# VEGETATION COVER MAPPING USING MULTI-TEMPORAL HJ SATELLITE DATA

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**Abstract – Vegetation cover plays a key role in terrestrial biophysical process and is related to a number of ways to the dynamics of global climate, carbon pool and ecosystem modelling. In this study, we explored the potential of multi-temporal HJ Satellite data for mapping of vegetation cover types in northeast part of China. Small Satellite Constellation for the Environment and Disaster monitoring and forecasting, is shortly named as HJ. HJ-1A and HJ-1B were launched in 2008, are in orbit and operational. The swath of CCDs are about 700 km, the spatial resolution is 30 m, and the revisit-period of the constellation could be less than 48 hours. It would be suitable for vegetation monitoring and mapping in local or regional scale. Analysis of temporal NDVI allows identification of distinct growth pattern between the different vegetation cover types, so as to improve the accuracy of the classification of vegetation. Vegetation map derived from multi-temporal HJ satellite data will be very useful as input to biogeochemical models that require timely estimation of forest area and type.**

**Keywords： Vegetation cover mapping, HJ-1A/1B, Multi-temporal, NDVI, Classification**

## 1. INTRODUCTION

Mapping the distribution of vegetation cover across regional area is prerequisite for informed nature resources management. While remote sensing data acquired in one time is reflected the status of land cover at that time, multi-temporal satellite imageries are beneficial to identify the growth cycle of crops and forest and their phonological cycle. Over the last decades, numerous studies of large scale mapping of land cover and land use have explored data from NOAA Advanced Very High Resolution Radiometer (AVHRR), SPOT-4 Vegetation, Moderate Resolution Imaging Spectradiometer (MODIS), Medium Resolution Imaging Spectrometer (MERIS) and Wide Field Sensor (WiFS) that provide daily or 3-5 days' observation of the earth. Such studies can exploit the change in the phenology of seasonal forest/vegetation, foliage activity and stress (Joshi et al, 2006). Vegetation monitoring at a spatial scale finer than 188 m and multi-temporal data is essential to understand regional scale land cover dynamics. HJ-1A/1B has the ability to fill the requirement due to its spatial and temporal characteristics. HJ data have been used to characterize the land cover classification (Ren et al, 2009) and extract the biophysical parameters of crops (Chen et al, 2010). However, no initiative has been taken to map vegetation cover using multi-temporal HJ data. Analysis of multi-temporal remote sensing imageries can indicate the phonological phase including greening, maturing, and senescence.

In this study, we explored the potential of multi-temporal HJ-1 Data for mapping various vegetation cover types in Maoer Montane Area of northeast part of China. The seasonal changes detected by HJ-1 data could be validated with the ground observation of phonological events for its spatial and temporal characteristics.

## 2. STUDY SITE AND HJ DATA

This study was conducted in the Maoer Moutane Area in Heilongjiang Province of the northeast part of China. The area covers about 37.8 square kilometers and the land cover types include crops, deciduous forests, coniferous forests, mixed

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This research is supported in part by Special Research Program for Public-welfare Forestry, Grant No. 200804001 and Dragon 2 Programme , ID 5314

forests, bushes, cities and towns, and water bodies. Fig.1 shows the location of the study site.

