

Mapping the spatiotemporal dynamics of impervious surfaces using time series Landsat data.

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Introduction: Impervious surfaces, as the most direct embodiment of urbanization, have a significant impact on biogeochemical cycles and urban climate such as urban heat island. Previous studies of impervious surface estimation from single or multi-temporal images mainly focused on the spectral differences between impervious surfaces and other land covers, but have been found ineffective to a certain degree due to the mixed pixel problem in the coarse or medium resolution imagery and the intra-class spectral variability problem in high resolution imagery. Landsat time series has the ability to retrieve impervious surfaces over long time scale due to its long record of continuous measurement at moderate spatial resolution and temporal frequency. Little attention has been paid to the differences in temporal spectral profile among various land covers that were derivable from a dense Landsat time series.

This study aimed at analyzing temporal spectral differences between impervious and pervious surfaces and improving mapping accuracy of impervious surfaces by developing a dense Landsat time series for the Pearl River Delta, southern China, from 1988 to 2013. In this study, it is found that the confusion between impervious and pervious surfaces due to similar spectral signatures can be reduced using temporal spectral characteristics.

Results: Pearl River Delta had experienced a dramatic urban expansion from 1988 to 2013. Impervious surfaces increased from 390 square kilometres in 1988 to 4,837 square kilometres in 2013, and expanded from urban cores to suburban areas.

In the period of 1988 to 1993, the impervious surface area in the Delta did not experience a significant change, which increased at an annual average rate of 12.53%. The Delta was in the early phase of urban development, being confined within the limits of each administrative unit (city/county). From 1994 to 1999, a large amount of new impervious surfaces was built within and around each city. The Delta experienced its first rapid urban growth period due to accelerated industrialization and urbanization. Impervious surface area yielded an annual average rate of 25.02%. For the period 2000 to 2005, the Delta experienced another period of rapid urban growth. Urban cluster started to form. The impervious surface area grew at an annual average rate of 15.39%. The period of 2006 – 2013 witnessed a more stable, and slowing-down urban development. Impervious surface area increased an annual average rate of 2.43%.

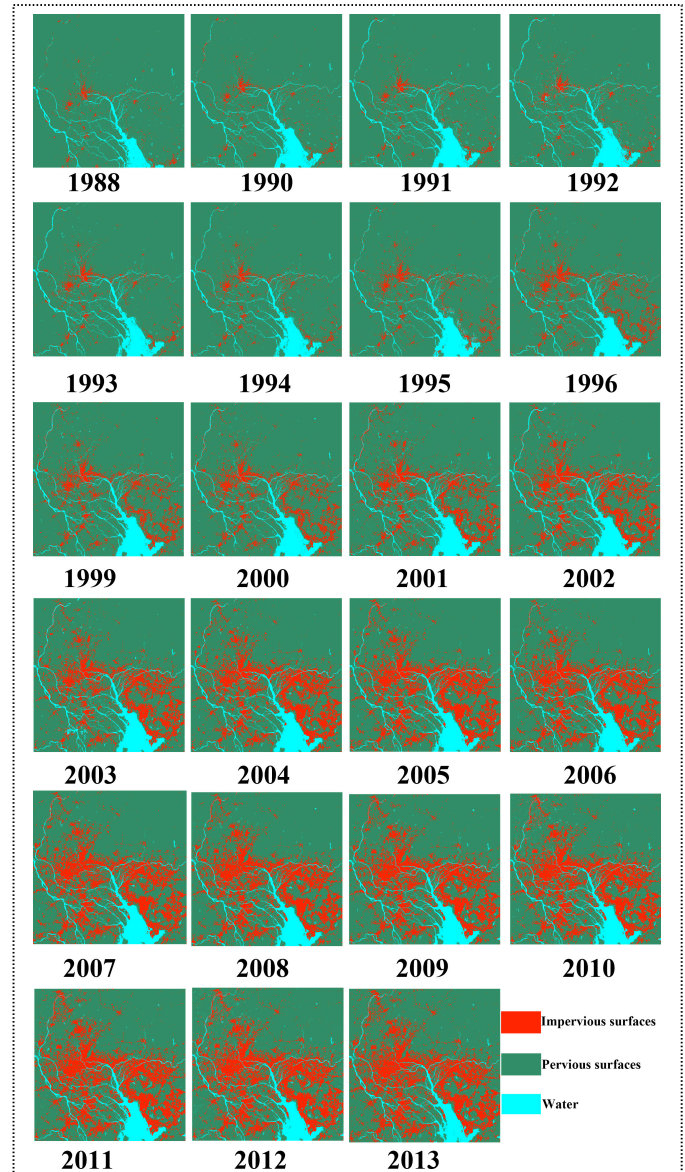


Figure 1. Annual impervious surface maps of the Pearl River Delta, China, 1988-2013.

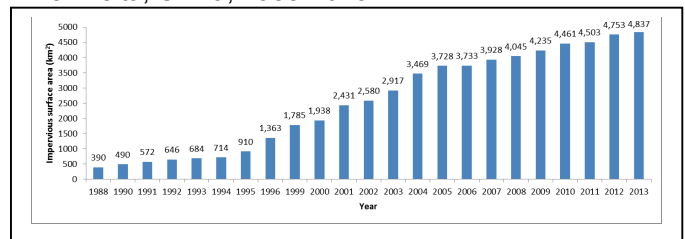


Figure 2. Impervious surface area in annual impervious surface images