Chapter 70
Land Surface Temperature Estimation and Urban Heat Island Detection:
A Remote Sensing Perspective

Abhisek Santra
Haldia Institute of Technology, India

ABSTRACT

Earth's land surface temperature is considered to be very important for modeling the environment. Following the trend of increasing global population, urban areas are expanding in spatio-temporal domain. In this way it is affecting the urban climate and subsequently the global climate. Thus, scientific understanding is required to conceive the knowledge about interaction between urban land use/land cover and the atmospheric conditions prevailing in that area. In this chapter the land surface temperature estimation and urban heat island detection are perceived from remote sensing perspective. The chapter in this context highlights three major aspects, viz. the theoretical background, description about some of the common thermal sensors and widely used algorithms to retrieve surface temperature from these satellite sensors.

INTRODUCTION

Land surface temperature (LST) is measured at the Earth's surface. It is considered as the skin temperature of the earth. It is an important quantity for many environmental models like energy and water exchange between atmosphere and surface of the earth; numerical prediction model of weather; global ocean circulation model; climatic variability model, etc. (Dash, Gottsche, & Olesen, 2002; Valor & Caselles, 1996). Urban growth and urban sprawl are the prime factors in regional landscape evolution across the globe. Understanding the interactions among different urban land use and land cover types, atmospheric conditions and land surface temperatures is significant to conceptualize urban climate. Rapid urban expansion due to large scale commercial, manufacturing and transportation development leads to the

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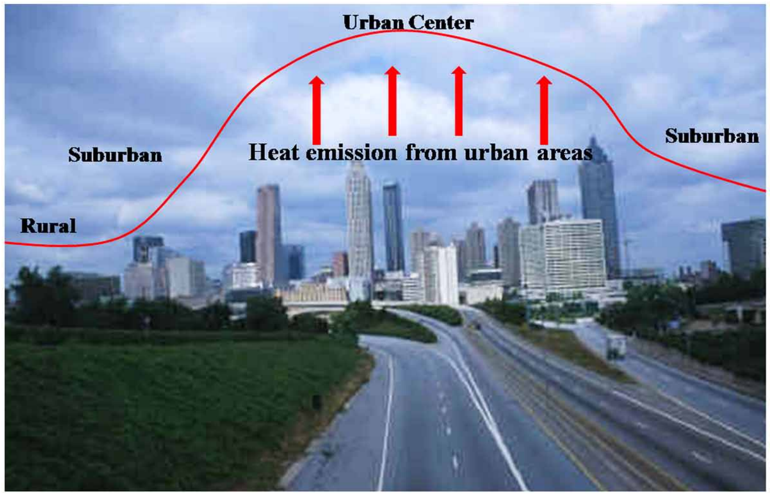
Figure 1. Urban heat island



emergence of Urban Heat Island (UHI) effect (Landsberg, 1981). The urban areas are characterized by higher temperature in comparison with the surrounding rural areas, as shown in Figure 1. The process of urbanization can raise the local temperatures, however, the temperatures of built-up fringed areas will generally remain constant (Resenzweig et al., 2005).

UHI results from differential characteristics of radiation and heat budget in urban landscape. Oke (1982) listed some common causes of the UHI including:

1. High absorption of short wave radiation because multiple reflection.
2. Human induces heat sources.
3. Attenuated outgoing long wave radiation due to the presence of atmospheric constituents.
4. Low radiative cooling.
5. High sensible heat storage due to increased thermal admittance of building materials.
6. Low evapotranspiration due to construction material.
7. Low total turbulent heat fluxes from wind speed reduction in the city.

However, the UHI effects may be decreased with increasing wind speed and cloud cover. Conversely UHI may raise with increasing population and size of urban areas. The stronger effect of UHI may be visible during summer to late fall season (Oke, 1982). UHIs are responsible for the changes occur in the precipitation characteristics of the urban areas. These changes may be similar or greater than that predicted by global change models (Changon, 1992). Thus, the increasing temperatures associated with UHI s may induce climatic and biophysical hazards in urban environments including heat stress, anxiety and acute response to air pollutants (Resenzweig et al., 2005; Watson, 2012). Similarly, UHIs also have significant impact on human health, energy demand and environmental conditions (Strathopoulou, Cartalis, & Kermatisoglou, 2004). Oke (1991) commented that the intensity of an UHI can be estimated by determining the maximum difference between urban minimum temperature and rural minimum temperature in consideration with the size, population, layout, topography and atmospheric conditions of the city. The UHI map depict the urban locations that produce hot spots within the city This may be