IMPACTS ON HUMAN SOCIETIES AND NATURAL ECOSYSTEM IN KARUR TALUK, TAMILNADU MONITORING USING LST & NDVI

Suvish S

Student,Department of Remote sensing,Bharathidasan university,Tiruchirapalli-23

Abstract

The present study aims to assess the trend of spatiotemporal relationship between Normalized difference vegetation Index(NDVI) and Land surface Temperature (LST) under different ranges of NDVI & LST for Karur district, Tamilnadu by using satellite imagery for the years of 2000,2010,&2020. The Normalized Difference Vegetation Index (NDVI) is a geographical data which is used to analyze the vegetation index by using remote sensing Technology. Landsat data is utilized for the computation of LST and NDVI.Thus NDVI was one of the key factor to simply and quickly identify vegetated areas and their conditions, it remains the most well-known method to detect live green plant canopies in multispectral remote sensing data. Land Surface The(LST) is an important parameter for many scientific disciplines since it affects the interaction between the land and the atmosphere. The increasing spatial and temporal resolution of globally available satellite gives a unique opportunity to monitor the NDVI & LST values time series systematically. This work has great potential to provide valuable support for monitoring NDVI and LST and providing precise management strategy. According to the land surface temperature, the vegetation growth also varies. Temperature variation of land surface temperature of 2000, 2010 and 2020 has been analyzed and correlated with respect to vegetation. Here land surface temperature has estimated by standard mathematical equation. In 2000,the LST ranges from 34.08 to 19.13 but in 2010, the temperature has get reduced as 32.08 to 19.13 and then in 2020 temperature ranges from 35.08 to 23.13.When we correlate the LST with NDVI, assumed it's ranges from 0.69 to -0.39. This provides an effective tool in evaluating the impacts for humans and other environmental ecosystems with remote sensing and geographical information systems.

Keywords: Spatiotemporal, NDVI, LST, Landsat, Remote Sensing

INTRODUCTION

Land Surface Temperature (LST) is defined as the temperature at interface between the Earth's surface and its atmosphere1. It is an important parameter in all physical processes of surface energy and water balance at local and global scales2-8. LST is playing a key role in land surface processes, not only, because of having climatic importance, but also due to its control of the sensible and latent heat flux exchange9- 10. LST have wide application in many fields viz; evapotranspiration, climate change, hydrological cycle, vegetation monitoring, urban climate and environmental studies11-18. LST is also used in models of vegetation stress19-21 and can be assessed for obtaining climatic trends when observed over many years22. Due to the limitations in in-situ observations and relatively large spatial variability in LST, it is commonly measured on a regional or global basis with satellite retrievals. On the availability of large scale satellite obtained LST data, near surface air temperature measurements can be evaluated23-25. LST data is useful for monitoring the temperature of different land use land /cover surfaces. It can be often used for checking and predicting of crop yield 26. Due to the strong heterogeneity of land use/ land cover (LU/LC) surfaces such as vegetation, surface roughness, topography and soil27-28 LST changes rapidly in space as well as in time 29-30. Therefore, it requires measurements with detailed spatial and temporal sampling.

Satellite based thermal infrared (TIR) data is directly linked to the LST through the radiative transfer equation. LST retrieval from remotely sensed TIR data has attracted much attention and its history dates back from 1970s31-32. Remote sensing technology provides a unique way for evaluating LST on global scale. Remote sensing application is required to observe the spatiotemporal land cover changes in relation to the basic physical properties and in terms of the surface radiance and emissivity data. Remote sensing benefits are having availability of high resolution data, consistent and repetitive coverage and are able to map the earth's surface conditions33. Thermal infrared (TIR) sensors are capable of obtaining quantitative information about surface temperature in different land cover classes. There are many workable thermal infrared sensors which are able to study LST viz; Geostationary Operational Environmental Satellite (GOES), NOAA-Advanced Very High Resolution Radiometer (AVHRR), Terra and Aqua- Moderate Resolution Imaging Spectroradiometer (MODIS).High resolution data from the TerraAdvanced Space borne Thermal Emission and Reflection Radiometer (ASTER) has a 90m resolution and LANDSAT-7 Enhanced Thematic Mapper (ETM+) and LANDSAT-8 TIRS having resolution of 100m in thermal region. LST is sensitive to vegetation and soil moisture; therefore, it can be used to observe land use/land cover changes, such as urbanization, desertification etc. The Spatial and temporal changes resulted in LST due to changes occurred in land us/ land over cover and influence on the local weather of that area. Nowadays urbanization has become a common phenomenon, since the 20th century, about 50% of the population living in the city now34. Rapid urbanization leads to an increase in LST, which is governed by surface heat fluxes and play a key role in global climate change. Urbanization results in global climate change in various ways and multiple dimensions. Recent research reported that urban population is expected to reach 65 % by (2025)35. Multi-temporal and multi-resolution remote sensing images can provide basic data for analyzing urban spatial information and thermal environment effectively. Previous studies suggest that there exists a strong negative correlation between NDVI and LST, while NDVI changes greatly with season. Normalized difference vegetation index (NDVI) have been used as an indicator for vegetation cover. The present study analyzes the potential of LANDSAT 5 TM & LANDSAT-8 TIRS in mapping of LST and interprets their relationship with NDVI using ArcGIS software.

