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Estimation of LANDSAT model and Normalized Difference Vegetation Index values for Namakkal District using Remote sensing and GIS

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***Abstract*— Over the past few decades many investigations has been carried in order to audit the changes and the variations in the land surface temperature research has been carried. The climate change and global warming is one of the greatest concern about the LST. In this study an attempt has been made to estimate the surface temperatures of Namakkal district in Tamil Nadu, India using remote sensing datasets observed by Landsat 5(Thematic Mapper), Landsat 7 (Enhanced Thematic Mapper+) and Landsat 8 (Thermal Infra-Red Sensors) satellites. NVDI values are determined from the Landsat Near Infra-Red and Infra-Red channels that has been redeemed from these above satellite datasets. Over the decades it has been clear that LST has been increased. To comprehend the local temperature change the medley of Land Surface Temperature and Normalized Difference Vegetation Index values gives clear data about the vegetation of the study area and areas can be classified into a green sustainable and eco-friendly areas. (*Abstract*)**

Keywords*— *ArcGIS, Digital Number, Land Surface Temperature, Normalized Difference Vegetation Index, Reflectance.

I. INTRODUCTION

The state of weather in the region or city is the climate. The earth's climate is progressive in nature and keeps on fluctuating in the global natural cycle. The climate change indicates the changes in these distribution of weather and it is the rise in the earth's average Surface Temperature. Municipal areas are dynamic in nature due to human activities, increase in the population, rise of concrete structures, urbanization.

The land use and the land cover patterns varies seasonally. This hugely impacts the micro climate of the region which in turn impacts the macro climatic pattern of the earth. To identify the disparity in the climate for a period of time, estimation of LST values are used. Estimation of LST values for Namakkal district for the years 1993, 2000, 2001, 2003, 2005, 2008, 2011, 2016, 2017 and the values of NDVI for 1993 and 2017 has been estimated in this study.

II. DATASET AND METHODS

A. Dataset and methods for estimation

The Boundary map is prepared from Google earth on 1:50,000 scale of Namakkal district. A total number of 20 Landsat 5(Band 6), (TM), Landsat 7(Band 6.2) (ETM+) and Landsat 8(Band 10) (TIRS) satellite images between 1990 and 2015 were acquired through the USGS GLOVIS (http://glovis.usgs.gov) data catalogues. The Landsat images has been obtained wholly full with all available spectral bands, including observations in the visible, near infrared and mid infrared spectrum. At first the DN values of the satellite images are converted in to radiance by Spectral Radiance Scaling method using ArcGIS 10.2. The radiance values are further processed to obtain LST model in degree Celsius .LST of specific areas were extracted from the calibrated thermal bands. The reflectance data in the red and near-infrared spectrum gives the NDVI values.

B. Study area

Namakkal district of Tamil Nadu (India) which is located between the Latitude 11° 18' 00" N and the Longitude 78° 07' 48" E. The district covers an area of about 3,420 square kilometers. The municipal comprises 34 panchayat villages. According to the 2011 census it had a total population of 1.727 million. The climate is generally characterized by high temperature and low humidity. The district is with an average mean temperature of 28.3 °C and monthly average temperatures ranging between 25.1 °C and 31.3 °C. The maximum temperature is 45°C.

