IMPERVIOUS SURFACE DYNAMIC ANALYSIS USING TIME-SERIES MODIS DATA IN PEARL RIVER DELTA

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ABSTRACT

Impervious surfaces are curial in natural ecosystems, their changes will influence the urban heat island, water logging and even local climate change. Rapid urbanizing process, mostly including change areas of impervious surfaces, was demonstrated in previous researches, but the inherent detailed changing regularity of impervious surfaces needed to be further studied. Time series remote sensing images, as useful data sets, were used to monitoring the dynamic change of the urban impervious surfaces. The objective of this study was to evaluate the seasonal variation of impervious surfaces using time series data sets. Pearl River Delta of China was selected as experiment region. The dynamic changes of impervious changes were discovered using MOD 09A1 (MODIS Surface Reflectance 8-Day L3 Global 500 m) through the support vector machine (SVM) classification method. The Google Map and Landsat images of the same year was utilized to select the training data. The result shows that whole area of the impervious surfaces in research region was gradually increased in the past 16 years.

1. INTRODUCTION

The ‘reform and open-door policy’ policy established by Chinese government enable city construction become more rapid in past years. The nature land surface revised critically by human beings. Land cover types changing greatly from agriculture land to artificial land cover types (Kuenzer et al, 2015). Artificial land also refers to impervious surface, mainly including the build-up areas constructed by human which water cannot penetrated (Wu and Murray, 2003). Impervious surface are mostly existed in urban areas, which occupy a small number of proportion of land cover types in Pearl River Delta (PRD), but it raise most people in this area. Beside, some rural place also take up some percentage of impervious surface in this areas. We take all the impervious surface as an aim to analyze no matter what the region is urban or rural.

Remote sensing technology is a useful tool to monitor dynamic changes of land cover type in large regions. Medium to coarse resolution remote sensing images have the advantage of easily acquisition and large area monitoring advantages over high resolution observation data. Along with the gradually open access of earth observation data, researches of time series analysis in land cover changes become blooming. Previous research have shown the efficient of using time-series remote sensing data to observe land surface change. Li et al., (1998) utilized the TM image of year 1988 and 1993 to monitor the urban expansion in PRD. Sexton et al. (2013) analyzed the urban growth of the Washington, D.C-Balitimore MD metropolitan region from 1984 to 2010 using Landsat TM images. Zhang and Weng (2016) utilized 330 scenes Landsat data to detect the dynamic changes impervious surface from 1988 to 2013. However, the target of the above studies only focus on specific cities using one scene image. The city groups as a whole needed to study as a whole, since city agglomeration will combined together to influence the regional economy and even the whole country.

2. STUDY AREA AND DATA

PRD is located at Guangdong Province of South Part of China (Figure 1) , sited between 112° 46′ 44.284 〃 E, 21° 34′ 28.168 〃 N and 114°1′4.89 〃 E, 23°55′ 57.167 N 〃 , with a population of 57.15

million at the end of 2013. It is a subtropical region have humid and rainy climate features. RPD city group is a world famous agglomeration, including Guangzhou, Shenzhen, Dongguan, Zhaoqing, Foshan, Huizhou, Jiangmen, Zhongshan, Zhuhai, Hongkong and Macau. It is one of the three large urban agglomeration in China and even the Asia-pacific region. This region is one of the most dynamic economic zone with 30% of the population in Guangdong, but create the 77% GDP of Guangdong. "The great pearl river delta" has become the world's third metropolis group. China's Pearl River Delta has overtaken Tokyo to become the world's largest urban area in both size and population, according to a report from the World Bank in 2014 (Deuskar, 2014). The rapid development of China is in full swing and there will appear new city groups. The deep research of PRD is urgently needed and it will offer reference for other urban studies.

Time series of MOD 09A1 (MODIS Surface Reflectance 8-Day L3 Global 500 m) between 2000 and 2016 were utilized as experiment data. We obtain these data sets through the Earth Explorer of USGS website (http://earthexplorer.usgs.gov). MOD09A1 provides Bands 1–7 at 500-meter resolution in an 8-day gridded level-3 product in the Sinusoidal projection. All these data were processed to change projection from their original format to the Universal Transverse Mercator (UTM) projection and Datum World Geodetic System 84 (WGS84) with GeoTiff format.