ROLE OF GEOINFORMATICS

Geoinformatics is the spatial hub of the IT industry. Town and regional planning and environmental and biodiversity management are increasingly becoming reliant on Spatial Information Systems together with the use of air- and space-borne observation platforms. Huge amounts of data are being collected which needs to be analysed. The derived results from such analyses need to be disseminated in user friendly formats that are regularly updated. The Internet has become the de facto instrument for disseminating information to broader audiences. With technological advances comes the need for training in the use and development of such systems. It is this milieu that the intended MSc and PhD programme in Geo-Informatics wishes to address.

OBJECTIVES

The report has been prepared after studying, comparing thematic data sets in a geographic information system (GIS) environment; assessment the impacts over the humans and also other natural ecosystems like vegetation, agriculture and other things which are dependent upon the environment. The Aim of this study is to analyze the LST and NDVI, for the time periods of 2000 and 2020 by using land sat satellite imageries of the Karur Taulk in Tamil Nadu.This study also focuses to map the Karur taluk with the aid of remote sensing and GIS techniques

The Key objectives of the study are:

1. Assessment of the temperature and effects on karur taluk by preparing Land surface temperature maps and Normalised difference vegetation index maps for the year 2000,2010&2020.

2. Identification of difference in vegetation on study area and correlate it with temperature.

AIM AND OBJECTIVES

To study the effect of Karur with respect urban planning and develop relation between planning characteristics which will be useful for urban planners/authorities to mitigate climate change in newly developing area of Karur Taulk.

LITERATURE REVIEW

Temperature plays a major role in day to day activities in that case all the living beings and other ecosystems on environments are dependent upon it.The major effects due to Temperature has been found to affect the living organisms in various ways, for example it has a growth, development and distribution of plants and animals.

STUDY AREA

There study area, Karur Taluk is located between10º45'47" N - 11º05'41" N Latitude and 77º55'19" E - 78º13'20" E Longitude. Cauvery and Amaravathi rivers drain the Taluk and normally found to be dry during the summer season. The soil is best suited for raising dry farming crops. The total geographical area of the taluk is about 504.44 sq km.

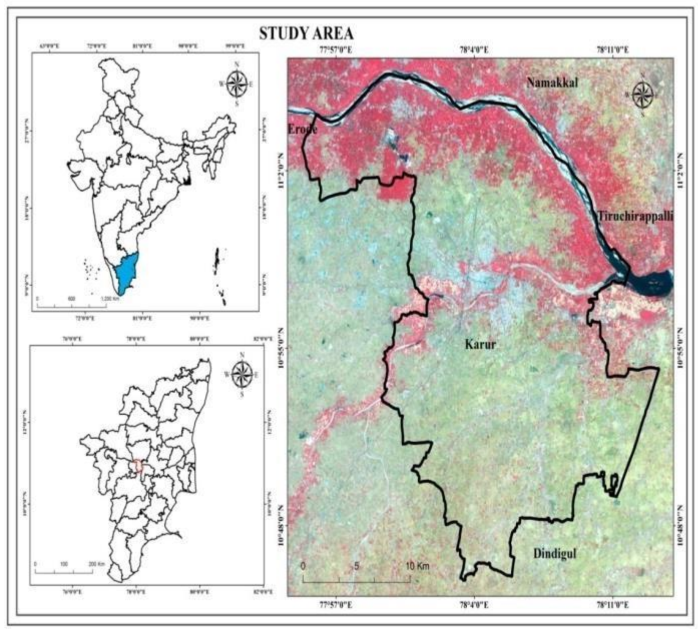
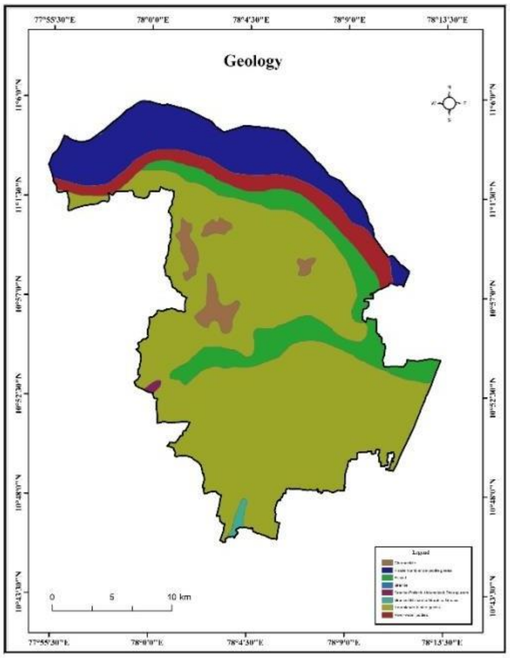


