Land Cover Change Analysis over Yellow River Basin by Remote Sensing

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1. Introduction

Remote sensing is efficient tool for consecutive monitoring the wide region such as whole basin of the Yellow River in China in this study. The purpose of this study is to analyze the change of land cover on the Yellow River basin for two decades since 1980 using several kind of remote sensing data. This report gives three relevant topics: increase of agricultural area in Qingtongxia irrigation district, change of vegetation in tributary of the Yellow River, and change of land cover in Loess Plateau.

2. Methodology

2.1 Increase of agricultural area in Qingtongxia irrigation district

The time series of AVHRR onboard NOAA satellite were mainly used to detect the change of agricultural area. The spatial resolution of AVHRR is relatively low as one kilometer compared to scale of agricultural field, however, the pseudo improvement of spatial resolution was applied by means of high resolution (30 meters) sensor of ETM+ onboard Landsat. The outline of the method is shown in figure 1. Annual maximum value of Normalized Difference Vegetation Index (NDVI) derived from AVHRR showed positive correlation with fraction of agricultural area in one square kilometer calculated from land cover map generated from ETM+. This means that percentage of agricultural area within one AVHRR pixel is able to estimated, and the change of agricultural area could be detected from time series of annual maximum NDVI. Time series of annual maximum NDVI were generated from original raw data for 17 years from 1984 to 2000. Every two years of data are shown in figure 2. Linear relation between annual maximum NDVI and fraction of agricultural area, [fraction of agricultural area] = 2.54 * [annual maximum NDVI] - 0.33, was applied to this time series. The result was compared to county based agricultural area derived from census in yearbook of Ningxia Hui Autonomous Region.

2.2 Change of vegetation in tributary of the Yellow River

It was suggested by previous results in hydrological simulation in this study that vegetation, mainly grass or shrub type vegetation, has been increased in Loess Plateau. Therefore, it has been checked using time series of AVHRR data. The Pathfinder AVHRR Land dataset, which has spatial resolution of eight kilometer, was used in this analysis. The annual maximum NDVI was generated from daily product by averaging of five samples from second to sixth maximum NDVI in a year because erroneous high NDVI exist in the dataset. The four sample area, which is shown in figure 3, were extracted from the data along the major tributaries of the Yellow River, Wuding, Fen, Luo, and Qin river.

2.3 Change of vegetation in Loess Plateau

Land cover classification was applied using four kilometer AVHRR data, which were generated from original raw data, for the years of 1982, 1991, and 2000. Only three land cover categories, barren, open shrubland, and grassland, were extracted on the Loess Plateau. Other land cover was followed the other classification result derived using MODIS data. The detail of the classification method is included in the reference [1].

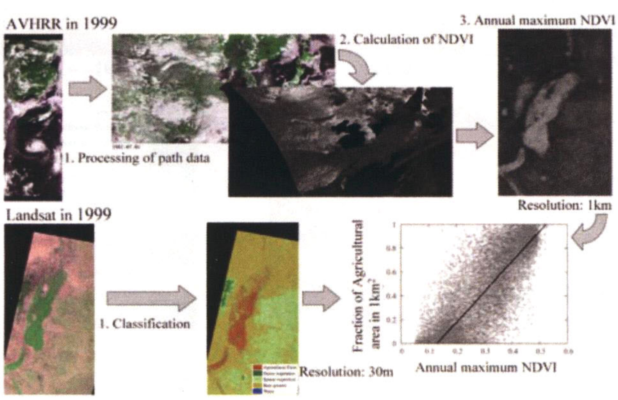
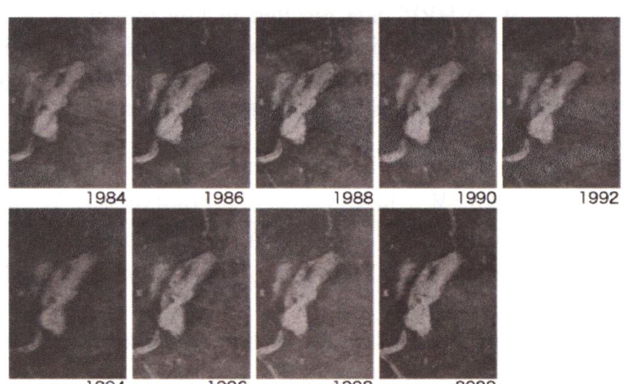


Fig. 1 Methodology of pseudo improvement of resolution



Fig, 2 Time series of annual maximum NDVI

3. Results and discussions

3.1 Increase of agricultural area in Qingtongxia irrigation district

Estimated time series of agricultural area is shown in figure 4, top figure is estimation using AVHRR and bottom is census value. Estimated time series has unrealistic fluctuation by year, compared to census value. Since the linear equation was derived from the data in 1999, good agreement was appeared in this year. On the other hand, the other years especially from 1993 to 1995 showed large decrease of the area. This is mainly due to the fluctuation of annual maximum NDVI, rather than due to the true variation of the agricultural area. Annual maximum NDVI has large inter-annual variation owing to the following two reasons. One reason is shortage of the sample. The AVHRR used in this analysis was received by University of Tokyo receiving station located in Tokyo, that is, Qingtongxia is western border of the receivable coverage. The enough sample for annual maximum calculation is not received for this region. The other reason is poor accuracy of geometric correction. The low geometric accuracy resulted in low contrast of the annual maximum NDVI image. Therefore, extremely low agricultural area was estimated especially in the years around 1994.

