International Journal of Civil Engineering and Technology (IJCIET)
Volume 8, Issue 8, August 2017, pp. 1450–1456, Article ID: IJCIET_08_08_159
Available online at http://http://www.iaeme.com/ijciet/issues.asp?JType=IJCIET&VType=8&IType=8
ISSN Print: 0976-6308 and ISSN Online: 0976-6316

ESTIMATION OF LAND SURFACE TEMPERATURE OF CHENNAI METROPOLITAN AREA USING LANDSAT IMAGES

***K. Ilayaraja, Wasi Reza, Vivek Kumar, Sourov Paul, Ravindra Chowdhary**
Department of Civil Engineering,
Bharath Institute of Higher Education and Research
Bharath University, Selaiyur-73, Chennai, India

ABSTRACT

This study estimates the land surface temperature of the Chennai Metropolitan Area (CMA) by using open source softwares like Quantum GIS (QGIS) and Geographic Resources Analysis Support System (GRASS GIS). Landsat (TM5) reflected band such as Band 1-5 & 7 were used to classify land use and land cover. The Band 6 (emitted) was used to determine the land surface temperature (LST) for the study area. The radiance values were computed for all the bands. The band 3 & 4 were used for classifying the Normalized Difference Vegetation Index (NDVI). Landuse/Land cover pattern in CMA was carried out by onscreen digitization with visual interpretation technique by using Survey of India toposheet (1970) and with the available years of satellite data sets such as Landsat Thematic mapper (TM5) 2006 and 2009. The total percentage of vegetation, water bodies, settlements and unclassified or barren lands covers about 11.45, 29.88, 42.20 and 16.47 respectively. The NDVI value varies from -0.42 to +0.74 and -0.38 to +0.69 during 2006 and 2009 respectively. The emissivity image was prepared and land use/land cover classes were identified and assigned with the corresponding emissivity values from 0.97 to 0.99. Land surface temperature was prepared for 2006 in which the values range from 18.5 ^{0}C to 34.56^{0}C and 19.2^{0}C to 35.9^{0}C for the year 2009. The study reveals that the nearby urban and surrounding areas have a temperature difference of 17^{0}C. Also it has been observed the dense settlement emits more heat when compared to water bodies and vegetation.

Key words: LST, GRASS GIS, QGIS, Radiance.

Cite this Article: K. Ilayaraja, Wasi Reza, Vivek Kumar, Sourov Paul and Ravindra Chowdhary, Estimation of Land Surface Temperature of Chennai Metropolitan Area using Landsat Images. International Journal of Civil Engineering and Technology, 8(8), 2017, pp. 1450–1456.
http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=8

1. INTRODUCTION

According to Dawson et al., (2009) urbanization which is anthropogenic activity plays evident and most powerful forces altering the Earth. It also alters the economic and social development (Zhao et al., 2006) which creates numerous environmental problems ranging from the local to the global scale. Due to increase in rapid growth of urbanization the urban environment is getting altered greatly (Linli Cui and Jun Shi 2012). Therefore metropolitan cities experiences various environmental challenges that a true for all the global cities.[4] This changes causes to alter the micro-climate or local weather climate. Due to this effect there is an increase of urban air temperature in over the cities in the world. Also temperature is one of the most urgent problems in urban area which is caused by increasing surface temperature. It mainly happens due to the alteration and conversion of vegetated surfaces to impervious surfaces. This lead to illustrious climatic condition termed as Urban Heat Island (UHI) in major cities

According to Karnieli et al., (2010) LST is one of the most important parameters in the physical processes of surface energy and water balance at local through global scales. Ilayaraja (2011) had measured NDVI a vegetation index for the Chennai City. Many studies are carried now-a-days by using GIS and remote sensing tools. (For Eg., natural resources (Dar et al. 2010), land surface temperature (Javed Mallick et al. 2008) and (Ayad Ali Faris, Sudhakar Reddy, 2010), evapotranspiration, climate change, hydrological cycle, vegetation monitoring, urban climate, environmental studies and NDVI (Weng, 2009; and Hansen et al., 2010).