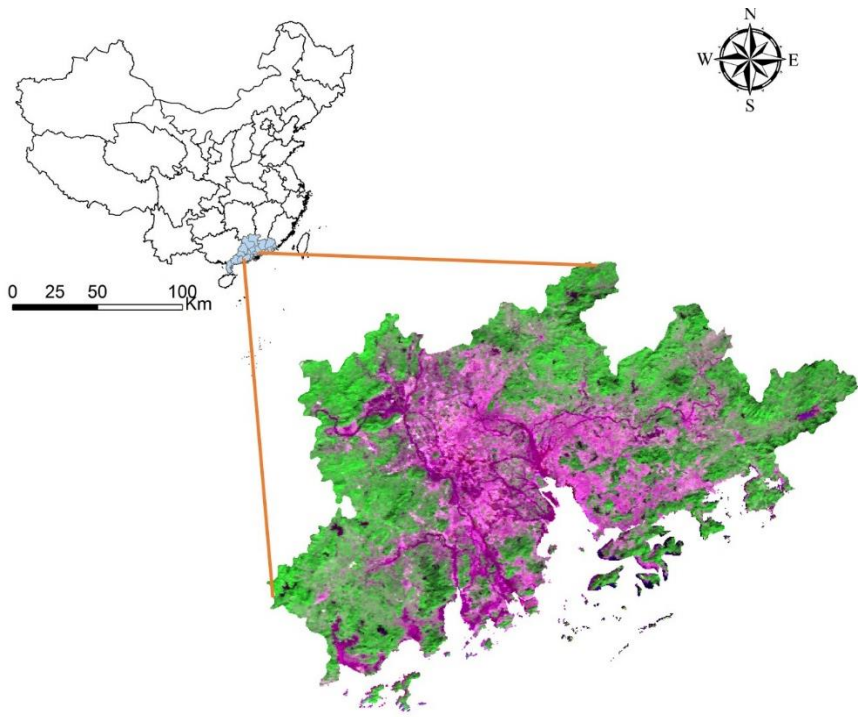
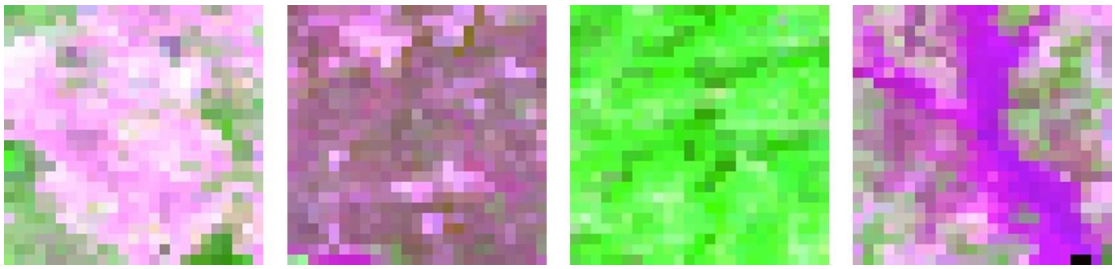


Figure 1. The location of PRD in China.

3. METHOD

The support vector machine (SVM) classifier was used to classify the experiment data. Four land cover types, impervious surface, wetland (a special land cover types in this area), vegetation and water were selected as training samples based on Landsat image and Google Map. Each image corresponding to one set of training sample. Samples in each data set were all different from others, but some samples in these images kept same.



Impervious surface Wetland Vegetation Water

Figure2. The sample of different land cover types

4. RESULTS

The selected impervious surface map from 2000 to 2015 are shown below.

