

Introduction

The side-effect of booming urbanization on the ecosystem and climate system has been continuously exacerbating. The coastal metropolises are located at the interface between land and ocean, unavoidably influenced by multiple aspects of the terrestrial environments, aquatic ecosystems, and urban developments.

In recent decades, drastic metropolitan and urban agglomerations in the Chinese coastal areas significantly affects their urban thermal environments in the context of climate change.

Natural lands are substantially replaced by various anthropogenic land use/cover (LCU) types. This process generates a mass of energies to alter the properties of the ecosystem and the interactions between the land surface and atmosphere, which is also the primary driving force for initiating the urban heat island (UHI) effect. Therefore, assessing Chinese megacities' UHI effect and formulating corresponding mitigation strategies have always been frontier issues on human health and urban sustainability.

Objectives

Land surface temperature (LST), namely the radiative surface temperature of the land retrieved from solar radiation, is treated as an essential proxy in the diagnosis of the surface UHI (SUHI) by the World Meteorological Organization. In this study, taking of the three Chinese bay metropolises — Guangzhou, Hangzhou, Shanghai—we attempt to

- 1) to delineate the spatiotemporal patterns and variations of surface urban heat island (SUHI) in three coastal metropolises of China based on bi-temporal Landsat-derived LST and LCU,
- 2) to clarify the spatial causalities between SUHI intensity and LUC using remote sensing quantified analysis,
- and 3) to sustainably regulate and optimize the urban environment and further create urban planning and policies for relieving urban thermal effect.