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C. Methodolgy

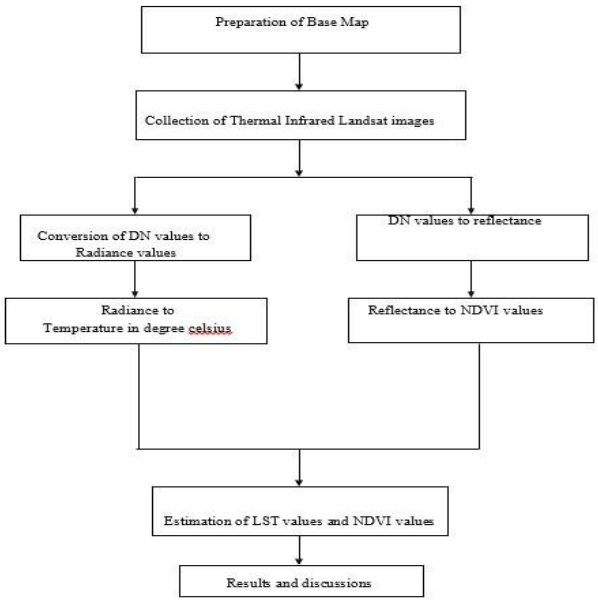

Fig 1.1 Methodology

D. Derivation of Land Surface Temperature values

The Land Surface Temperature is studied for the years 1993, 2000, 2001, 2003, 2005, 2007, 2008, 2011, 2013 and 2015. In order to find the Land Surface Temperature initially the satellite image are downloaded and clipped for the study area. A total number of 20 Landsat 5 (TM), Landsat 7 (ETM+) and Landsat 8 (TIRS) satellite images between 1990 and 2015 were acquired through the USGS GLOVIS (http://glovis.usgs.gov) data catalogues. The details of the Landsat Images collected are given below in the table I. Each pixels of the satellite image is represented by Digital Number (DN). To find the radiance of each pixel the DN has to be converted in to sensor radiance. The procedure followed to convert the DN to radiance is discussed below.

E. Conversion of DN to radiance

Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity that you use in an equation.

- Do not mix complete spellings and abbreviations of units: “Wb/m2” or “webers per square meter,” not “webers/m2.” Spell units when they appear in text: “...a few henries,” not “...a few H.”
- Use a zero before decimal points: “0.25,” not “.25.” Use “cm3,” not “cc.” (*bullet list*)

F. Conversion of DN to radiance

For the conversion of DN to LST, the first step is to convert the Digital Number to radiance value. The digital number is converted into radiance value using the ArcGIS software.For this conversion band 6 of Landsat 5 TM, band 6.2 of Landsat 7 ETM+ and band 10 of Landsat 8 TIRS were used. The following mathematical formula were used for the LST calibration and the values are obtained from the metadata of the Landsat series. Conversion of DN to radiance for Landsat 5 and 7,

$$L_S = ((Ls\ max - Ls\ min)/(Qp\ max - Qp\ min)) * (Qp\ cal - Qp\ cal\ min) + Ls\ min \quad (1)$$

L_S = Spectral Radiance at the sensor's aperture in watts/(m^2 * ster *µm)

Qp cal = The quantized calibrated pixel value in DN

Ls min =The spectral radiance that is scaled to Qp in watts/(m^2*ster*µm)

Ls max=The spectral radiance that is scaled to Qp in watts/(m^2*ster*µm)

Qp min = The minimum quantized calibrated pixel value in DN

Qp max = The maximum quantized calibrated pixel value in DN

For converting DN to radiance for LANDSAT 8

$$L_S = M_X\ Qp\ cal + Ad \quad (2)$$

L_S = Spectral radiance (Watts/ (m2 * srad * µm))

M_X =Band-specific multiplicative rescaling factor from the metadata (RADIANCE_MULT_BAND_x,where x is the band number i.e. for band 10)

Ad =Band-specific additive rescaling factor from the metadata (RADIANCE_ADD_BAND_x,where x is the band number i.e. for band10)

Qcal =Quantized and calibrated standard product pixel values (DN)

G. DERIVATION OF NDVI

According to Tucker et.al (1979) NDVI is based on the difference between the maximum absorption of reflectance in R as a result of chlorophyll pigments and the maximum reflectance in NIR spectral region as a result of leaf cellular structure.

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NDVI = (αNIR- αRED) / (αNIR + αRED)
Where, αNIR and αRED are the reflectance in the near infrared (NIR) and Red bands of Landsat satellite images respectively.

IV. RESULTS AND DISCUSSIONS

A. NORMALIZED DIFFERENCE VEGETATION INDEX OF NAMAKKAL DISTRICT:

S.K.Singh et al (2015) has used NDVI to analyze the reason for change in LST because the amount of vegetation present is an important factor and NDVI can be used to infer general vegetation conditions. NDVI also shows the most important role in shaping the land use pattern of the study area. The vegetated area can be easily mapped using the NDVI values. Normally the values of NDVI ranges from -1 to +1 where higher values indicates the vegetation and lower values indicates the free standing water. "Fig. I", shows NDVI for 1993 varies from -0.505376 to 0.584541 in 1993.

"Fig. II", shows NDVI values varies -0.145794 to 0.0609533 low to high in 2017.

From the estimated values of NDVI most of the Namakkal district has both the values of negative and positive values of NDVI. The values are being estimated using ArcGIS 10.2.2.