Therefore, the aim of the study is to estimate the land surface temperature of Chennai metropolitan area using Landsat images. **[8-12]**The following objectives to achieve the aim of the study are such as (i) To prepare a base map by using survey of India Toposheet. (ii) To classify the image and preparing various Land Use and Land Cover such as Built up area, Water bodies, Vegetation and Barren land. (iii) To collect Satellite data and converting the DN value into at - sensor radiance/reflectance. (iv) To prepare a Normalized Difference Vegetation Index (NDVI) map. (v) To estimate the Emissivity of land surface. (vi) To estimate the Land Surface Temperature (LST) of study area.

2. MATERIALS AND METHODOLOGY

In this present study the available data sets like SOI toposheet (1970), Landsat satellite imageries were collected for the years 2006 and 2009. Thematic mapper imageries were freely downloaded from the Global Land Cover Facility. The GLF develops and distribute remotely sensed satellite data and products are available free of cost by the GLCF. The thematic mapper image of 2006 and 2009 has a resolution of 60 meters. Visual interpolation techniques were adopted to classify the pixels in the images into different classes such, water bodies, settlements, road network, rail lines, and barren land.

The base map was geo-referenced and was projected to standard projection called the Universal Transverse Mercator (UTM) projection with the zone 44N by using Quantum GIS (QGIS) software. The satellite data which was downloaded composed of seven bands and the standard band combination was carried out for the generation of false composite colour (FCC) image. The satellite images were subset by using clip analysis for the limitation of the study area. Therefore all the pixels within the study area are classified into various classes or themes. The generalized flowchart adopted for the present study is shown in figure 1.

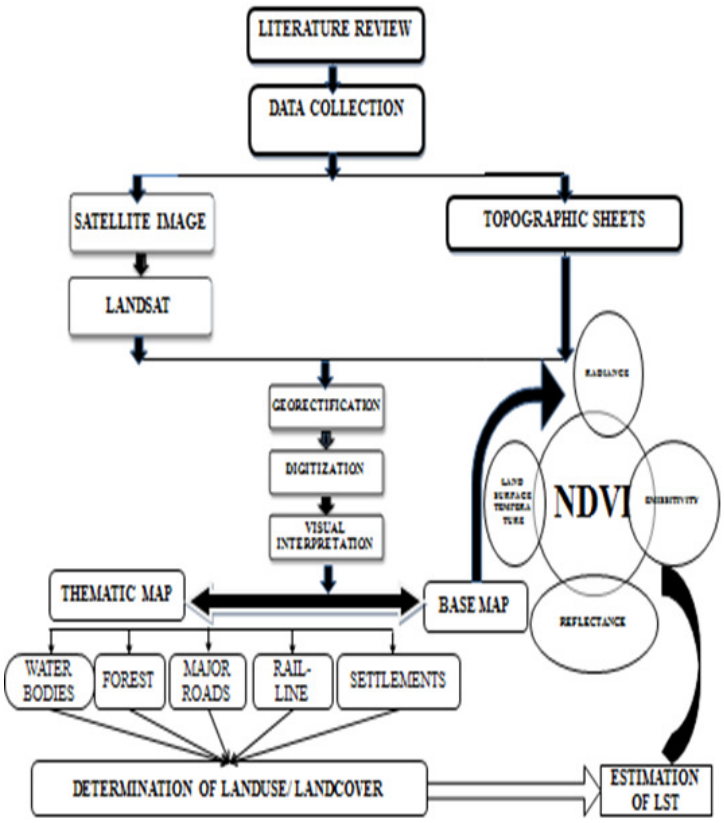

Figure 1 Methodology

3. STUDY AREA

The Chennai Metropolitan Area (CMA) is the fourth largest metropolitan area in India after the regions of Delhi, Mumbai and Kolkata. It is situated within the longitude of 80.15687 to 80.24471 and latitude of 12.87778 to 13.25716 (Figure 2) and being a coastal area and lying near the equator, the temperature here has extreme variations. The study area has an area of 1207.77 km² spread over three districts. It includes the whole of Chennai district, parts of Kanchipuram district and Tiruvallur district respectively.