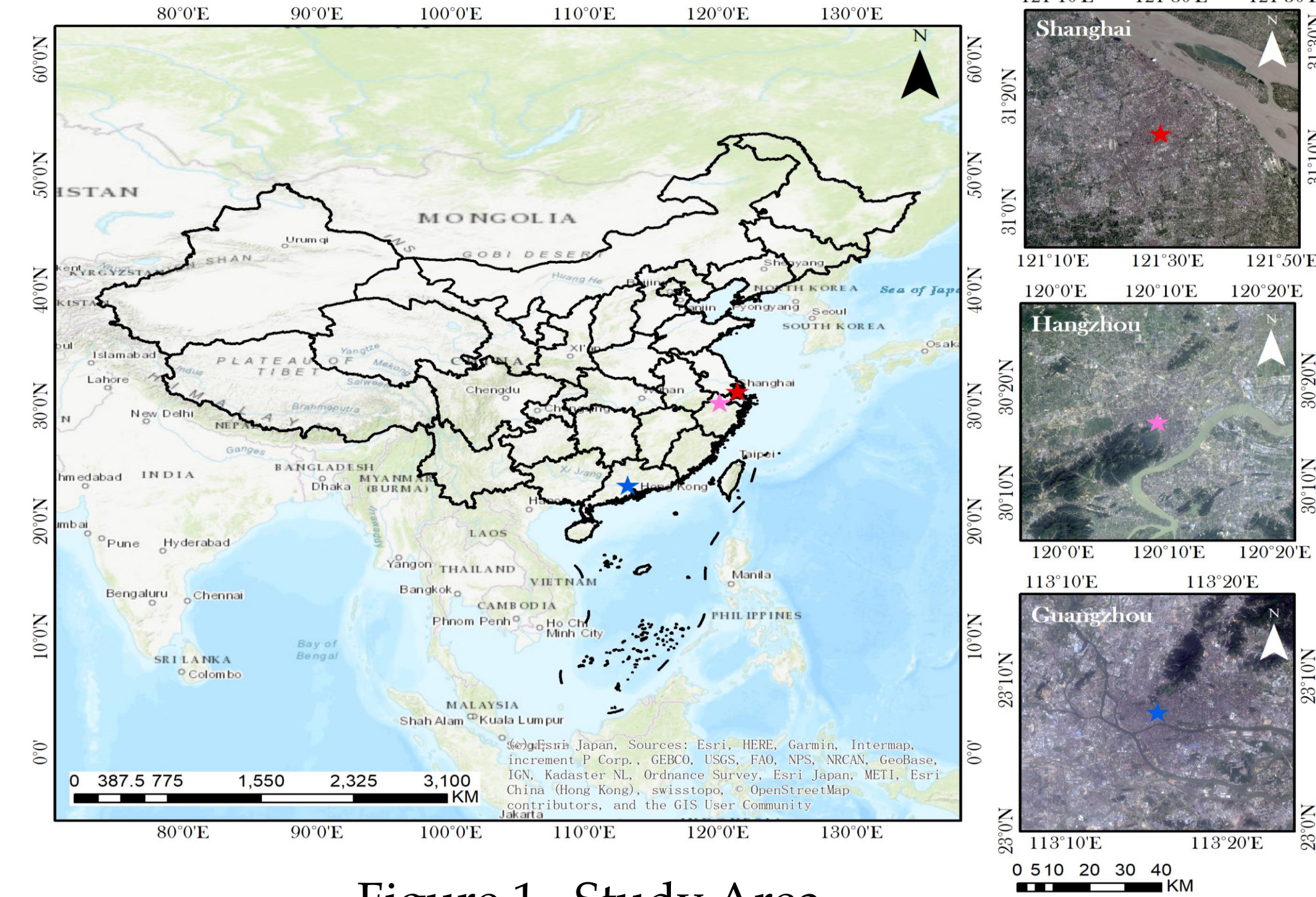


Figure 1. Study Area

Study Area

Since the implementation of China's Belt and Road Initiative (BRI), there have been growing attention to the sustainable planning and development of the Pearl River Delta and Yangtze River Delta. The study targets are Guangzhou metropolitan area (GMA), Hangzhou metropolitan area (HMA) and Shanghai Metropolitan area (SMA) in China. They are:

- One of the most highly developed regions in China;
- The superiority of geographical and economic situation.
- The abundant development potentiality;
- The urgent ecological risk and pressure;
- Similar position and function in the urban agglomeration.