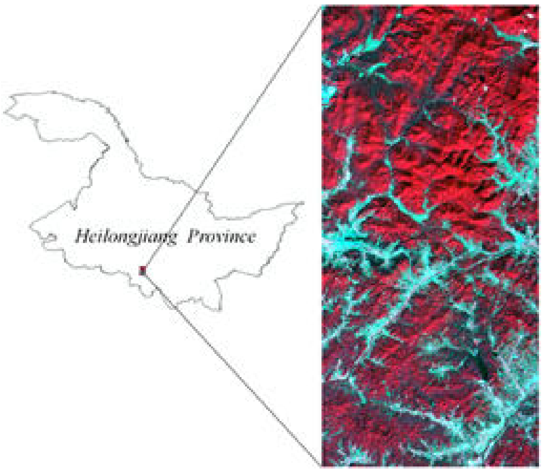


Fig. 1 The location of the study area

A time series of HJ-1A/1B satellite imageries from April to December were used as the input dataset. The dataset includes 12 images which cloud was less than 10%, and 7images were cloudless. A Micro-satellite Constellation for Environment and Disaster Monitoring was successfully launched in China on September 6, 2008, which includes two small satellites, Satellite-A (HJ-1A) and Satellite-B (HJ-1B). It was the first time for China to launch this type of earth observation satellite, especially used for the environment and disaster monitoring. The payloads of HJ-1A include a multispectral imager and an interferometric imaging spectrometer; the payloads of HJ-1B include an infrared scanner and the same multispectral imager as that of the HJ-1A. The multispectral imagers of HJ-1A/1B are the main sensors of the small constellation. Both multispectral imagers are of the same design: the field of view for CCD amount to 360 kilometers, and the nadir ground resolution is 30 meters. Table 1 shows their spectrum ranges from 430 nm to 900 nm with 4 spectral bands which are similar as Landsat TM1, 2, 3, 4. The ground sample distance (GSD) of the multispectral imagers is 30m. Under the cooperation of the two satellites and the large imaging swath, HJ-1A/B multispectral imagers can revisit the same location no more than two days. HJ-1A/B has played an important role in environmental protection and disaster assessment, land cover.mapping, and other fields.

Table 1 HJ-1A/1B CCD Camera's Parameters

| | | |
|---|---|---|
| HJ-1A/1B CCD Cameras | Spectrum ( μm ) | 0.43-0.52 |
| | | 0.52-0.60 |
| | | 0.63-0.69 |
| | | 0.76-0.90 |
| | GSD ( m ) | 30 |
| | Swath ( km ) | 360 (Single CCD)<br>700 (double CCD) |
| | Repetition Cycle (days) | 4 (one satellite)<br>2 (Constellation) |

## 3. METHODOLOGY

The methodology adopted is shown as fig.2. The different stages are elaborated below.

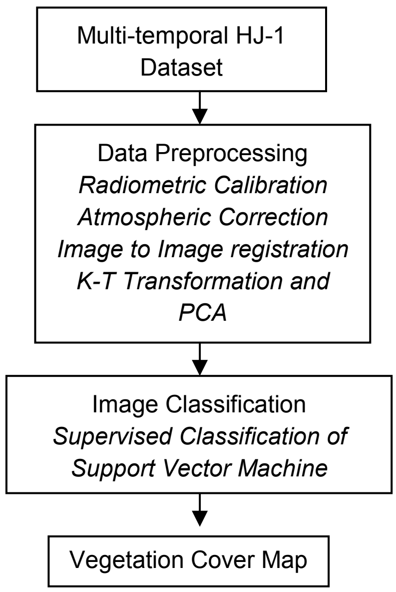


Fig. 2 Workflow of Vegetation Cover Mapping

### 3.1 Radiometric calibration

The radiometric calibration coefficient of remote sensor is quantitative transformation between DN value and observed physical quantities. The TOA reflectance of the earth detected by HJ satellite was computed according to the equation (1):

$$L = \frac{DN}{A} + L_0 \quad (1)$$

Where

$L$ = Spectral Radiance [W/(m2 sr μm)]

$A$ = Gains[unitless]

$L_0$ = Bias. [unitless]

The values of $A$ and $L_0$ can be retrieved from the metadata of HJ 1A/1B data. The details about the values of $A$ and $L_0$ for different bands of sensors are shown in Table 2.

Table 2 The radiometric calibration coefficient HJ-1

| | | B1 | B2 | B3 | B4 |
|---|---|---|---|---|---|
| HJ-1A | A | 0.6925 | 0.7438 | 0.9636 | 1.0545 |
| CCD1 | $L_0$ | 7.3250 | 6.0737 | 3.6123 | 1.9028 |
| HJ-1A | $A$ | 0.6360 | 0.5910 | 0.8142 | 0.8768 |
| CCD2 | $L_0$ | 7.5575 | 7.0944 | 4.1319 | 1.2232 |

### 3.2 Atmospheric Correction

QUAC was used for atmospheric correction of time series of HJ-1A/1B data. QUAC is a visible-near infrared through shortwave infrared (VNIR-SWIR) atmospheric correction method for multispectral and hyperspectral imagery. Unlike other first-principles atmospheric correction methods, it determines atmospheric compensation parameters directly from the information contained within the scene (observed pixel spectra), without ancillary information.

