Change Detection in Land Surface Temperature Using Remote Sensing and GIS Techniques: A Case Study of Biyagama

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Abstract— *Several studies carried out by different scholars have proved that the world climate got hotter during the last years. Most of the temperature increases since mid-20th century has been caused by increases in atmospheric greenhouse gas concentrations produced by industrialization. Other than that, urbanization caused to increase the area temperature because its transform the natural land surface with modern land use and land cover such as buildings, roads and other impervious surface.*

When considering about Sri Lanka, now a days Biyagama area is identified as a rapidly developing area and due to this reason most probably the temperature may be changed. But in Biyagama area, there is no meteorological observatory and data could be got from the Colombo meteorological observatory which is located near the Southeast boundary of the city. Due to failure of a proper mechanism to identify the temperature variation in this area, there may be makes some restrictions to analyse the spatial pattern of temperature and the temperature levels in the Biyagama area.
The purpose of this study is to evaluate the use of Thermal Infrared Remote Sensing data for assessing temperature differences in Biyagama area and examine the factors influencing the elevation of temperature in the Biyagama area. Thermal remote sensing has been used to measure the Land Surface Temperature and its capability in monitoring temperature and effecting microclimate in urban areas.

In this study, bands of Landsat-7 ETM+ and Landsat 8 OLI & TIRS imagery obtained during 2001-2018 will be analyzed for the spatial distribution of changes in temperature in Biyagama area. The study showed the increment of Land Surface Temperature (LST) near the industrial area in comparison with suburban areas, also building is one of the factor that reflect more heat and it is responsible for raising the surface temperature. It is noticed that, Oil Refinery could be considered the main source of heat in Sapugaskanda area.

Keywords— **Land Surface Temperature, Thermal Infrared Remote Sensing, Landsat, Spatial distribution**

I. INTRODUCTION

Global Warming is one of the biggest problem facing the world today and it is a threat to all living things on earth. Several studies conducted by different scholars have shown that the global climate has become hotter in recent years and recent climate studies have shown that the surface temperature of urban areas has increased compared to neighboring vegetated areas.

It is very important to identify the distribution of LST in urban areas and identify high- temperature areas. Remote satellite sensing offers an excellent cost- effective and time- saving methodology for analyzing distributed LSTs, as satellite imaging covers a wide area. Ground-based observations reflect only thermal local condition around the station. Meanwhile, using remote sensing thermal bands enabled to acquire the thermal state for each pixel in the copy. Nowadays thermal remote sensing has been used over urban areas to assess the urban heat island and climatic situations.

Now a few days Biyagama is identified as a rapidly growing region. In Sapugaskanda there are 03 thermal power stations. In addition, the Ceylon Petroleum Corporation (CPC) carries out its refinery operations in this area, the only oil refinery on the island. Gasses emitted by industrial establishments in Sri Lanka have included ammonia from urea factory at Sapugaskanda. Oxides of sulphur and nitrogen are also liberated from factories and power plants burning diesel and furnace oil as fuel. This area is

currently the most vulnerable to degradation of air quality in Sri Lanka. Furthermore, a well developed industrial estate in Biyagama borders the region. Industrialization and Urbanization are the focal influence for island heat. Moreover, the oil industry has a great potential for environment hazards. These days, In comparison with suburban areas, there is an increase in LST near industrial area. Climate essentials are almost experimental in cities by climate locations. In various cases the current climate variability and microclimate conditions are not expressed. Sometimes, in the city under investigation, the meteorological station may not be found. Meteorological data could therefore be obtained from the neighboring stations. This limits the analysis of the spatial temperature pattern and temperature levels in the central area of the city. In Biyagama area, there is no meteorological observatory and data could be got from the Colombo meteorological station which is located near the Southeast boundary of the city. Thermal Infrared Remote Sensing has capability in monitoring temperature and effecting microclimate in urban area. Currently there is no such a temperature study has been done in Biyagama area and it is important for the planners, living community for the planning of future projects.

II. STUDY AREA

Biyagama was selected as the objective zone of this investigation. Biyagama city lies on the geographical coordinates of 06°56'32"N, 79°59'03"E and height above sea level is 16m, 52.49ft, 629.92in. It is extending over 59 km^2 with population of 186,585 and Industrial area 380 acres.