Fig.1 Location map of the study area

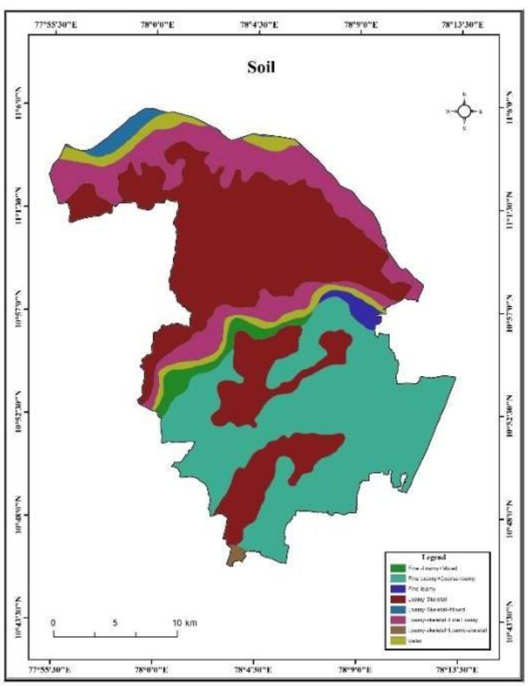
The Karur Taluk is located in Karur district of Tamilnadu.The karur taluk contains town Panchayats in Karur include Aravakurichi, Pallapatti, Punjaipugalur, TNPLPugalur (Ka githapuram), Puliyur, Uppidamangalam, Palaya Jeyankonda Cholapuram, Krishnarayapuram, Marudur, and Nangavaram.The demographics of Karur taluk describes according to the 2011 census, the taluk of Karur had a population of 444,721 with 221,107 males and 223,614 females. There were 1011 women for every 1000 men. The taluk had a literacy rate of 74.55. Child population in the age group below 6 was 19,786 Males and 18,295 Females.Karur is one of the hottest district in Tamilnadu.

GEOLOGY

The rock types found in our study area are majorly covered by hornblende biotite gneiss and then other rock types are fissile hornblende biotite gneiss , Charnockite (which is a hypersthene bearing granites),and granites.The cauvery river flow along our study area.It deposits the Sediments which transported over the cauvery river.



SOIL



The different types of soil are identified in Karur taluk which are fine loamy + mixed,fine loamy + coarse loamy,fine loamy,loamy skeletal,loamy skeletal + fine loamy.The study area is covered with mostly loamy soil.Loamy soil is well suited for cultivation.The crops like vegetable, sugarcane, wheat, cotton, etc...are grown well in this soil .

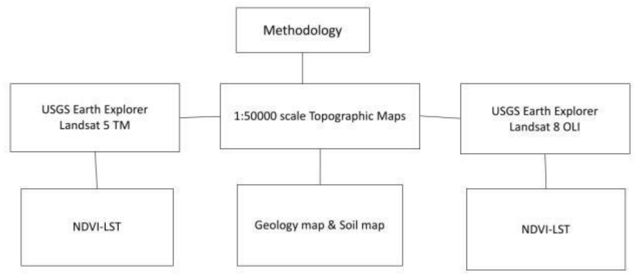
METHODOLOGY

Data Collection and Methodology

Cloud Free Landsat satellite data of 2000,2010&2020 for the study area has been downloaded from USGS Earth website. All the data are pre-processed and projected to the Universal Transverse Mercator (UTM) Projection system.

Table 1: Detail of data collection.

Sensor / Satellite	**Date of Image**	**Path / Row**
Landsat TM 5	April 2000,2010	143/53
Landsat 8 OLI	April 2020	143 / 53



Study of the following methodology is adopted which involves satellite data collection. classification of the imagery, preparation of NDVI class and LST maps.These are briefly outlined here.

NDVI

The Normalized Difference Vegetation Index (NDVI) is a measure of the amount and vigour of vegetation at the surface. The reason NDVI is related to vegetation is that healthy vegetation reflects very well in the near infrared part of the spectrum.NDVI is calculated fro the visible and near-infrared light reflected by vegetation. NDVI calculation are based on the principle that actively growing green plants strongly absorb radiation in the visible region of the spectrum while strongly reflecting radiation in the near infrared NDVI value of the pixel varies between -1 to +1 in which the value -1 indicates usually water and the value +1 indicates strongest vegetation growth. In this study area the data for the period of 2000 shows the pixel values range from -0.39 to 0.68, period of 2010 the pixel value range from -0.33 to 0.69, and finally the period of 2020 the pixel value ranges from -0.53 to 0.53.The high vegetation is played well in the year of 2010 range of 0.69 and in 2000 &2020 there may be a moderate to low range of vegetation.

