at a regional scale, frequent coverage is critical. Analysis of multiple-date imagery in the phonological cycle provides information on how the specific agricultural variables are changing through time. Thus, the key point for testing the applicability to crop management is that KOMPSAT-2 has to establish a special operational policy to acquire imageries off-nadir and oblique viewing at critical dates for a predetermined agricultural area.

However, we can expect that there may be some operational and observational difficulties in temporal resolution that mean lack of obtaining a series of good quality of images for a given geographic area. So, an up-to-date agriculture related data inventory development using information obtained from remote sensing data analysis and existing databases of crop and rural water resources can be an alternative. This kind of approach can help an identification of agricultural species, cultivation area, and crop condition during the growth stage. As the crop information from both images and field investigations are accumulated, reasonable crop mapping, crop condition and crop yield estimation would be possible. This paper presents a methodology for development of an up-to-date agriculture related data inventories especially for crop mapping, crop condition and crop yield estimation using IKONOS multi temporal images and with field investigations

2. Study Area, Remote Sensor Data and Preprocessing

The study area as shown in Fig. 1 is Gosam-myeon in Anseong-si that has a diverse agricultural environment. It lies between the coordinates of latitude N 37° 03′ 31″ to N 37° 07′ 53″ and longitude E 127° 13′ 56″ to E 127° 18′ 16″. For 27.8 km^2, more than 52.0 % is forested and 16.8 % of lowland is paddy fields. The remaining area is dry field farming (6.6 %) and rangeland (2.7 %) scattered between the forest and the paddy.

Table 1 shows three selected IKONOS images to evaluate agriculture-related information. IKONOS Standard Geo Level images were ortho-rectified by using GCPs and 5 m DEM from 1:5,000 NGIS digital map and in-situ GPS data acquired from Trimble GeoExplorer III. Generic Pushbroom Model of ERDAS (1999) IMAGINE OrthoBASE 8.5 was used for ortho- and geo-rectification. Fig. 2 shows the IKONOS image before with GCPs and after orthorectification.

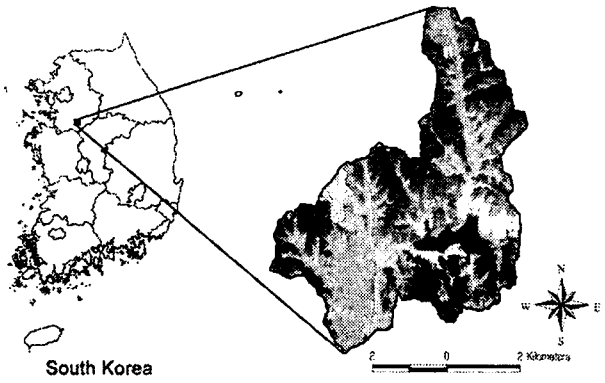


Fig. 1. The study area.

Table 1. The selected IKONOS images and their result of orthorectification

Obs. date	Type	RPC	GCPs	RMSE (m) X/Y/Z
May 25, 2001	Pan. 1	-	513	3.40/3.38/1.07
	M/S 4	-	499	1.54/1.69/0.25
Dec. 25, 2001	Pan. 1	-	509	3.12/3.10/0.75
	M/S 4	-	497	2.01/3.18/1.50
Oct. 23, 2003	Pan. 1	NIR_RPC	5	2.01/3.18/1.50
	M/S 4	RGB_RPC	5	0.60/1.43/0.23

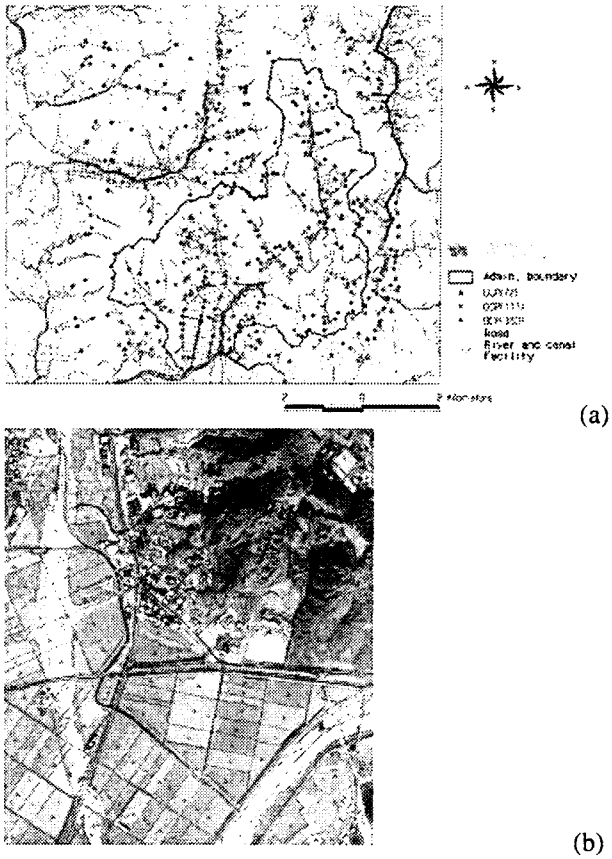


Fig. 2. Ortho-rectification a) GCPs before, b) after.