Methodology

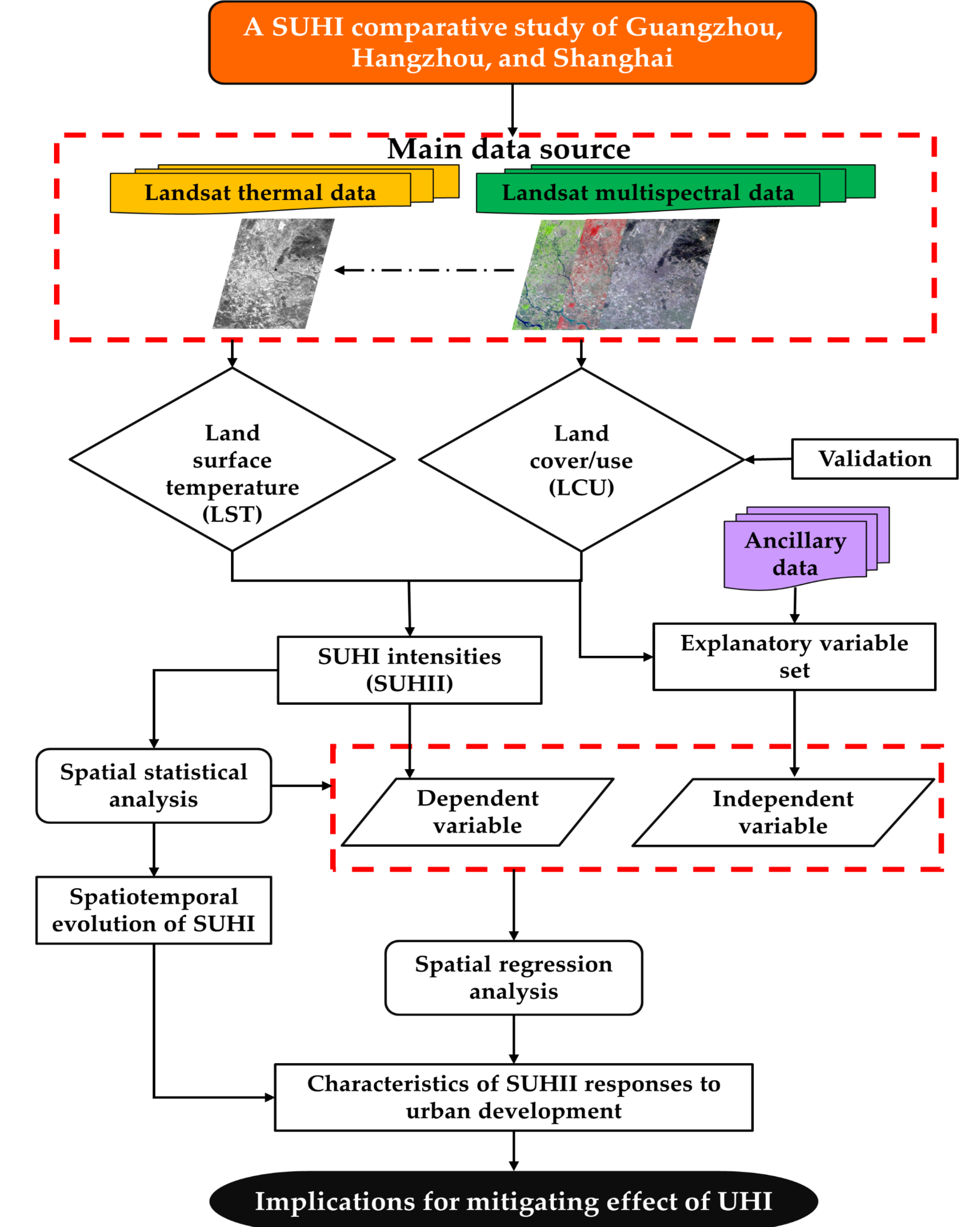


Figure 2. Technical flowchart

LST retrieval: Radiative Transfer Equation (RTE) and standardize derived LST;

SUHI intensity: Subtracting the average normalized LST (NDLST) values of non-urban pixels from the NDLST value of each pixel within the study area.

Land cover thematic maps: support vector machine (SVM)

Formation of SUHI: ordinary least square (OLS) and geographically weighted regression (GWR) model.