Sapugaskanda Oil Refinery is one of the biggest refinery in Sri Lanka. It is also located in this study area. It extents between 06 57 29 N to 06 58 06 N lat and 79 57 13 E to 79 57 42 E log and cover 165 acres. Not only that numerous industrial plants like Litro Gas Lanka, Alumex, JBF Industries Lanka Pvt. Expolanka (private) Limited etc located in this area.

Figure IV. The 2018 Biyagama study area in Sri Lanka.

III. LITERATURE REVIEW

As of late, examination into the use of TRS in urban zones has concentrated on: investigation of the surface temperature of the land or the spatial structure of urban thermal examples and their relationship to surface parameters; urban surface vitality balance and transitions; the connection between climatic temperature and LST. A few investigations have analyzed the effect of changes in LU/LC on LST. A few investigations evaluated the connection between LST and the wealth of vegetation, diverse vegetation files, for example, the NDVI and fragmentary vegetation cover were utilized to demonstrate vegetation abundance. The outcomes demonstrated that the negative correlation between's the LST and NDVI and the cooling impact of green territories. LST changes have been connected to numerous components, including LU changes, LS parameters, occasional variety and environmental change. Furthermore, economic advancement, and so on. (Jianga and Tian, 2010).

In my examination I have investigated the connection between the LST in a similar zone more than 17 years with NDVI and LULC. This examination is vital in light of the fact that this kind of research has at no other time been completed in Sri Lanka.

Remote sensing is a worldwide application system for the assessment of UHI impacts in urban areas even in districts where there are no sets of urban and rustic temperature records. Remote sensing related to the geological information system (GIS) has been broadly utilized in the location of LULC, the reason for accidental environmental change in urban communities, the evaluation of surface temperature dissemination attributes and the Urban Heat Surface Island and exploring the connection between land use/arrive cover and surface temperature. (Tyubee and Anyadike, 2015).

LST estimates from remotely sensed information are right now noticeable. LST is a key parameter in land surface material science since it is associated with vitality balance, evapo transpiration and desertification. The broad utilization of LST for ecological investigations and the administration of the assets of the earth has made the remote detecting of LST a critical scholastic subject over the most recent two decades. (AlSultan et al., 2005).

Refineries are commonly viewed as a noteworthy wellspring of contaminations in zones where they are found and controlled by various air, land and water

ecological enactment. Oil refineries are an imperative wellspring of dangerous and perilous air poisons.

They are additionally a noteworthy wellspring of air contaminations: particulate issue, sulfide hydrogen (H2S), oxides of nitrogen (NOx), and sulfide dioxide (SO2), carbon monoxide (CO). Refineries additionally discharge less harmful hydrocarbons like flammable gas (methane) and other unstable light powers and oils. Air discharges can emerge out of various sources in an oil refinery, including: breaks of gear (from valves or other hardware); high - temperature burning procedures in the real ignition of powers for power age; steam and process liquid warming; and item exchange. A huge number of pounds of these contaminants are traditionally discharged into the earth by typical discharges, outlaw discharges, inadvertent discharges or plant unsettling influence throughout the year. (Dangerous Substance Research Centers, 2003).

III. METHODOLOGY AND DATA COLLECTION

USGS is the row data source and information were gotten by the Landsat 8 OLI and TIRS and Landsat 7 ETM+. The three images for geometric and radiometric errors have just been remedied. Landsat 7 is the earth watching satellite with the most exact adjustment. The ETM+ likewise contains extra highlights that make it an increasingly flexible and effective device for worldwide change thinks about, observing area inclusion and count, and vast region mapping than its structure genealogies.

A. Estimation of LST

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C

S (K)

EmissivityLST (K) S (K) ()

()

$S_t(C) = S_t (K) – 273.13$

B. Calculate NDVI

The NDVI is an index that gives an institutionalized method to look at the green vegetation of satellite images. NDVI is characterized as the distinction between the NIR and the visible bands. The NDVI is an elective proportion of the number and state of vegetation. It is identified with vegetation protect attributes, for example, leaf region list, biomass and level of vegetation cover).

$$NDVI = (IR – R)/ (IR+R)$$

Where;

IR Infrared band

R Red band

NDVI varying between from -1 to +1;

For Landsat 7 images NIR band is band 4 and R band is band 3.

For Landsat 8 NIR band is band5 and R band is band 4.