3. Development of Data Inventories

1) Reservoir Water Surface Area

The Sobel edge detector filtering was adopted to enhance each image and the reservoir water surface was extracted using feature extraction and digitizing method. Fig. 3 shows the comparison result of extracted water surface. The white spots by feature extraction are fishing boats that are counted as errors in estimating water surface area. May 21 image showed a decreased water surface area (152.8 ha, 66.1 %) because of the reservoir release for irrigation of downstream paddy fields compared to October 24 image (211.8 ha, 91.7 %). December 25 image (205.8 ha, 89.1 %) could not fix a certain boundary between land and water because of the ice/snow cover along the waterside.

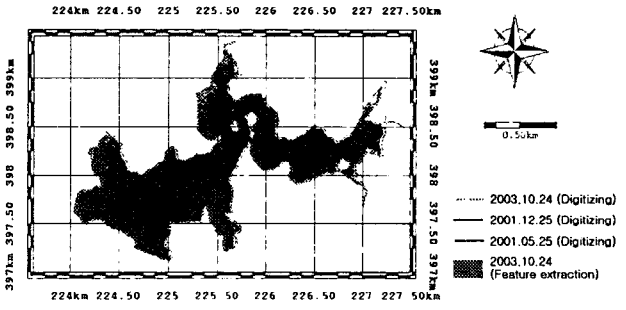


Fig. 3. Comparison of extracted reservoir water surface by feature extraction and digitizing method.

2) Crop Cover Information in the Phonological Cycle of Selected Crops

Crop texture and average pixel value of each band were adopted as data inventory of crop information. Texture from image and photo by field survey for May 25 and October 24 were made out to cultivation calendar of rice, pear, grape, red pepper, corn, barley and garlic. Fig. 4 shows an example of pear, and Fig. 5 shows the band 1 and band 2 average pixel value for the selected crops of May 25 of 2001 and October 24 of 2003. The values of May 25 ranged widely compared to the values of October 24. This means that May 25 image is better to discriminate each crop than October 24.

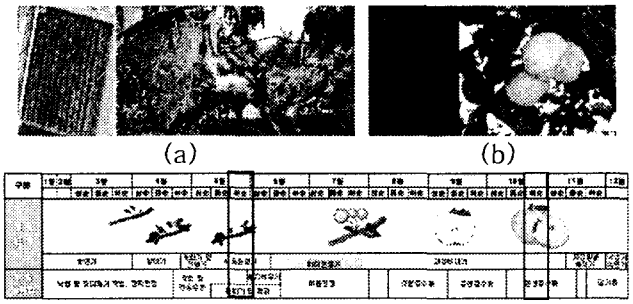
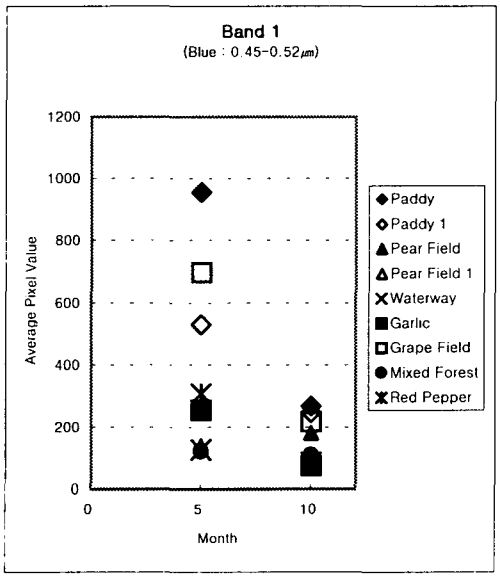


Fig. 4. Texture from image and photo by field survey with cultivation calendar of pear. a) May 25, 2001, b) October 24, 2003



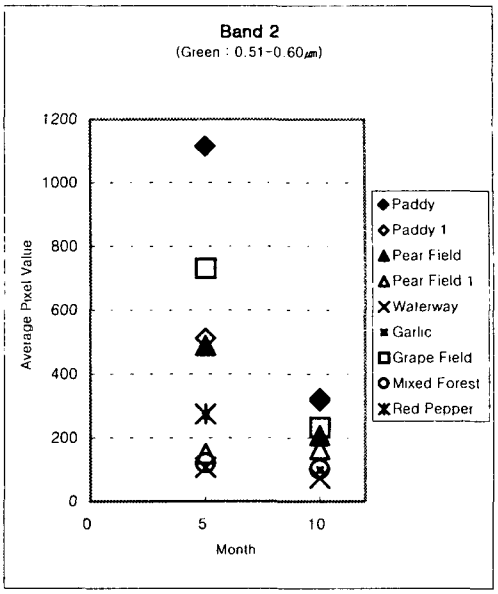


Fig. 5. The average pixel value of selected crops for band 1 and band 2 of May 25, 2001 and October 24, 2003 images

4. Summary and Conclusions

A method of up-to-date agriculture related data inventory development using crop cover information such as texture and average pixel value of the crop based on cultivation calendar was suggested. Three IKONOS images (May 25, 2001, December 25, 2001, October 23, 2003) were used to obtain crop cover characteristics such as rice, pear, grape, red pepper, corn, barley, garlic, and surface water cover of reservoir with field investigations. Especially during the early period of KOMPSAT-2, this kind of approach would be a practical application for crop management to identify crop species, cultivation area, and crop condition. As the crop information from both images and field investigations are accumulated for several years, reasonable crop mapping, crop condition and crop yield estimation would be possible.

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