### 3.3 Geometric Correction

The ortho-rectified Landsat TM data was chosen as the reference imagery. All time series of HJ-1A/1B data were co-registered with root mean square error of less than one pixel for further analysis.

### 3.4 NDVI

NDVI images were computed from 7 HJ-1A/1B images without cloud, and layers tacked to form a composite image with 7 bands. The composite image was then PCA transformed. The first 3 principle components were selected and displayed in Fig.3. We can identify the differences among crops, forest easily. Crops were shown in dark blue and light blue colour, and forests were in pink and light pink colour. Buildings, roads and water were in light green colour.

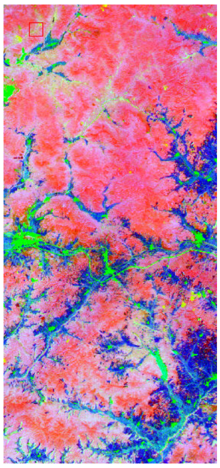

Fig.3 First 3 PCA components of NDVI composite image

### 3.5 Vegetation mapping

Considering the local land surface, classification scheme for vegetation mapping covers crops, coniferous forests, deciduous forests, mixed forests, bushes and grasses, impervious surfaces (including cities , towns and bare lands), and water.

Follow Lefsky's method of data processing (Lefsky, 2010), the time series of 12 HJ-1A/1B images were transformed using Kauth and Thomas's approach (Crist and Cicone, 1984) to reduce data storage sizes while preserving most of the information content of the original images. This results in 12 KT images, each with 3 band representing brightness, greenness, and wetness indices. Images for each of three indices for each KT image were layerstacked to create 3 images, each with 12 bands. These images were then PCA transformed, and the first three principle components were selected and layer stacked to create a single image with nine bands. The first three bands of the final image are the three brightness components, and so on for greenness and wetness. Support Vector Machine (SVM) of Supervised classification methods was adopted for vegetation mapping, and the final image with 9 bands was used as input for vegetation cover mapping.

## 4. RESULTS

With the multi-temporal HJ satellite images, we used the phonological information and spectral information for vegetation cover mapping. According to the result of vegetation cover mapping (Fig. 4), crops area is about 22.3 percent, deciduous forest area is about 10.4 percent, coniferous forest area is about 19.2, mixed forest area is about 44.0 percent, water area is about 0.46 percent, and impervious surface is about 2.95 percent.

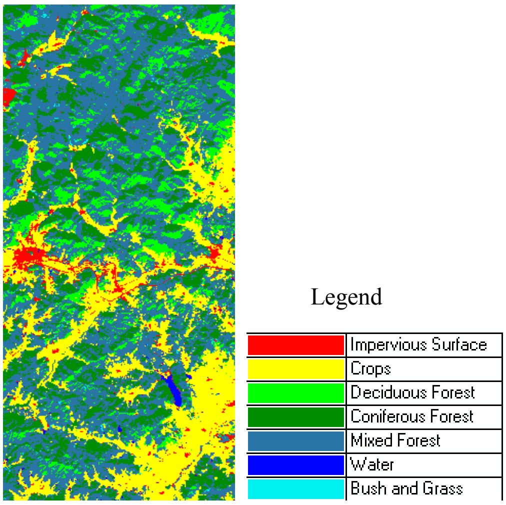


Fig. 4 Vegetation Cover Map

## 5. CONCLUSIONS

From multi-temporal HJ data, phenological information and seasonal changes could be used in identifying crops and forests. After Kauth and Thomas's transformation and PCA , the nature information of different land cover can be easily extracted. Our result showed that multi-temporal HJ-1A/1B satellite images are suitable for vegetation cover mapping.

## ACKNOWLEDGEMENTS

We acknowledge China Center for Resources Satellite Data and Application (CRESDA) for providing the HJ-1A data. All HJ-1A/1B images used in the paper are copyrighted by ©HJ image, Copyright CRESDA 2010.

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