The Egyptian Journal of Remote Sensing and Space Sciences xxx (2017) xxx–xxx

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Contents lists available at ScienceDirect

The Egyptian Journal of Remote Sensing and Space Sciences

journal homepage: www.sciencedirect.com

Research Paper

Monitoring and assessment of urban heat islands over the Southern region of Cairo Governorate, Egypt

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ARTICLE INFO

Article history:
Received 29 March 2017
Revised 19 July 2017
Available online xxxx

Keywords:
Change detection
Vegetation index
Urban heat island
Land surface temperature
Land use/cover
Neural network

ABSTRACT

Differencing in both land uses and covers are basically occurred by urbanization and changes of land covers. It has a notable power on the climate, by incorporating with buildings, roads, and other impenetrable surfaces, urban areas have the higher absorption of solar radiation, and it stored larger thermal capacity and conductivity, so the heat through the day and freed night. Consequently, urban areas be likely to be wormer matched with the around rural areas. This temperature difference, in addition to the heat released by transport and industry, adds to the evolving urban heat island (UHI). Study area covers Cairo and Giza Cities, which have a rapid urban expansion over the past three decades due to a high population density, accelerated economic and industrial development.

The primary objectives of this work are to map urban heat islands (UHI) intensity for study area using Landsat TM/ETM+/OLI thermal band for the periods 1984-2000-2015. Moreover, to find the relation between land covers with its change rates, land surface temperature (LST), and urban heat islands (UHI).

The results exposed that the neural network method is the superior method to produce land cover maps of the study area. Results obtained illustrate the great urban expansion from 1984 to 2015; in addition to spatial and temporal variability in LST in those urban areas, (especially industrial buildings that released a higher temperature than its surroundings), besides, the sizes of UHI in 2015 are greater than 1984.

1. Introduction

Cities are major sources of Green House Gas (GHG) emissions, the world's urbanization rate has risen by 21% over the past 60 years. Cities demonstrate higher daytime temperatures than surrounding rural areas, which caused what called "urban heat island (UHI) effect and the consequences of mass urbanization upon the environment have now become clear (Fu and Weng, 2017; Lelovics, 2011). Urban heat island phenomenon is the higher documented climate change phenomenon (Tan et al., 2010a; Santamouris, 2015).

Urban and industrial expansions improve our lives and luxury; however, they also induce many Leading to increasing environmental problems to human beings, like global warming, industrial air pollution (Falahatkar et al., 2011a,b). Currently, urbanization considered the most important driver of climate change (E-Hattab, 2016). The urban heat island effect is a critical factor for air quality management and public health in urbanized areas (Wilby, 2008). The adverse effects of UHI include increase in energy consumption also it has bad effect in tourism. Great benefit of studying the urban heat island is that the quantity of attention is not the entire urban temperature, but the temperature difference between the urban and rural areas (Streutker, 2003). Urban areas relatively higher temperature compared with the surrounding rural areas (Buyantuyev and Wu, 2010). This thermal difference, in conjunction with the heat of transport and industry, was contributed to the development of urban heat island (Yuan and Bauer,2007). The intensity of urban heat island is the difference between average temperature of urban heat island areas and that of rural areas (Zhang et al., 2013).

Urban heat island (UHI) refer to the natural warming of both the atmosphere and surfaces inside the cities compared to their surroundings, especially at night (Gabriel and Endlicher, 2011). Under optimum conditions, UHI may be up to 10–15 °C (Chow and Roth, 2006). The urban heat island (UHI) occurrence may rises air

Peer review under responsibility of National Authority for Remote Sensing and Space Sciences.

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https://doi.org/10.1016/j.ejrs.2017.08.008
1110-9823/

temperatures in cities by 2–5 °C (Onishi et al., 2010; Chen et al., 2008). Increasing in urban areas temperature is due basically to due to the heat stored and radiated again by huge and complex urban constructions, in addition to the anthropogenic heat released from other sources like cars, factories, and other heat sources (Falahatkar et al., 2011a,b). Thus, the UHI is of an increasing concern to the scientific community and has been investigated through the remote sensing techniques, Satellite remote sensing techniques has made the studying of UHI in global scale feasible (Ramachandra and Kumar, 2010).

Nowadays, thermal infrared bands have become one of the important means to study the UHI (Keramitsoglou et al., 2011). Recent years have witnessed the increasing use of thermal infrared (TIR) data for the UHI studies. A series of studies have been performed. Cao et al.,2008 have been performed a research to relate land surface temperature (LST) and Normalized Difference Vegetation Index (NDVI). Falahatkar et al., 2011a,b) have been analysed the impact of land cover change surface temperature. Zhao-ming et al., 2004; Effat et al., 2014 have been studied the impact of urban growth on urban heat island (UHI). Chen et al. (2006), Xian and Crane (2006) and Yuan and Bauer (2007) have been related UHI patterns to land-cover/land-use changes, to vegetation and impervious fraction. (Effat and Hassan, 2014) have been explored.

Mapping and detecting changes in land-cover and heat islands over Cairo only through three decades using multi-temporal Landsat TM satellite data. According to the thermal infrared sensing data of Landsat TM/ETM+ and OLI were used to quantify the land surface temperature (LST) of the study area.

