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# Utility of landsat Image in the Study of Land Cover and Land Surface Temperature Change

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## Abstract

Scientists have aimed at exploring land use and land cover (LULC) and their environmental influence in order to improve our understanding of the causes and consequences of these phenomena. This study addresses and use and land cover change (LUCC) in the upper reaches of Pearl River Delta, China, from 1990 to 2008. Based on remotely sensed images of Landsat, LUCC and land surface temperature were assessed. Results showed that land surface temperature was highly influenced by the LUCC from 1990 to 2008. An examination of the relationship between the LULC and LST maps was finally conducted to comprehension their interactions. Results indicated that Landsat image was effective for quantifying the heat environment and providing reliable measurements of land use change. LST was found to be positively correlated with impervious surface but negatively correlated with vegetated land. Each temperature zone was associated with a dominant LULC category.

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**Keywords:** Land use; land surface temperature; object-based classification; TM/ETM+; Fast developing region

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## 1. Introduction

Over the past decades population growth and economic expansion have been the primary drivers of LUCC worldwide, especially in the developing countries with an increasing desire for prosperous economy. Until recently, the urban area accounted for only 2% of the earth surface; however, the

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urbanized and urbanizing landscapes have resulted significant impacts on the local and global ecosystems. Among tremendous environmental issues associated with human activities, the LST effect has been one of the increasing concentrations of urban problems. The distribution of thermal phenomenon was commonly referred to as temperature differences between different land use types, with higher air temperatures in densely built cities and lower temperatures in surrounding rural regions.

The LST is the energy balance of land surface energy and has been extensively studied with the technology development of effective sensors for thermal remote sensing. The measurement of LST using satellite thermal infrared sensors from which brightness temperatures of land surfaces can be derived using Planck's law. Research on LST shows that the balance of land surface energy can be well influenced by the conversion of surface soil, water content and vegetation. Generally speaking, LST are a multi-function of different surface properties: albedo, emissivity, thermal properties of land use cover types. Each of these characteristics plays a wide range of variation with the land use and land cover change caused by the quick urbanization.

In China, land use and land cover patterns have undergone a fundamental change due to accelerated economic development under its economic reform policies since 1978. Urban growth has been speeded up, and extreme stress to the environment has occurred. This is particularly true in the coastal region such as the Pearl River Delta where massive agricultural land is disappearing each year, converting to urban or related uses. Evaluating the magnitude and pattern of China's urban growth is an urgent need. Furthermore, because of the lack of appropriate land use planning and the measures for sustainable development, rampant urban growth has been creating severe environmental consequences. Thus, there also is a need to assess the environmental impact of the rapid urban expansion.

## **2. Study area and data source**

### *2.1. Study area*

The Pearl River Delta is the pioneering area in China's reform and opening up. It has played the role of a testing ground during the past thirty years. It's has led Guangdong as it changes from an agricultural province to the country's top province in business and production. It is now one of China's major economic powerhouses and world's manufacturing homes. Considered its rapid urbanization process in the past 30 years, the Pearl River Delta Estuary (PRDE), along the coast of South China Sea, was selected as the study area. Four countries named Panyu Zhongshan Shenzhen and Dongguan were selected in this study.

Since Economic Reform and Open Door Policy were adopted in the later in 1970s, and its adjacency to Hong Kong, the PRDE has experienced rapid urbanization and become one of the leading economic regions of China. With the rapid population growth and urban area expansion, great changes on land use and environmental problems have taken place.

### *2.2. Data source*

The Landsat data are the longest running programs for acquisition the earth surface images from space. The Landsat satellites have acquired millions of images that are valuable source for global change research and are well applied broadly in geology, agriculture, forestry, regional planning, education and environmental parameters.

Landsat 5 TM images (acquired on Oct. 13, 1990 and Dec. 22, 2008) acquired under clear sky conditions having good quality were selected. All images bands 1–5 and 7 for landsat 5 have the spatial resolution of 30 m, and the thermal infrared band (band 6) has a spatial resolution of 120m respectively.

The data acquisition date has a highly clear atmospheric condition, and the image was acquired through the USGS Earth Resource Observation Systems Data Center, which has corrected the radiometric and geometrical distortions of the images to a quality level of 1 G before delivery.

The acquired images were firstly projected to Universal Transverse Mercator(UTM) zone 49N, Datum (WGS 84) according to the topographical map.

The Landsat image was further rectified to a common Universal Transverse Mercator coordinate system based on 1:24,000 scale topographic maps, and was resampled using the nearest neighbor algorithm with a pixel size of 30 m by 30 m for all bands including the thermal band. The resultant RMSE was found to be less than 0.5 pixels

### **3. Method**

#### *3.1. Land Use Classification*

Interpretation of all of the remote sensing data was finished with the object-based method [1]. Object-based classification merges pixels into image objects or segments by many properties, except for pure spectral information. Since regions in the image provide much more information than single pixel, there are many different image object features for measuring color, shape, and texture of the associated regions. Even more information may be extracted by taking the network structure and the classification of the image objects in place of the pure spectral or spectral-derivative information [2-4].

#### *3.2. Retrieval of LST*

The Landsat remote sensor which has the thermal band (TM6) images has been extensively studied for retrieval the LST [5-6]. The mono-window algorithm requires only two atmospheric parameters for LST retrieval from Landsat TM6 data, one is transmittance and the other is mean atmospheric temperature compare to the other retrieval methods[7].