$$NDVI = (NIR – RED) / (NIR + RED)$$

Table 2: Detail band for NDVI

Data	Band	Band
Landsat 5	Band 4	Band 3
Landsat 8	Band 5	Band 4

LST

Land surface temperature is the temperature at the interface of earth's surface with its atmosphere. It can be measured from the ground surface up to the height of 2-3m. While calculating of LST from the Landsat-8 satellite data, different mathematical algorithms were used and processed in ArcGIS software. Evaluation of LST, from LANDSAT-5&8 data in ArcGIS raster processing involving the following steps:

1. Conversion of satellite digital number into radiance by:

   $L\lambda = L{*}Qcal\ ALOi$ ....(1)

   Where, ML represents the band-specific multiplicative rescaling factor,Qcal is the Band 10 image, AL is the band- specific additive rescaling factor, and Oi is the correction for Band 10.

2. Conversion of Radiance to At-Sensor Temperature by;

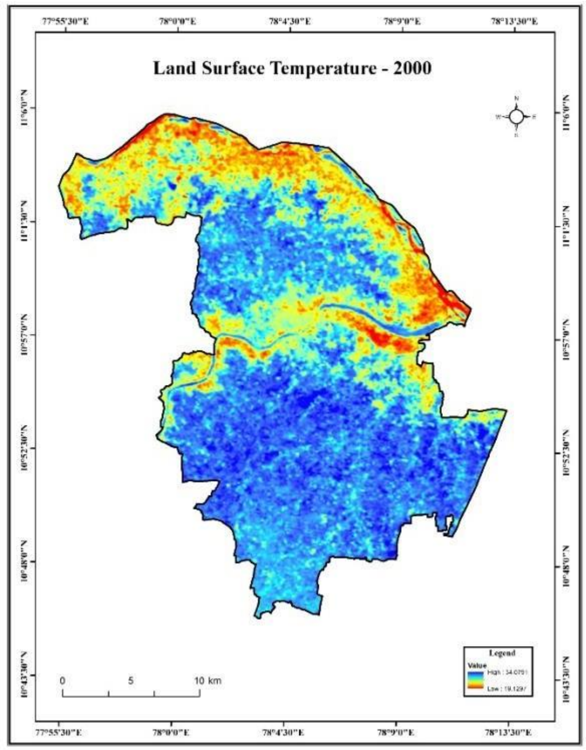
   $BT = K2 / \ln [K1/ L\lambda + 1] - 273.15$.… (2) Where, Tb is effective at satellite temperature in absolute temperature, K1 and K2 stand for the band-specific thermal conversion constants from the metadata. For obtaining the results in Celsius, the radiant temperature is revised by adding the absolute zero (−273.15°C)

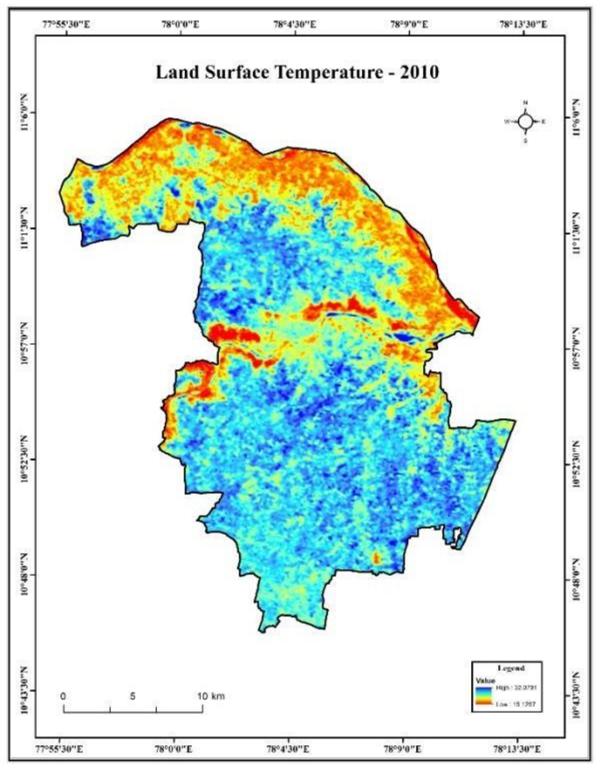
3. Conversion of Satellite Brightness Temperature into LST by;