IV. DATA PRESENTATION AND ANALYSIS

LST of Biyagama and NDVI classification was done by means of GIS techniques and Remote Sensing. Landsat 8 OLI/ TIRS and Landsat 7 ETM+ satellite imageries used to give maximum information of LST in the investigated area.

There are a few data gaps in Landsat 7 images after 2003 because of a few issues in sensors. Due to that choosing appropriate satellite image are extremely testing and troublesome. Landsat 7 thermal band 6 utilized for gauge the LST in 2001. The Landsat 7 thermal band 6 information records allude to the settings the band is obtained from. Since Band 6 is obtained in both high and low gains, the gain settings are accessible as two un.mistakable band records. FILE_NAME_BAND_6_VCID_1 offers an all-inclusive powerful range and lower radiometric goals (affectability), with less immersion at high Digital Number (DN) values. FILE_NAME_BAND_6_VCID_2 has higher radiometric goals (affectability), in spite of the fact that it has a progressively constrained unique range. In this examination vcid_2 band was utilized.

The studies showed that, the builtup areas and industrial represent the highest LST in the meantime, water bodies and vegetation represent the lowest one. Highly

urbanized area surface temperature clearly higher than less industrial zone. It's observed that, oil refinery can reflect the core cause of the increasement of temperature in the Sapugaskanda area along with factories in the industrial zone. Oil refinery and factories accountable for raising the surface temperature at built-up area.

