Land Cover Classification over Yellow River Basin using Terra/MODIS in RR2002 Project

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Abstract: The Terra/MODIS data set over Yellow River Basin, China is generated for the purpose of an input parameter into the water resource management model, which has been developed in the Research Revolution 2002 (RR2002) project. This dataset is mainly utilized for the land cover classification and radiation budget analysis. In this paper, the outline of the dataset generation, and a simple land cover classification method, which will be developed to avoid the influence of cloud contamination and missing data, are introduced.

Keywords: Land cover, Yellow River, MODIS.

1. Introduction

Since 1970s, the stream of Yellow River frequently has not reached Bohai Sea for many days in a year because of the water shortage as a result of the climate change and human activities such as irrigation. Therefore, the hydrology and water resource model in the Yellow River domain has been developed under the project "Development of models for water resources prediction and management", which is one subject in "Research Revolution 2002 (RR2002)" project funded by Ministry of Education, Culture, Sports, Science and Technology of Japan.

Land cover is one of the most important factors to understand the climate change and human activities, and in addition, it is one of the essential parameters for the calculation of the water balance and radiation budget. The land cover analysis in such wide region as Yellow River domain is impossible to achieve without satellite data.

2. Outline of the study

1) Study Area

The length of the Yellow River is about 5500 km, and the area of the basin is over 750,000 km^2. The basin is subdivided into three parts, i.e. main recharge area in upstream, dry area including large irrigation fields around the Loess Plateau in midstream, and flat and relatively humid area in downstream. The study area is set up from 32N to 43N degrees in latitude, and 95E to 123E degrees in longitude, where whole of the Yellow River domain is included (red frame in Fig.2).

2) Satellite Datasets

According to the spatial and temporal characteristics of the sensors, three kinds of satellites data, Terra/MODIS NOAA/AVHRR and Landsat/TM and ETM+, are used in this project. The outline of the satellite datasets generation in this study is shown in figure 1, and outline of the datasets is shown in table 1.

Since the MODIS is new sensor and it has number of spectral bands, the data are used to understand the current status of land cover. AVHRR is used to detect the change of land cover, because it has been operated from 1970s and long term data over 20 years are archived. The AVHRR data are rectified to the same projection and same temporal frequency as MODIS data, and these two data are compared each other for the overlapped period in 2002 to understand the relation between land cover derived by MODIS and AVHRR reflectance. Afterward, AVHRR data are compared between years to detect the land cover change for 20 years. The TM and ETM+ have relatively high spatial resolution. The data are applied for the purpose of validation of coarse resolution data and the detection of land cover change over irrigated agricultural area along the Yellow River.

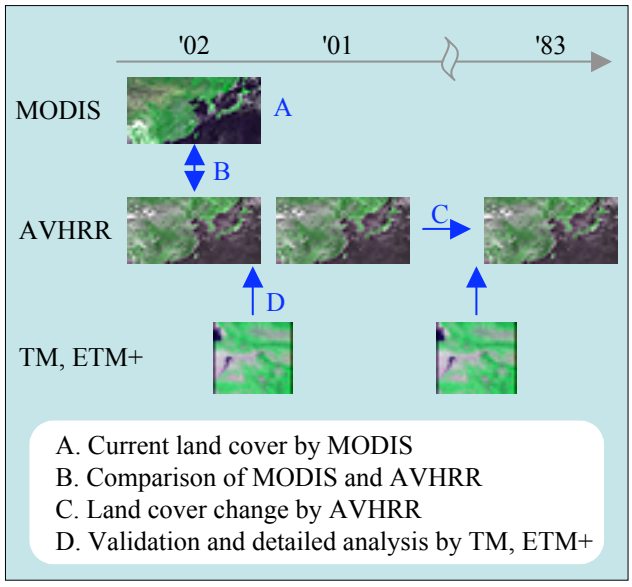

Fig. 1. Outline of this study

Table 1. Outline of the satellite datasets

Sensor	Period	Resolution	
		Spatial	Temporal
MODIS	2002	30 seconds	3 data/month
AVHRR	1983 - 2002	30 seconds	3 data/month
TM, ETM+	1983 - 2002	30 meters	Irregular

3) Terra/MODIS dataset

The MODIS onboard Terra has been operated since 1999 and variety of products have been generated for the purpose to study global change [1]. Four kinds of products are used as the source of the dataset in this study. The process of the dataset generation is listed bellow and the example of 10 days composite data is shown in Fig.2.