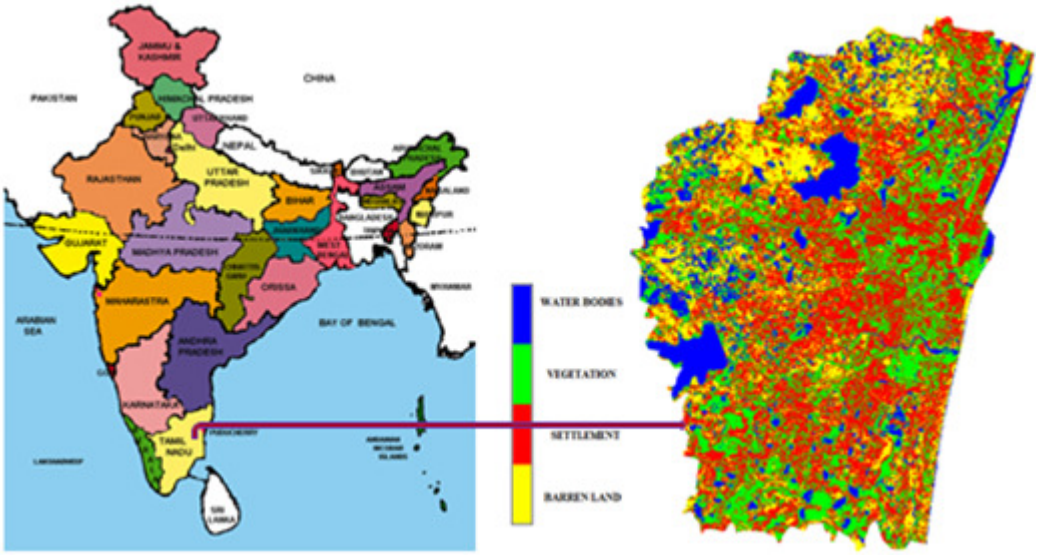

Figure 2 LULC of the study area

4. RESULT AND DISCUSSION

4.1. Landuse and Land cover (LULC)

SOI toposheet (1970) and with the available satellite data sets such as LANDSAT Thematic mapper (TM5) for the year 2006 and 2009 respectively were used in this study. The Landuse/landcover patterns such in the Figure 2. The total area of the study area is about 1207.77 km^2 out of which settlement area was found to be 509.69 $km^2$and the vegetation or forest cover is about 360.93km^2. Water bodies and Barren or unclassified land covered 138.35and 198.82km^2 respectively. The total percentage of water bodies, vegetation, settlements and barren lands covers about 11.45, 29.88, 42.20 and 16.47 respectively.

4.2. Normalized Difference Vegetation Index (NDVI)

NDVI has found a wide application in vegetative studies as it has been used to estimate crop yields, pasture performance, and rangeland carrying capacities among others. According to Holmes et al (1987) healthy vegetation will reflect more NIR wavelength. The NDVI can be computed by using the formula NDVI = (Band 4 - Band 3)/ (Band 4 + Band 3). Therefore the output values will be ranging from -1 to +1 in which the positive values will indicate the dense vegetation and negative values indicate water or barren areas. The NDVI values for the year 2006 vary from-0.42 to +0.74 and during 2009 it varies from -0.38 to +0.69 (Figure 3).