The optical bands for all images have been used in mapping land use/land cover and related changes and the thermal bands have been used in thermal mapping, analyzing the changes in temperature and detection of urban heat islands.

In this paper, LULC has been obtained from remotely sensed data using three classifications techniques; neural network, maximum likelihood, and minimum distance methods. Then calculating land surface temperature, followed by illustrating the urban heat islands, to explore the relationships between LULC and LST, UHI.

2. Study area

It is representing the area lies south of Cairo city centred by the River Nile. It comprises part of the Nile Delta cultivated land and the River Nile from the west, and desert from the east. Most of the urban areas were mixed with vegetation, commercial, public, and industrial areas in different degrees. The study area consists of 19 Division and centers like; 15 May, Ahram, Pasaten, Tebbin, Giza, Hawamdia, Dokki, Agouza, El Omraneya, Maadi, Bulaq Dakrur, Helwan, Tora, Masr Gedida, Badrashin, Saff, Ayat, Osim, Kerdasa. Through the last three decades, the study area has a noticeable urban increase at the expense of the around agricultural lands on the western bank and towards eastern desert areas.

3. Data sources

- The data has collected from Landsat data acquired from three different sensors (Landsat-5 TM, Landsat-7 ETM+, and Landsat-8 OLI), on 3 August 1984, 23 August 2000, and 9 August 2015. Fig. 1 illustrates the study area.
- Thirty well distributed differential GPS control points were collected obtained with 10 cm accuracy in x,y,z.

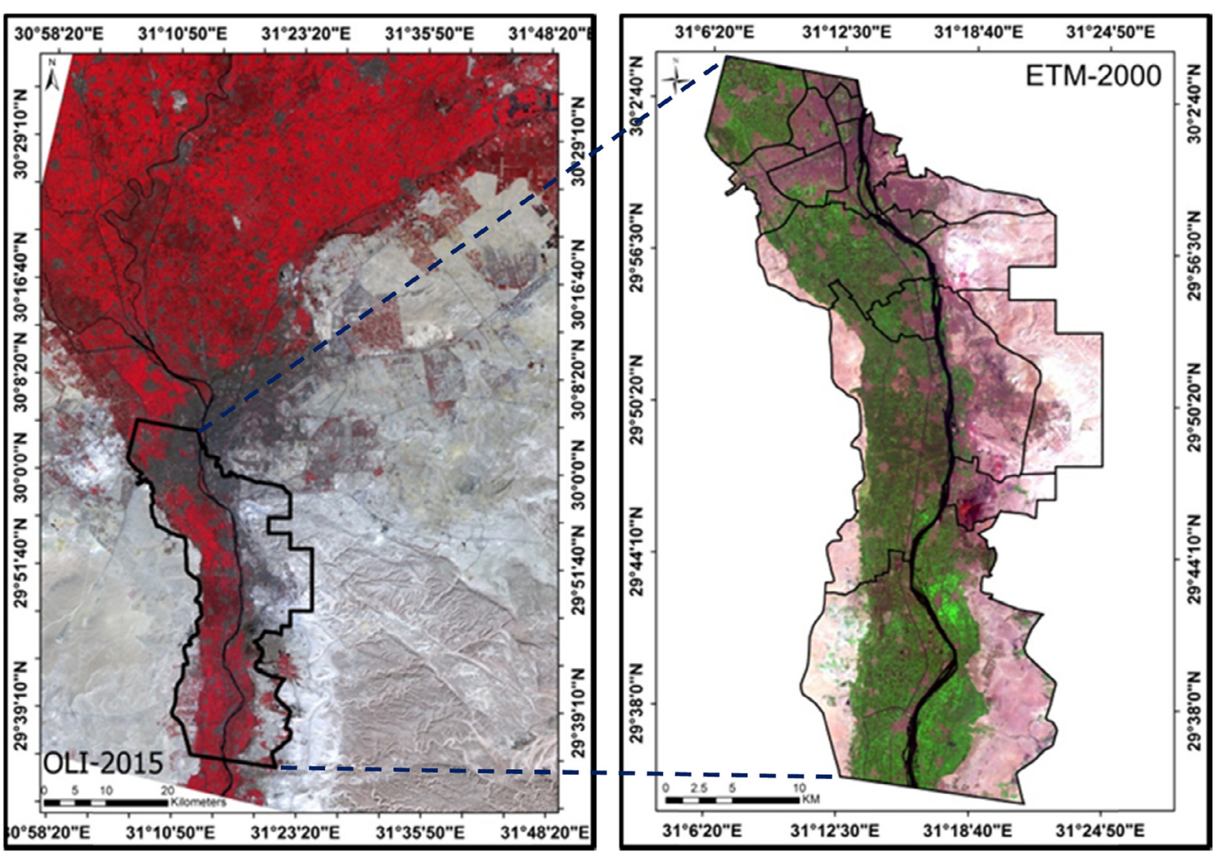

Fig. 1. Study area (East and West the River Nile).

Please cite this article in press as: El-Hattab, M., et al. Egypt. J. Remote Sensing Space Sci. (2017), https://doi.org/10.1016/j.ejrs.2017.08.008