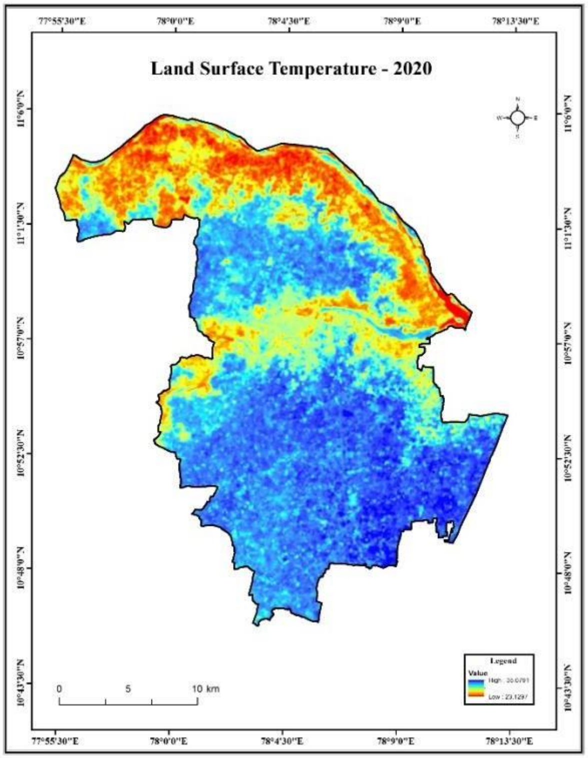
   $Ts = BT/\{1+\lambda(BT/\rho)\ln\varepsilon\lambda]\}$ …. (5) Where Ts is the LST in Celsius (°c), BT is atsensor BT (°c), λ is the wavelength of emitted radiance (λ = 11.5 µm), ε is the emissivity.

RESULT AND DISCUSSION

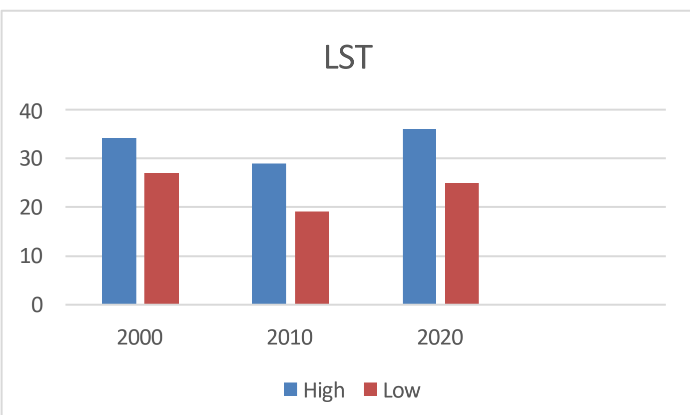
Land surface temperature acquired from satellite data represents the surface temperatures of each object within a pixel, which may be composed of several land cover types. With the help of above described equations processing of Landsat-8 thermal band 10, has been done in ArcGIS and LST maps of the study area were prepared. LST mapswere prepared are showing the spatial distribution of surface temperature within the watershed. The different thermal signatures seen in the LST maps of the watershed are because of the different land cover classes having different physical properties.







2000, Temperature ranges from 19.13 to 34.08
2010, Temperature ranges from 19.13 to 32.08
2020, Temperature ranges from 23.13 to 35.08



By using this LST parameters we have able to correlate it with NDVI which is a vegetation.If there is a rise of temperature there may be a low range of vegetation.and if there is a Low temperature zone there it plays a high range of Vegetation.

LST maps is prepared by using the formula

LST = BT / 1 + w * (BT / P) * Ln (e)

NORMALIZED DIFFERENCE VEGETATION INDEX

A vegetation index is a single value that quantifies vegetation health or structure. The math associated with calculating a vegetation index is derived from the physics of light reflection and absorption across bands. For instance, it is known that healthy vegetation reflects light strongly in the near infrared band and less strongly in the visible portion of the spectrum. Thus, if you create a ratio between light reflected in the near infrared and light reflected in the visible spectrum, it will represent areas that potentially have healthy vegetation.

The normalized difference vegetation index (NDVI) is a simple graphical indicator that can be used to analyze remote sensing measurements, typically, but not necessarily, from a space platform, and assess whether the target being observed contains live green vegetation or not.

The NDVI is calculated from these individual measurements as follows:

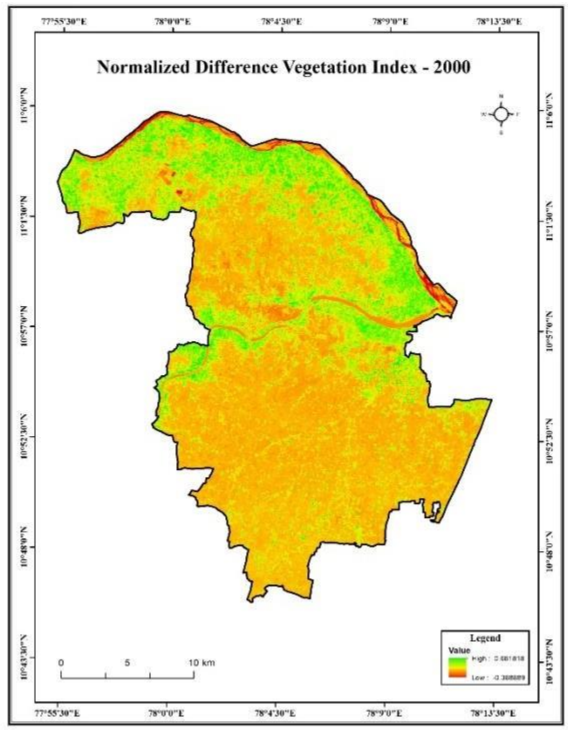
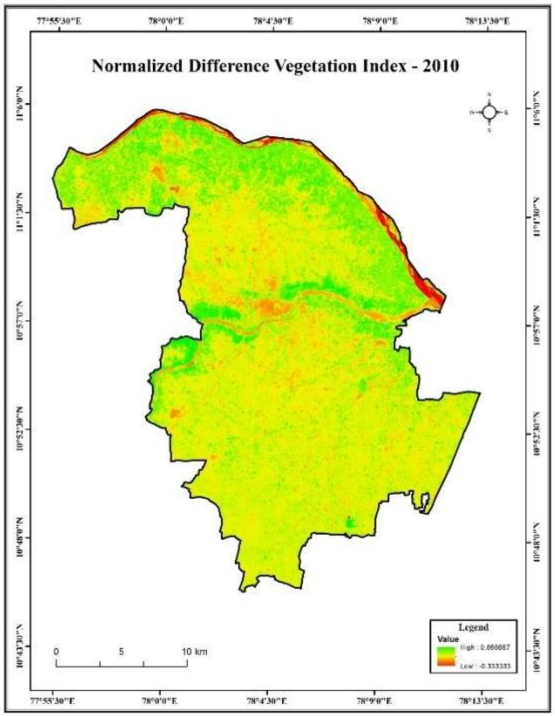
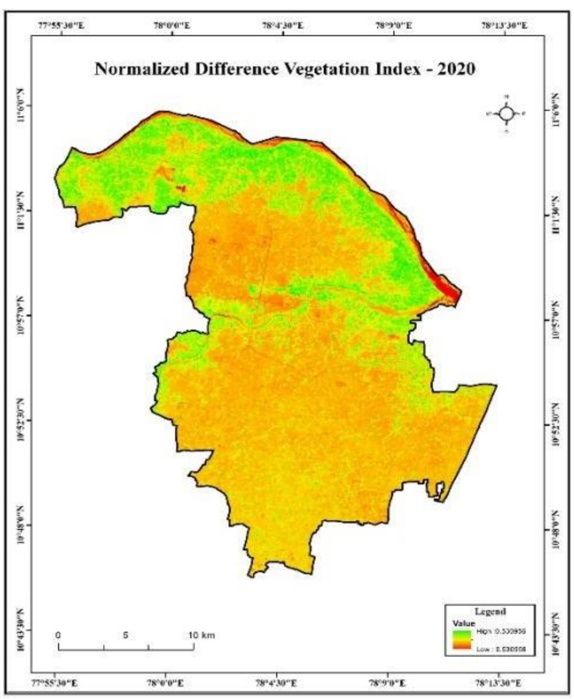


Fig:7 Normalized Difference Vegetation Index -2000

NDVI = -1 to 0 represent Water bodies
NDVI = -0.1 to 0.1 represent Barren rocks, sand, or snow
NDVI = 0.2 to 0.5 represent Shrubs and grasslands or senescing crops
NDVI = 0.6 to 1.0 represent Dense vegetation or tropical rainforest
The NDVI rate can be calculated using raster calculator :



NDVI values range from +1.0 to -1.0. Areas of barren rock, sand, or snow usually show very low NDVI values (for example, 0.1 or less). Sparse vegetation such as shrubs and grasslands or senescing crops may result in High NDVI values (approximately 0.6-1).



NDVI values for 2020 range from +1.0 to -1.0. Areas of barren rock, sand, or snow usually show very low NDVI values (for example, 0.1 or less). Sparse vegetation such as shrubs and grasslands or senescing crops may result in very low to moderate NDVI values (approximately 0.2-0.5)

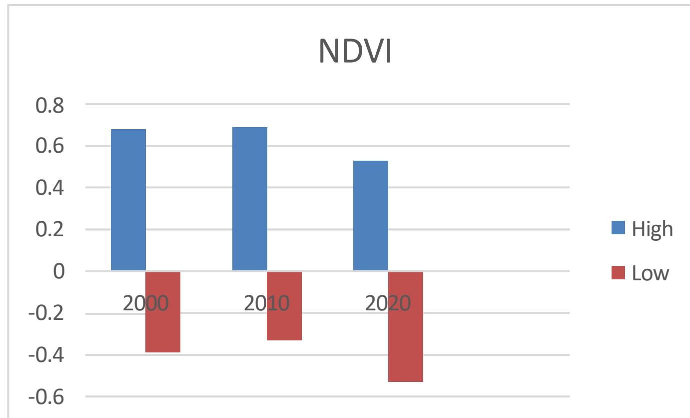
For Landsat 5 data,

NDVI = (Band 4 – Band 3) / (Band 4 + Band 3)