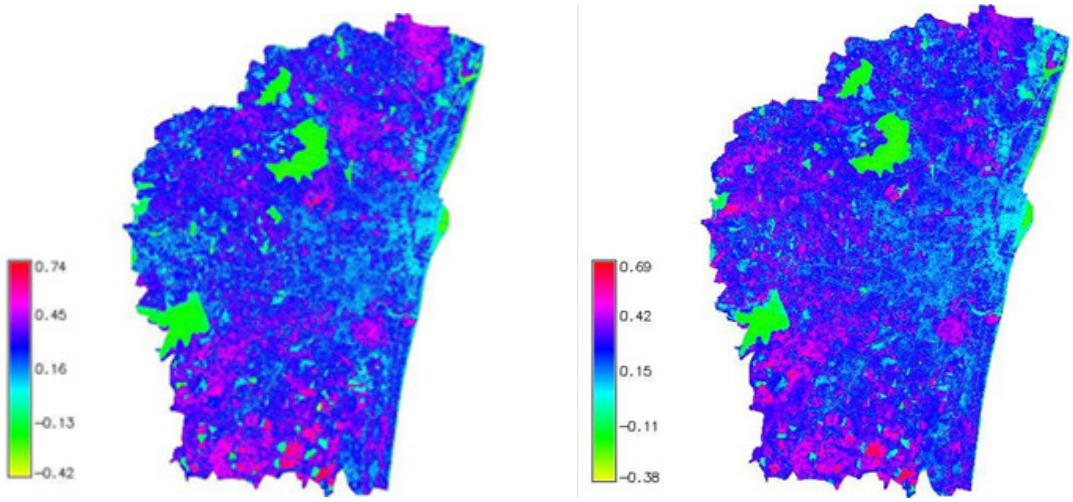

Figure 3 NDVI Map during 2006 and 2009

4.3. Conversion from Digital Number to Radiance

The standard methods adopted by Sobrino et al. (2004) were used in computing the radiance and reflectance values. Based on the NDVI values of different land use classes, emissivity image was prepared by assigning emissivity values ranging from 0.97 to 0.99.

4.4. Land Surface Temperature

Land surface temperature (LST) is generally defined as the skin temperature of the ground. It is calculated by the following formula

$T_S = T_b / 1 + (\lambda * T_b / \gamma) * \ln \varepsilon$

Where

T_b= at satellite temperature

λ= wavelengths of band 6 (11.5 µm)

$\gamma = h*c/a$ (0.01438m.K)

c = velocity of light ($3*10^8$ m/s)

Based on the NDVI values of different land use classes, Land surface temperature was prepared values ranging from 18.5 to34.56 for 2006 and for 2009 it is ranging from 19.2to 35.9 (Figure 4).