1. Radiances in bands 1-7, 17-20, 31 and 32 are extracted from MOD02 and the top-of-atmosphere reflectance is calculated for each bands. The geolocation (latitude and longitude) and observation geometry (solar zenith angle, solar azimuth angle, sensor zenith angle and sensor azimuth angle) are extracted from MOD03. Land surface temperature and emissivity in band 31 and 32 are extracted from MOD11. Cloud mask is extracted from MOD35.
2. Extracted data are geometrically rectified in Equidistant Cylindrical Projection (latitude/longitude projection) with the range from 20N to 50N in latitude and 90E to 150E in longitude with the spatial resolution of 30 seconds.
3. Daily dataset is generated by the composition of these rectified swath data. Though less of the area is overlapped, minimum sensor zenith criterion is applied, that is, the datum with minimum sensor zenith angle is selected among overlapped data.
4. Three nearly 10 days composite dataset in one month are derived from daily datasets to eliminate the cloud. Minimum sensor zenith angle criterion is also applied in this process, but in addition, the cloud screening using cloud mask product is applied as the preprocessing. Therefore, minimum sensor zenith angle among the clear day is selected. This criterion is suitable for this study since the selected datum has minimum observation footprint and minimum fluctuation by the bidirectional effect of the land surface.

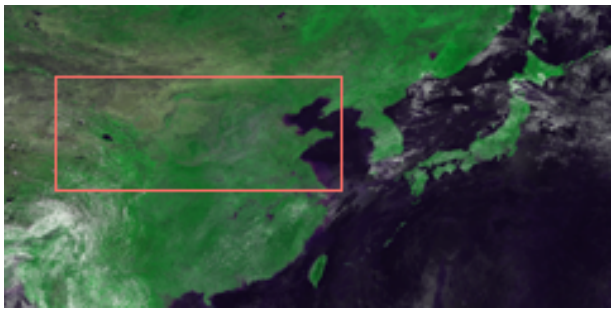

Fig. 2. Example of MODIS dataset (1-10 July 2002)

4) Land Cover Classification

Land cover and its change is one of the essential parameter of the water balance model to acquire the evapotranspiration over natural land surface as forest, grassland, and bare soil, and artificial land surface as agricultural fields. In addition, land cover information aims the model to handle the irrigated water combined with auxiliary data as statistics and maps. In this study, the current status of the land cover is derived by means of the statistical classification of the MODIS dataset.

In general, land cover classification in regional to global scale is achieved using the time series of vegetation index, brightness temperature and reflectance derived from moderate resolution satellite data as AVHRR. Though 10 days to monthly composite data are used as input data, the period of the composite is longer, the percentage of clear data is higher, but the seasonal variation of the land surface is less clear. It is in the first stage of the study, the concepts of the classification are decided as follows.

1. Supervised classification based on the minimum distance or maximum likelihood criterion using training data derived from existing maps and Landsat/ETM+ image is applied since we have several auxiliary data.
2. Land cover classes are defined suitable for the input to the water management model. The important point is the detection of the irrigated agricultural field since it has much affect on the water usage and evapotranspiration. Since it seems to be difficult to detect the irrigated field only from the satellite data, another information from statistics and maps will be combined with satellite data.
3. The time series of top-of-atmosphere reflectance and vegetation index included in the 10 days composite MODIS data are used as the source data.
4. The cloud mask is used as the auxiliary data to screen out the cloudy pixels. The cloudy pixels are eliminated in the calculation of the statistical distance, because a few cloudy data in the time series have much harmful impact on the statistical distance between pixels and classes.

3. Conclusion

The outline of MODIS datasets generated in RR2002 project and land cover classification strategy are introduced. It is the first stage of the project, and the production of the datasets is carried out selectively. The implementation of land cover classification is on the next stage of this study.

Reference

[1] **URL:** MODIS Home Page. http://modis.gsfc.nasa.gov/