### **4. Result and Discussion**

#### *4.1. Land use and land cover change*

Form the comparison of land use of for 1990 and 2008, we can find that the built-up area expanded dramatically and the other rural land decreased little or much. The shrub which scattered in flat filed had the priority to change in to the built-up area because of the convenient transport and the accessibility. The amount of water and fishery changed little. The built-up area expanded from 605.50 km<sup>2</sup> in 1990 to 2394.26 km<sup>2</sup> in 2008, the expansion was nearly 4 multiples.

Although the area of the built-up land in Shenzhen was the most among the four regions (Shenzhen, Dongguan, Zhongshan and Panyu), the built-up land area in Dongguan was the hugest in 2008. The phenomenon that farm land of Dongguan in 1990 was the most in area but it decreased to be the lest indicated that the expansion of built-up area consumed the other land use types such as farmland and the other rural land. With the expansion of built-up land, some rural land which has the good utility condition for construction changed into built-up area to sustain the demand of economic development and the demand for the housing and factor of the immigrating population.

Compared to the other three cities, the proportion of different land use types in Zhongshan was more equal in the whole study period. The built-up area expanded little in Zhongshan from 1990 to 2008, and

the configuration of the different land uses can be well continued, so the changes among the 6 land use type was little in the study period.

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#### *4.2. Retrieval of LST*

The LST ranged from 283.96K to 309.43K with a mean of 295.27 K and standard deviation of 1.97K for the 1990 thermal map (Fig. 5) . The LST ranged from 281.88K to 305.19K with a mean of 294.74 K and standard deviation of 2.69K for the 2008 thermal map.

The different levels of LST located in the certain regions corresponding to the location of the built-up area, vegetation, and the water body. The high LST located in the built-up area especially in the urban, road, and the shrub with little vegetation. Low LST scattered in the forest, arable land, fishery, and the water.

In order to get the relationship Of LST and LULC, LST and land use map of 2000 were compared in Fig. 5. The contour line of the LST was obvious similar to the contour line of the land use map. The higher LST overlapped the built-up boundary, and the lower accord to the patch of vegetation and the water. It indicated that the phenomenon of the HI caused by the built-up area was obvious while the Cool Island (CI) was mainly raised by the abundance of water and vegetation.

### **5. Conclusion and Discussion**

Understanding land use dynamics and the thermal environment require the rigorous use of technologies and methods in order to develop helpful sources of information. Recent years, remote sensing has been widely used in spatiotemporal assessment of urban development and landscape changes, primarily through post-classification comparison. This study has demonstrated the usefulness of satellite-derived thermal environment change associated with the land use change. The method of identifying here to map continuous land use and it's environment change was based on the synergistic use of medium-resolution satellite imagery multivariate statistical analysis. Overall, this method has been quite effective because it did not involve any sophisticated algorithms, such as object-based classification or LST retrieval, but offered comparable mapping. On the other hand, the comparison of land use types and thermal zones has been quite effective for regional land use characterization. The spatiotemporal changing trend of thermal

environment was found to be compatible with the land use/cover changing trend detected through image interpretation. This study has also established a well-documented regional case study focusing on Pearl River Delta, a well-known coastal tourism resort in Southern China.

In this study, the integration of remote sensing and GIS was used for evaluation of rapid land use and land cover change, and its impact on surface temperature in the Pearl River Delta, China. Results revealed a notable increase of built-up area and the decrease of vegetated land use types between 1990 and 2000. The remote sensing image classification with the object-based method implied this way of land use mapping is effective to comprehend information on the nature, rate and location of land use change. The integration of remote sensing and GIS provides an efficient way to detect land use change especially the built-up area expansion and to evaluate its impact on land surface temperature. The spatial pattern of LST was correlated with the pattern of land use. Built-up land development was uneven in different parts of the study region, and its expansion influent the transfer of the heat distribution. Such study should be possible to apply to other regions that are undergoing a rapid urbanization. It can also be applied to investigate regional and global environmental impacts of land use and land cover change.

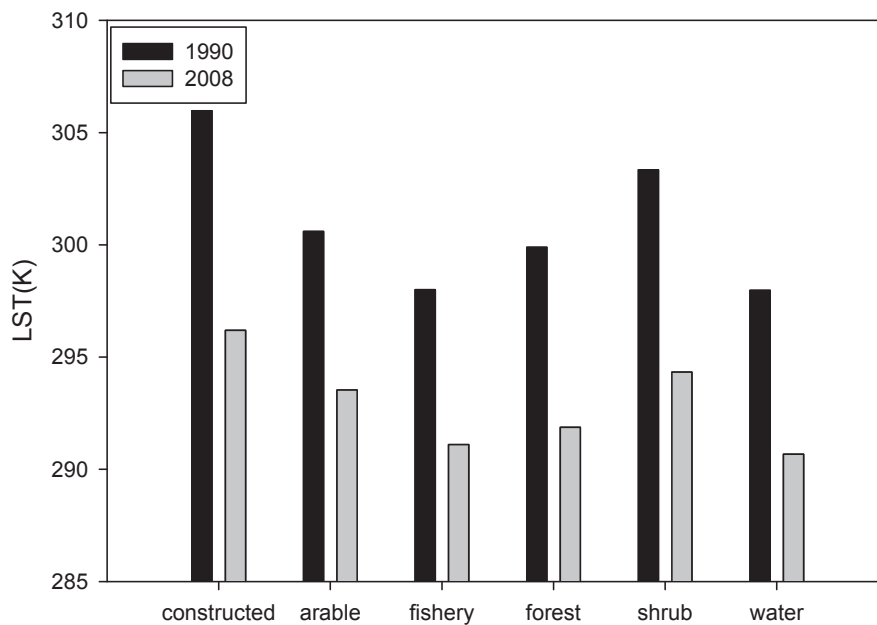


Fig. 5. the land surface temperature of different land use for 1990 and 2008

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