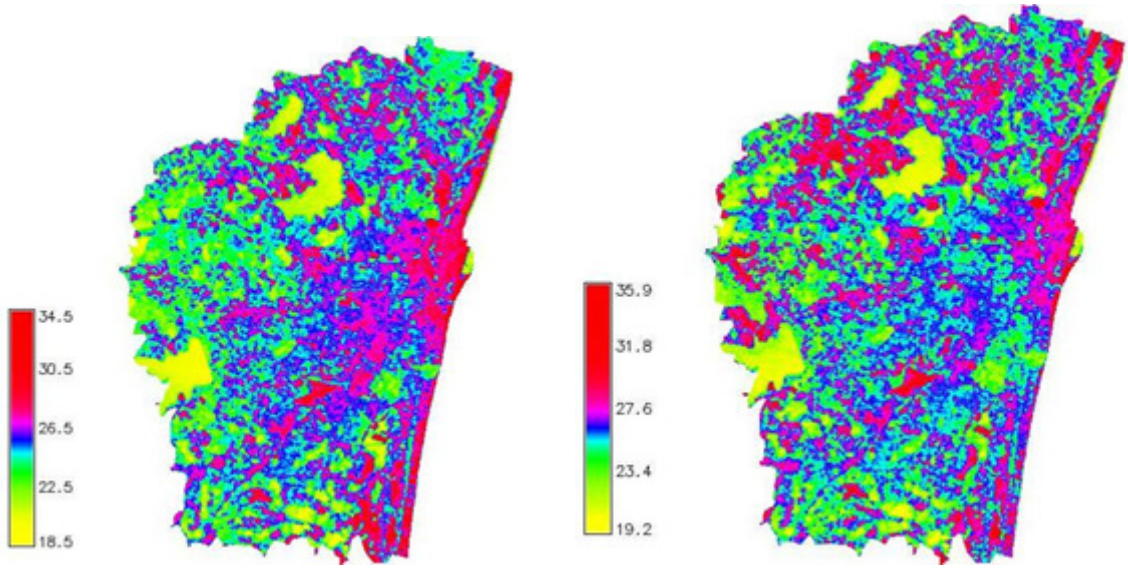

Figure 4 Land Surface Temperature during 2006 and 2009

5. CONCLUSION

The estimation of land surface temperature of Chennai metropolitan area is presented for the year 2006 and 2009. The total of the study area is 1207.77 km^2 out of which settlement area was found to be 509.69 $km^2$and the vegetation or forest cover is about 360.93km^2. Water bodies and barren land covered is138.35 $km^2$and 198.82km^2. The total percentage of vegetation, water bodies, settlements and barren lands covers about 29.88, 11.45, 42.20 and 16.47 respectively. The NDVI value varies from -0.42 to +0.74 and -0.38 to +0.69 during 2006 and 2009 respectively. The emissivity image was prepared and land use land cover classes were identified and assigned with the corresponding emissivity values from 0.97 to 0.99. Land surface temperature was prepared and the values are ranging from 18.5 ^{0}C to 34.56^{0}C for 2006 and 19.2^{0}C to 35.9^{0}C for the year 2009. The study reveals that the nearby urban and surrounding areas have a temperature difference of 17^{0}C.

From the result it is identified that the nearby urban are showing more temperature when compared to rural areas. The study clearly indicates the presence of Urban Heat Islands in the urban regions. The study reveals that the nearby urban and rural areas have a temperature difference of 17^{0}C. Also it has been observed the dense settlement in the study are emits more heat when compare to water bodies and vegetation. This study reveals that the open source Quantum GIS and Geographical Resource Analysis Support System (GRASS) GIS can be satisfactorily used for the government agencies and educational institutions for urban planning and research works. The study also recommends in making use of the available open source

software in research fields. This study is considered to be useful to develop counter measure for the associated impact of the anthropogenic activities, effects on the microclimate and Urban Heat Island of Chennai Metropolitan Area. The study is potentially useful for administrators and urban planners in Chennai Metropolitan Area.

REFERENCES

[1] Dawson, R.J., Hall, J.W., Barr, S.L., Batty, M., Bristow, A.L., Carney, S., Dagoumas, A., Evans, S., Ford, A., Harwatt, H., Köhler, J., Tight, M.R., Walsh, C.L., Zanni, A.M., (2009). A blueprint for the integrated assessment of climate change in cities. Tyndall Working Paper 129, pp. 26.

[2] Javed Mallick, Yogesh Kant and B.D.Bharath (2008) "Estimation of land surface temperature over Delhi using Landsat-7 ETM+". J. Ind. Geophys. Union. Vol.12, No.3, pp.131-140.

[3] Linli Cui and Jun Shi (2012) Urbanization and its environmental effects in Shanghai, China. Urban Climate. V2. pp. 1–15

[4] Zhao, S.Q., Da, L.J., Tang, Z.Y., Fang, H.J., Song, K., Fang, J.Y., 2006. Ecological consequences of rapid urban expansion: Shanghai, China. Frontier in Ecology and Environment 4 (7), 341–346.

[5] Karnieli, A. N., Agam. R. T. Pinker, M. Anderson, M. L. Imhoff, G.G. Gutman, N. Panov and A. Goldberg (2010) Use of NDVI and land surface temperature for drought assessment: merits and limitations. Journal of Climate. 23, pp. 618-633.