3.2 Change of vegetation in tributary of the Yellow River

The time series of annual maximum NDVI over four tributaries of the Yellow River, which was extracted from Pathfinder dataset, is shown in figure 5. Five lines in each figure indicates the NDVI value for the sample of 10, 30, 50, 70, 90 percent in the region. All figures indicates large inter-annual variation of NDVI, it is same as previous analysis. Continuous increase of NDVI is appeared only in Wuding river region, but almost stable (except inter-annual variation) for other region, in the broad view.

3.3 Change of land cover in Loess Plateau

Land cover classification over Loess Plateau in 1982, 1991, and 2000 are shown in figure 6. Relatively larger increase of grassland is appeared in northern part of Loess Plateau between 1982 and 1991. This suggest the possibility of the increase of the vegetation mainly due to the reforestation implemented in 1970s and 80s, even though the inter-annual variation of the vegetation is larger in this region. The further analysis is needed for this point.

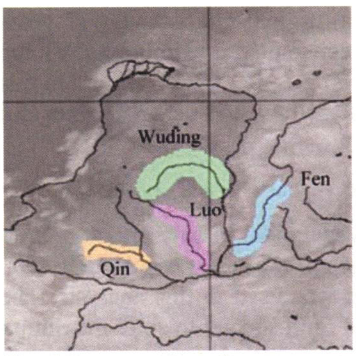


Fig. 3 Four sample region

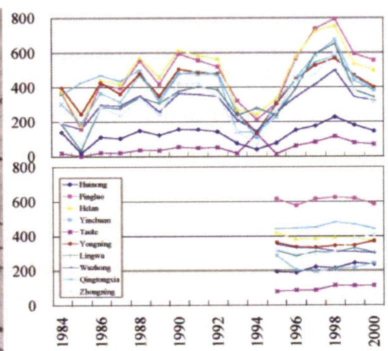


Fig. 4 Time series of Agricultural area (top: this study, bottom: census)

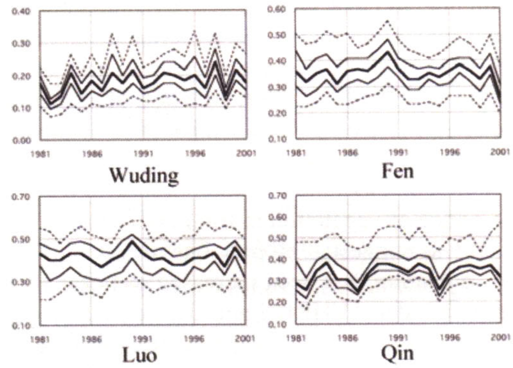


Fig. 5 Time series of annual maximum NDVI

4. Conclusion

Three topics, Increase of agricultural area in Qingtongxia irrigation district, change of vegetation in tributary of the Yellow River, and change of land cover in Loess Plateau, were reported concerning the land cover change of the Yellow River basin. Though the large inter-annual variation of vegetation and low processing accuracy of AVHRR data resulted in low reliability of land cover change in both analysis, Obvious change of land cover was not detected from all of three analyses. The result of hydrological model reported in this symposium shows similar conclusion.

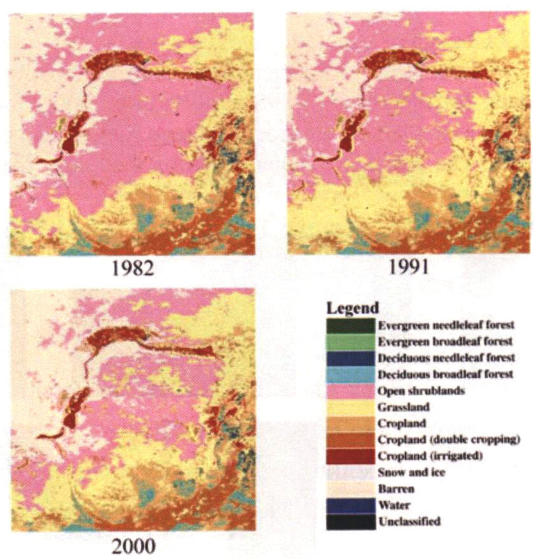


Fig. 6 Land cover map of Loess Plateau

Reference:

[1] Matsuoka, M., Hayasaka, T., Fukushima, Y., and Honda, Y., "Land cover in East Asia classified using Terra MODIS and DMSP OLS products", International Journal of Remote Sensing, Vol. 28, Nos. 1-2, pp. 221-248, 2007.