For Landsat 8 data,

NDVI = (Band 5 – Band 4) / (Band 5 + Band 4)

The NDVI value varies from -1 to 1. Higher the value of NDVI reflects high Near Infrared (NIR), means dense greenery. Generally, we obtain following result:



Conclusion

The Temperature plays a very important role in daily life. Rise in temperature are worsening many types of disaster includes stroms, heat waves, floods and droughts. Higher temperature mean that heat waves are likely to happen more often and last longer too. Warmer temperature can also lead to chain reaction of other changes around the sourrounding area, that’s because increasing air temperature and also affects the oceans, weather patterns, snow, plants, animals, and as well as human beings. Rise of temperature will affect the weather pattern in such a way that wet areas become wetter and dry areas become more drier. Temperature rise is mainly occurred due to existing of rural areas. Urban development increase the buildings, industries and usage of vehicle these all are one of the major factor increasing the rise of temperature. The temperature rise will lead to melting of ice bergs which cause rise of sea level. This study shows the rise of land surface temperature in Ahmedabad for past three decades due to development of urbanization.In this study ,the year of 2000 and 2010 there is difference in temperature . We have correlate the NDVI and LST in this paper and identified the difference between the taken year for our study.

References

1. Niclòs, R., Valiente, J.A., Barberà, M.J., Estrela, M.J., Galve, J.M. & Caselles, V., Preliminary results on the retrieval of land surface temperature from MSG-SEVIRI data in Eastern Spain, in EUMETSAT 2009: Proceedings of Meteorological Satellite Conference (2009) 21-25.
2. Brunsell, N.A., & Gillies, R.R, Length scale analysis of surface energy fluxes derived from remote sensing. Journal of Hydrometeorology, (2003)4 1212–1219.
3. Rodell, M., & Coauthors, The global land data assimilation