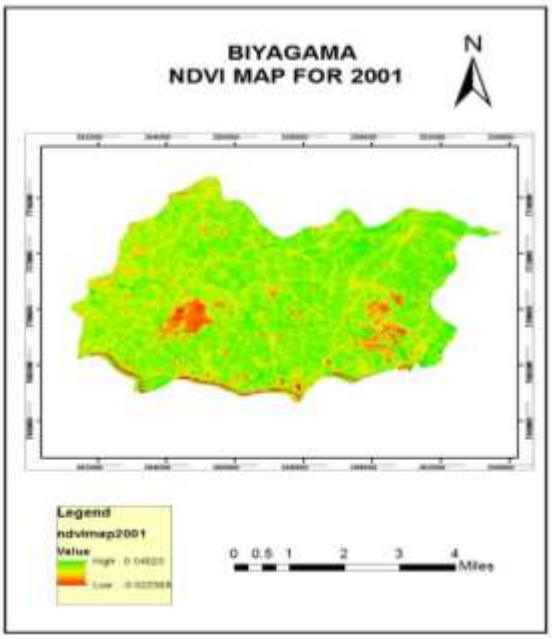

Figure 2. NDVI Map for 2001

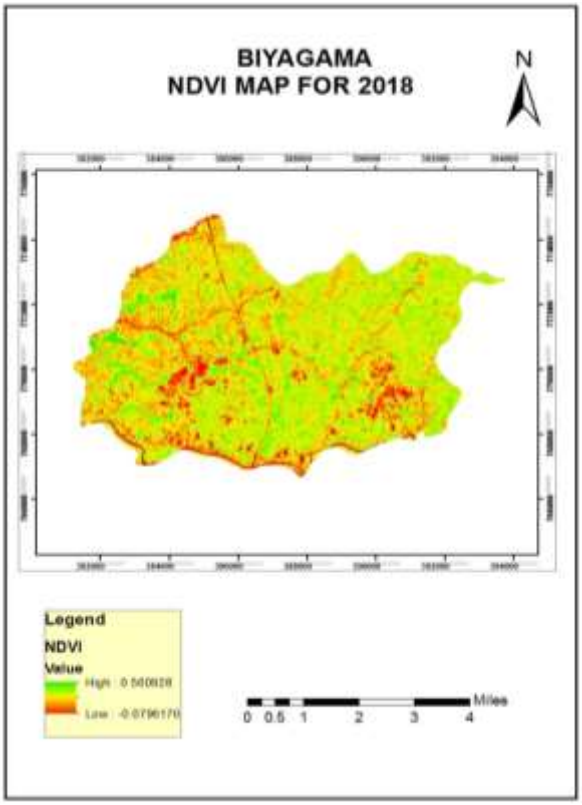

Figure IV. NDVI map for 2018

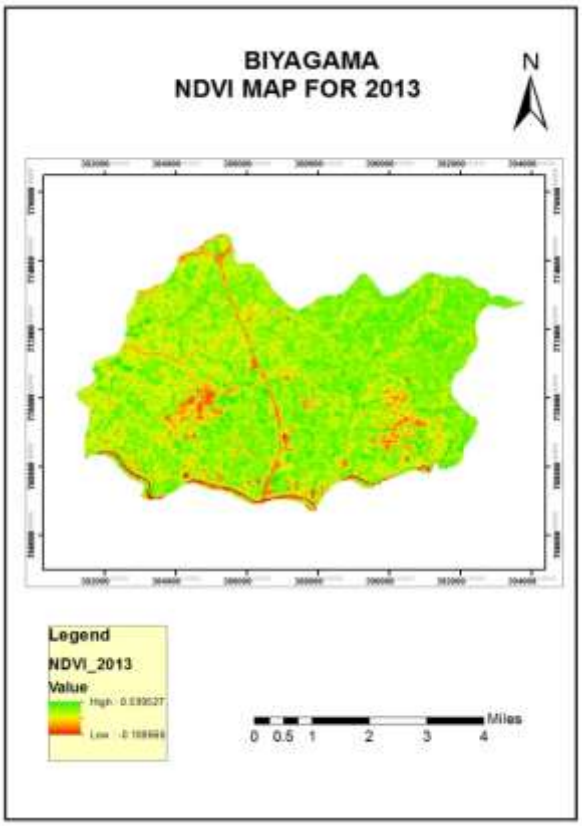

Figure 3. NDVI Map for 2013

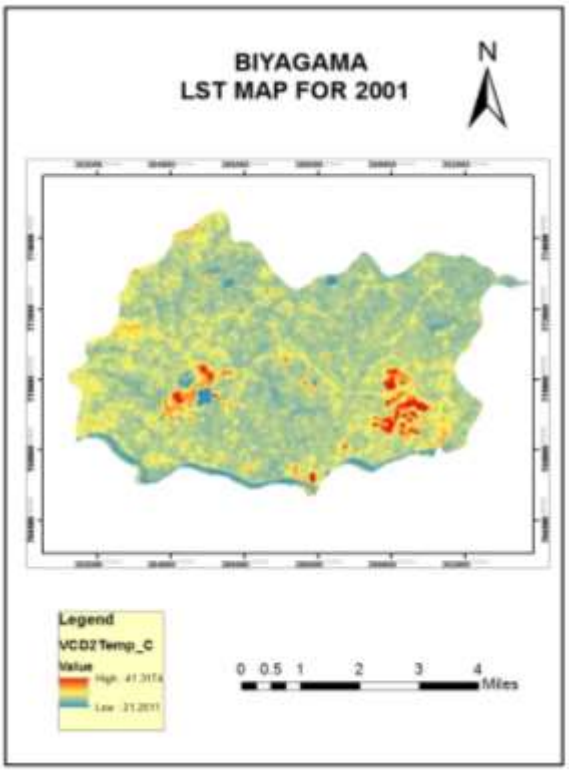

Figure 5. Land Surface Temperature (LST) Map for 2001

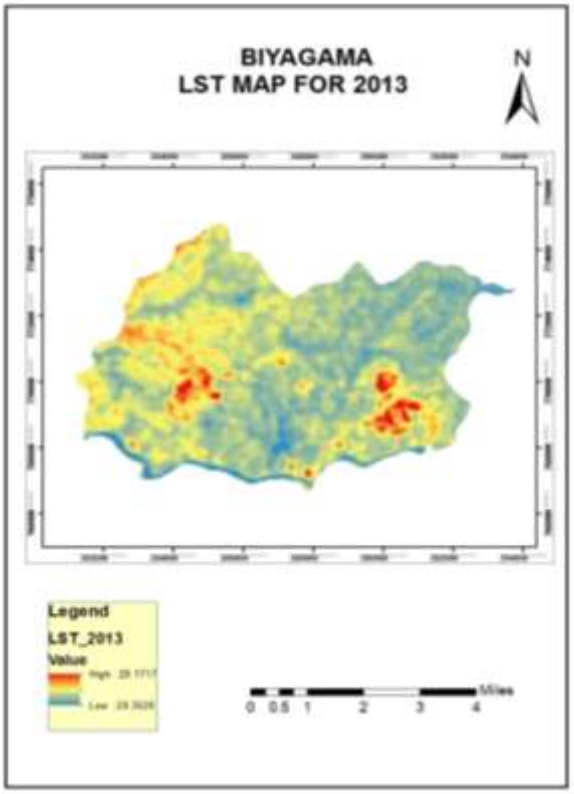

Figure 6. Land Surface Temperature (LST) Map for 2013

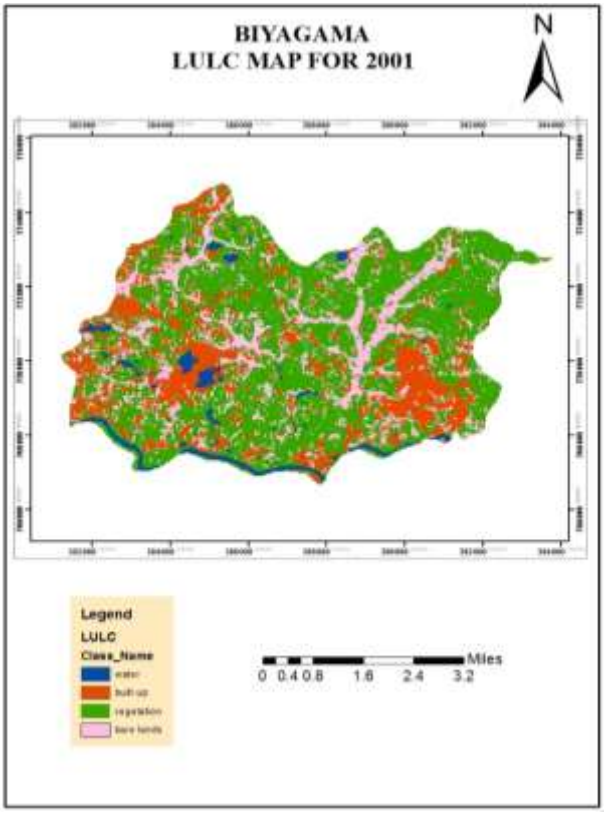

Figure 8. Land Use Land Cover Map for 2001

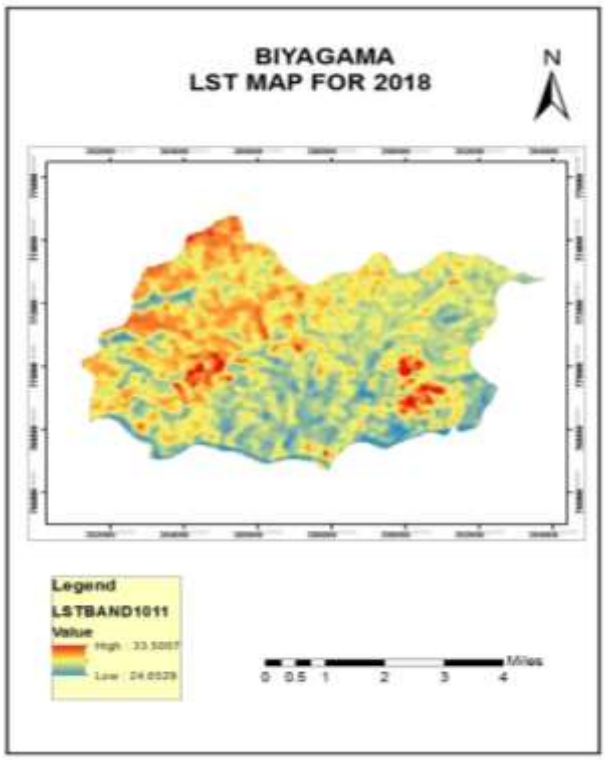

Figure 7. Land Surface Temperature (LST) Map for 2018

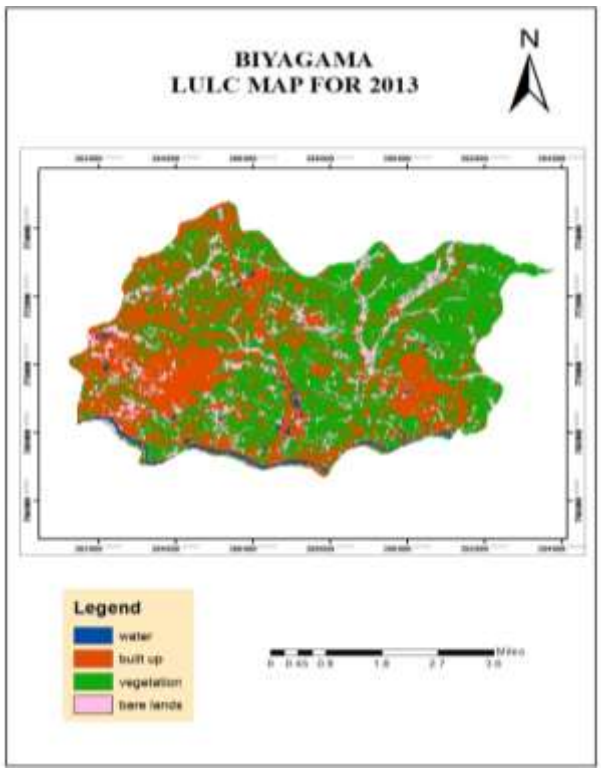

Figure 9. Land Use Land Cover Map for 2013

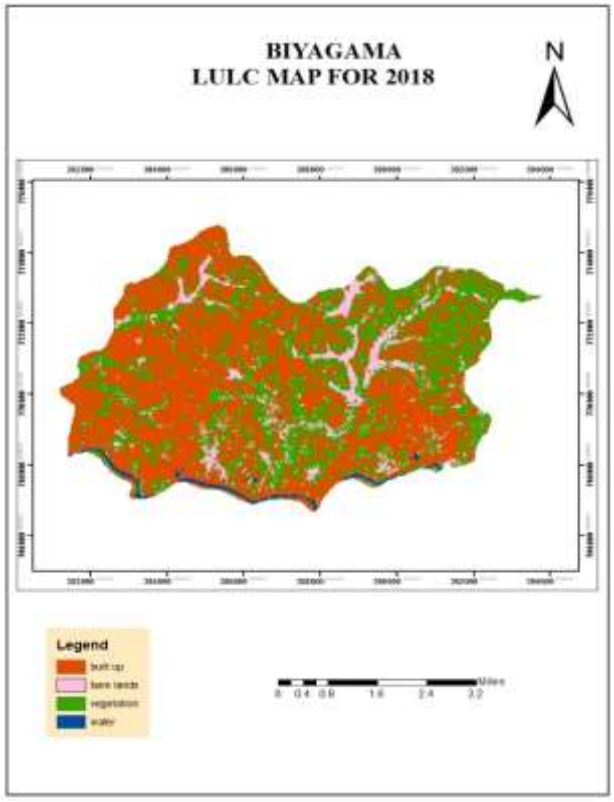

Figure 10. Land Use Land Cover Map for 2018

V. CONCLUSION

This paper provides the methodology of determination LST from Remote sensing data. In this study, images from three distinct dates (2001, 2013, 2018) were analyzed and it is clearly seen that highly urbanized