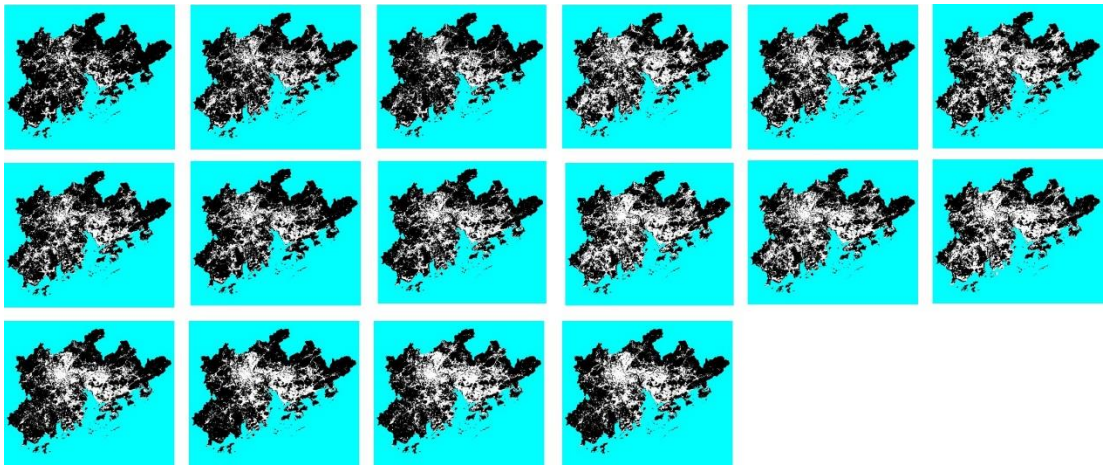


Figure 3. The dynamic of impervious surface (white color represent impervious surface)

The statistic of impervious surface areas are shown below:

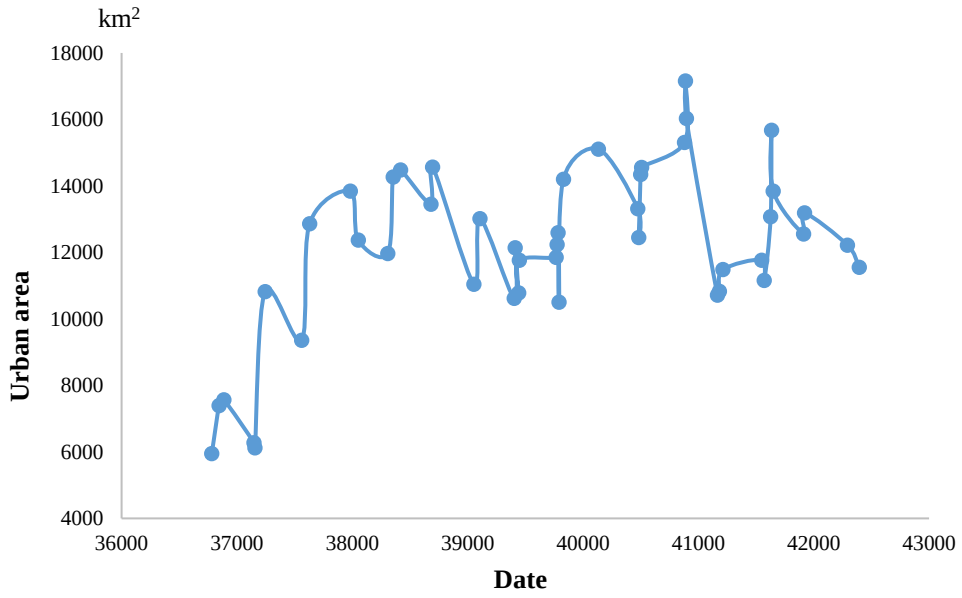


Figure 4. Statistics of urban areas of time-series image

5. DISCUSSION AND CONCLUSIONS

From the above analysis, some primary results can be got. The whole areas of PRD is increasing in the past 16 years. There also exist some decrease of impervious surface areas within the research time period. This phoneme may be attribute to the data quality of MOD09A1 for it is an 8-day composite data sets which also influenced by cloud. Once the impervious surface is built, it is unreasonable for it to change to other land cover types.

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