[6] Rajeshwari and Mani (2014). "Estimation of Land Surface Temperature Of Dindigul District Using Landsat 8 Data"Ijret: International Journal Of Research In Engineering And Technology. 3 (5). pp. 2321-7308.

[7] K. Ilayaraja (2011). "Vegetation response of Chennai City using Normalized difference vegetation index (NDVI) from Landsat images "International Journal of Engineering Trends and Technology (IJETT) –Volume2 issue3Number1. pp.1-3.

[8] Ayad Ali Faris and Y. Sudhakar Reddy (2010). "Estimation of Urban Heat Island Using Landsat Etm+ Imagery at Chennai City". International Journal of Earth Sciences and Engineering, 3(3), pp. 332-340**.**

[9] Kumar J., Sathish Kumar K., Dayakar P., Effect of microsilica on high strength concrete, International Journal of Applied Engineering Research, v-9, i-22, pp-5427-5432, 2014.

[10] Dayakar P., Vijay Ruthrapathi G., Prakesh J., Management of bio-medical waste, International Journal of Applied Engineering Research, v-9, i-22, pp-5518-5526, 2014.

[11] Iyappan L., Dayakar P., Identification of landslide prone zone for coonoortalukusing spatialtechnology, International Journal of Applied Engineering Research, v-9, i-22, pp-5724-5732, 2014.

[12] Srividya T., Kaviya B., Effect on mesh reinforcement on the permeablity and strength of pervious concrete, International Journal of Applied Engineering Research, v-9, i-22, pp-5530-5532, 2014.

[13] Sandhiya K., Kaviya B., Safe bus stop location in Trichy city by using gis, International Journal of Applied Engineering Research, v-9, i-22, pp-5686-5691, 2014.

[14] Ajona M., Kaviya B., An environmental friendly self-healing microbial concrete, International Journal of Applied Engineering Research, v-9, i-22, pp-5457-5462, 2014.

[15] Sachithanandam P., Meikandaan T.P., Srividya T., Steel framed multi storey residential building analysis and design, International Journal of Applied Engineering Research, v-9, i-22, pp-5527-5529, 2014.

[16] Saraswathy R., Saritha B., Planning of integrated satellite township at Thirumazhisai, International Journal of Applied Engineering Research, v-9, i-22, pp-5558-5560, 2014.

[17] Saritha B., Rajasekhar K., Removal of malachite green and methylene blue using low cost adsorbents from aqueous medium-a review, Middle - East Journal of Scientific Research, v-17, i-12, pp-1779-1784, 2013.

[18] Saritha B., Ilayaraja K., Eqyaabal Z., Geo textiles and geo synthetics for soil reinforcement, International Journal of Applied Engineering Research, v-9, i-22, pp-5533-5536, 2014.

[19] Ilayaraja K., Krishnamurthy R.R., Jayaprakash M., Velmurugan P.M., Muthuraj S., Characterization of the 26 December 2004 tsunami deposits in Andaman Islands (Bay of Bengal, India), Environmental Earth Sciences, v-66, i-8, pp-2459-2476, 2012.

[20] M Jhansi, K Pushpa Rani, Chandrasekhara Reddy T, Global Land Temperature Analysis Using Hadoop User Experience (Hue), Volume 8, Issue 7, July-2017. pp. 249-255.

[21] Ali H. Al-Aboodi, Husham T.Ibrahim and Sarmad A.Abbas, Performance of Sequencing Batch Reactor (SBR) for Domestic Wastewater Treatment Under Low Temperature in Basrah City (South Of Iraq), International Journal of Civil Engineering and Technology, 8(6), 2017, pp. 787–796.

[22] Ilayaraja K., Ambica A., Spatial distribution of groundwater quality between injambakkam-thiruvanmyiur areas, south east coast of India, Nature Environment and Pollution Technology, v-14, i-4, pp-771-776, 2015..