system. Bull. Amer. Meteor. Soc., (2004) 85 381–394.
4.Jiang, G.M., Li, Z.L. & Nerry, F., Land surface emissivity retrieval from combined mid-infrared and thermal infrared data of MSG-SEVIRI. Remote Sensing of Environment, (2006)105 326–340.
5. Anderson, M. C., Norman, J. M., Kustas, W. P., Houborg, R., Starks, P. J., & Agam, N., A thermal-based remote sensing technique for routine mapping of land-surface carbon, water and energy fluxes from field to regional scales. Remote Sensing of Environment, (2008), 112, 4227–4241.
6. Zhang, R., Tian, J., Su, H., Sun, X., Chen, S., & Xia, J., Two improvements of an operational two-layer model for terrestrial surface heat flux retrieval. Sensors, (2008), 8, 6165–6187
7. Kustas, W., & Anderson, M. Advances in thermal infrared remote sensing for land surface modeling, Agricultural and Forest Meteorology, (2009), 149, 2071–2081.
8. Karnieli, A., Agam, N., Pinker, R. T., Anderson, M., Imhoff, M. L., & Gutman, G. G. Use of NDVI and land surface temperature for drought assessment: Merits and limitations. Journal of Climate, (2010), 23, 618–633
9.Aires, F., Prigent, C., Rossow, W. B., & Rothstein, M. A new neural network approach including first guess for retrieval of atmospheric water vapor, cloud liquid water path, surface temperature, and emissivities over land from satellite microwave observations. Journal of Geophysical Research, (2001), 106 (D14) 14887–14907.
10. Sun, D., & Pinker, R.T., Estimation of land surface temperature from a Geostationary Operational Environmental Satellite (GOES-8). Journal of Geophysical Research, (2003)108, 43-26.
11. Bastiaanssen, W. G. M., Menenti, M., Feddes, R. A., & Holtslag, A.A.M., A remote sensing surface energy balance algorithm for land (SEBAL) Formulation. Journal of Hydrology, (1998) 212 198–212
12. Kogan, F. N., Operational space technology for global vegetation assessment, Bulletin of the American Meteorological Society, (2001)82 1949–1964.
13. Su, Z., The Surface Energy Balance System (SEBS) for estimation of turbulent heat fluxes. Hydrology and Earth System Sciences, (2002)6 85–100.
14. Arnfield, A. J., Two decades of urban climate research: a review of turbulence, exchanges of energy and water, and the urban heat island. International Journal of Climatology, (2003) 23 1–26.
15. Voogt, J. A., & Oke, T. R., Thermal remote sensing of urban climates, Remote Sensing of Environment, (2003) 86, 370–384.
16. Weng, Q., Lu, D., & Schubring, J., Estimation of land surface temperature vegetation abundance relationship for urban heat island studies, Remote Sensing of Environment, (2004)89, 467–483.
17. Kalma, J. D.,McVicar, T. R., &McCabe,M. F., Estimating land surface evaporation: A review of methods using remotely sensed surface temperature data. Surveys in Geophysics, (2008) 29, 421–469
18. Weng, Q., Thermal infrared remote sensing for urban climate and environmental studies: methods, applications, and trends. ISPRS Journal of Photogrammetry and Remote Sensing, (2009)64, 335–344.
19. Jackson, R. D., S. B. Idso, R. J. Reginato, and P. J. Pinter Jr., Canopy temperature as a crop water stress indicator, Water Resour. Res., (1981) 17, 1133–1138
20. Moran, M. S., Clarke, T. R., Inoue, Y., &. Vidal, A., Estimating crop water deficit using the relation between surface air temperature and spectral vegetation index. Remote Sens. Environ., (1994)49, 246–263
21. Anderson, M. C., Norman, J. M., Mecikalski, J. R., Otkin, J.A., & Kustas, W.P., A climatological study of evapotranspiration and moisture stress across the continental United States based on thermal remote sensing: Surface moisture climatology. J. Geophys. Res., (2007) 112(D10).
22.Jin, M., Analysis of land skin temperature using AVHRR observations, Bull. Amer. Meteor. Soc., (2004)85, 587–600.
23.Cresswell, M. P., Morse, A.P., Thomson, M.C., & Connor, S.J., Estimating surface air temperatures, from Meteosat land surface temperatures, using an empirical solar zenith angle. Int. J. Remote Sens., (1999)20, 1125–1132.
24.Prihodko, L., & Goward, S.N., Estimation of air temperature from remotely sensed surface observations. Remote Sens. Environ., (1997) 60, 335–346
25. Stisen, S., I. Sandholt, A., Norgaard, R., Fensholt., & Eklundh, L., Estimation of diurnal air temperature using MSG SEVIRI data in West Africa. Remote Sens. Environ, (2007)110, 262–274.
26. Rafiq, M., Rashid, I., & Romshoo, S. A., Estimation and validation of Remotely Sensed Land Surface Temperature in Kashmir Valley, Journal of Himalayan Ecology & Sustainable Development, (2014)9
27. Liu, Y., Hiyama, T., & Yamaguchi, Y., Scaling of land surface temperature using satellite data, A case examination on ASTER and MODIS products over a heterogeneous terrain area, Remote Sensing of Environment, (2006)105, 115–128.
28. Neteler, M., Estimating daily land surface temperatures in mountainous environments by reconstructed MODIS LST Data, Remote Sensing, (2010)2, 333–351.
29. Vauclin, M., Vieira, R., Bernard, R., & Hatfield, J. L., Spatial variability of surface temperature along two transects of a bare, Water Resources Research, (1982)18, 1677–1686.
30 . Prata, A. J., Caselles, V., Coll, C., Sobrino, J. A., & Ottlé, C., Thermal remote sensing of land surface temperature from satellites: Current status and future prospects, Remote Sensing Reviews, (1995), 12, 175–224.
31.McMillin, L.M., Estimation of sea surface temperature from two infrared window measurements with different absorptions, Journal of Geophysical Research, (1975) 80, 5113–5117.
32 .Carlson, T.N. Augustine, J.A., & Boland, F. E., Potential application of satellite temperature measurements in the analysis of land use over urban areas, Bulletin of the American Meteorological Society, (1977)58,1301–1303.
33. Owen, T.W., Carlson, T.N. & Gillies, R.R., Remotely sensed surface parameters governing urban climate change, Internal Journal of Remote Sensing, (1998)19, 1663- 1681.
34. United Nations, "World Urbanization Prospects: The 2005

Revision, Database, New York: Department of Economic and Social Affairs, Population Division," 2006
35. UNFPA The state of world population 2007: Unleashing the potential of urban growth. United Nations Population Fund, (United Nations Publications)
36. Zha, Y., An Effective Approach to Automatically Extract Urban Landuse from TM Imagery, Journal of Remote Sensing, (2003)1, 37–41,
37 .Schadlich, S., Göttsche, F., Olesen, F.S., Influence of land surface parameters and atmosphere on METEOSAT brightness temperatures and generation of land surface temperature maps by temporally and spatially interpolating atmospheric correction, Remote Sens Environ, (2001)75(1) 39–46
38. Sobrino, J.A., Jiménez-Muñoz, J.C., Paolini, L., Land surface temperature retrieval from LANDSAT TM 5, Remote Sens Environ, (2004) 90(4) 434–440
39. Sundara Kumar, K., Udaya Bhaskar, P., Padmakumari, K., Estimation of Land Surface Temperature to Study Urban Heat Island Effect Using Landsat Etm+ Image, International Journal of Engineering Science and Technology (2012) 4 (02)
40. Chen, L., Li, M., Huang, F., & Xu, S., Relationships of LST to NDBI and NDVI in Wuhan City based on LANDSAT ETM+ Image, in 6th International Congress on Image and Signal, Processing (CISP2013).