Results

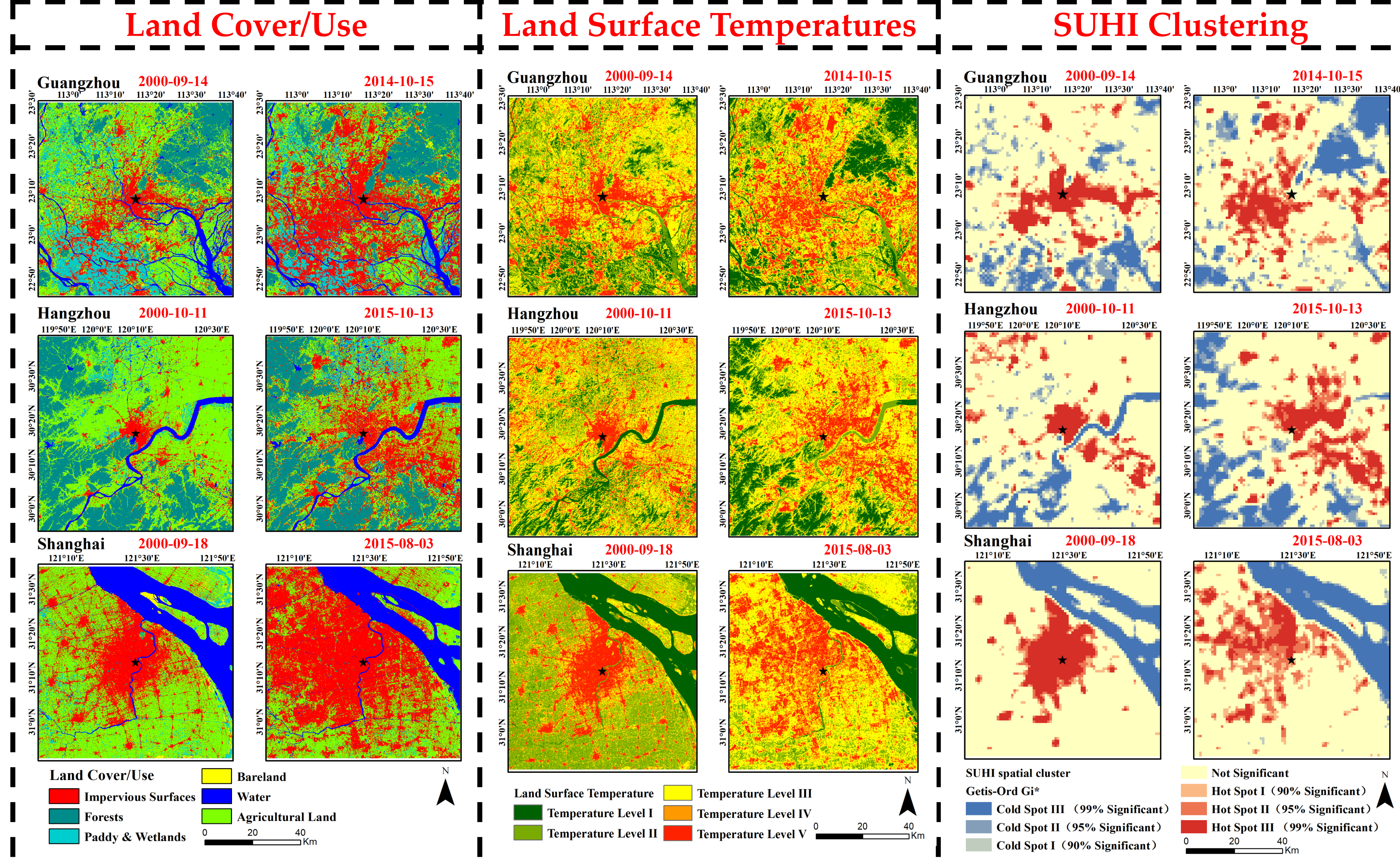


Figure 3. Spatiotemporal layouts of LCU

Figure 4. Spatiotemporal layouts of LST

Figure 5. Spatial evolutions of SUHI

Key Findings and Conclusion

Overall, within a nearly 15-year interval, the extents of hot spots in three metropolises were significantly expanded, the spatial patterns of SUHI have been transformed from monocentric to polycentric high-LST clusters, which were identical to the trend of urban expansion.

However, these three metropolises possess distinct features in terms of the thermal layouts and land cover/use composition. The urban thermal environments in three coastal metropolises are different because of the land surface conditions including the attribute, composition, configuration, and variation of land cover. Although the total area of SUHI hot spots in Shanghai has surged, the intensity of some hot spots has been a shrink.

The interactions and associations between SUHI and urban development were investigated using spatial regression analysis. The urban composition and configuration considerably affected the intensity of SUHI. Terrain morphology constrained the SUHI. Prolific population growth had a continuing effect on SUHI formation. The proportion of forests displayed a consistently critical influence on easing the adverse of SUHI.

It is essential to appropriately consider the impacts of water in the comparative analysis of different thermal environments. However, water might be treated as a time-invariant factor and have a limited effect on the bi-temporal comparison for each metropolis.

These findings suggest the policy-makers and urban planners should balance and optimize the land cover/use configurations with accommodating the increasing population, reasonably maximize the reservations of the greenbelt and green space under improving the utilization of urban infrastructures and constructions.