areas have more surface temperature variance than the other areas. Sapugaskanda oil refinery area and the Industrial zone area can be identified as vital areas which has elevated LST values. Connection between LST and LC types effectively utilized in future urban planning. The thermal atmosphere in urban regions is categorized by the heat island phenomenon affecting energy, human health and environmental condition. It is advised to surround the oil refinery area and industrial zones by green belt buffers.

TRS can cover large areas with more subtleties of thermal conditions in the scene. The strategy which connected here was extremely valuable in understanding the spatial appropriation of surface temperature in a specific urban setting, instead of relying upon estimated information by the meteorological station on not very many areas. Ground-based perceptions reflect just thermal nearby condition around the station however the remote sensing thermal bands empowered to get the warm condition for every pixel in the image. Plainly city arranging needs to dig with this fast urbanization through strategy mediations. Land use rules should be set up. The aftereffects of this examination can be utilized adequately in future urban advancement and arranging ventures and in a naturally well-disposed way to deal with actualizing guidelines and controls by the specialists for supportable urban improvement.

VI. REFERENCES

Xiaolei, Y., Xulin, G. and Zhaocong, W. (2014). Land Surface Temperature Retrieval from Landsat 8 TIRS—Comparison between Radiative Transfer Equation-Based Method, Split Window Algorithm and Single Channel Method.

Manawadu, L. and Liyanage, N. (2008). ¬ Identifying Surface Temperature Pattern of the City of Colombo. Vol. XXXX1(No. 05), pp.133-140.

Yue, W., Xu, J., Tan, W. and Xu, L. (2007). The relationship between land surface temperature and NDVI with remote sensing: application to Shanghai Landsat 7 ETM+ data. pp.3205-3226.