B.Figures and Tables

TABLE I. VALUES FOR DETERMINING SPECTRAL RADIANCE

	LANDSAT-5 TM	Landsat-7 ETM+
Ls MAX	15.303	12.650
Ls MIN	1.238	3.200
Qp MAX	255	255
Qp MIN	1	1

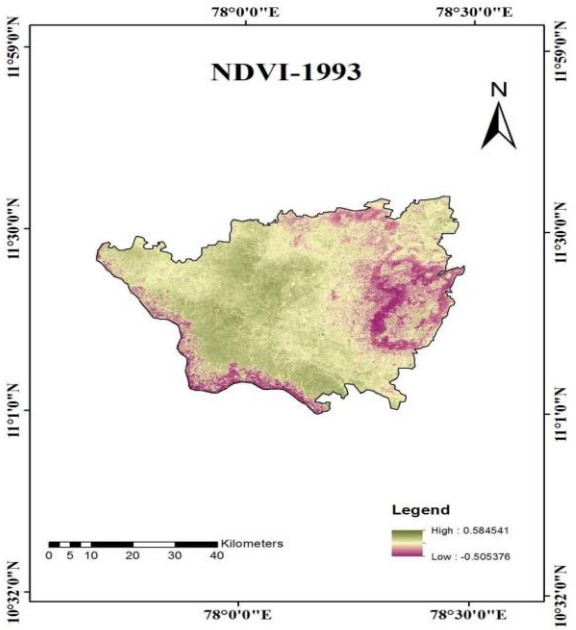

Fig. 2. Normalized Difference Vegetation Index values for the year 2013

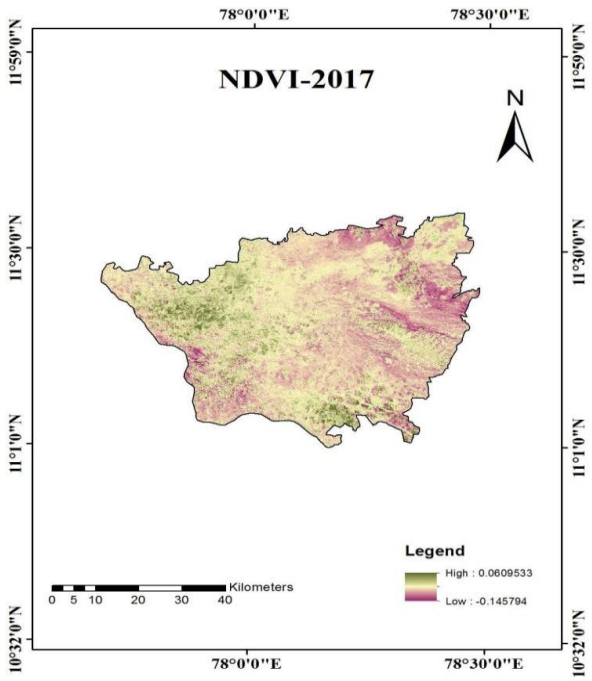

Fig. 3. Normalized Difference Vegetation Index values for the year 2017

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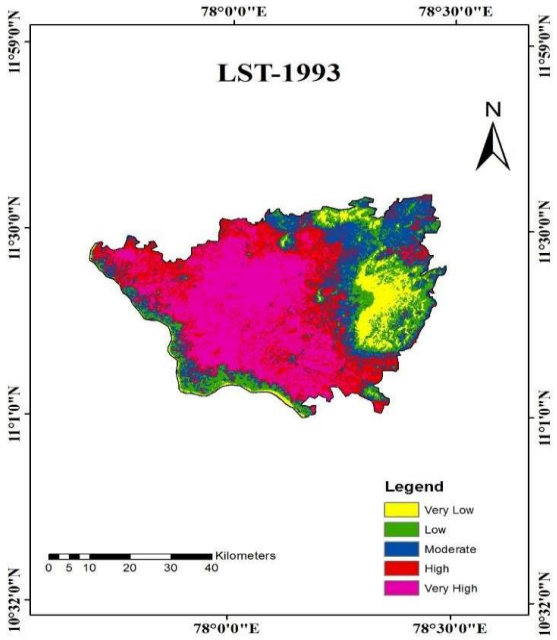
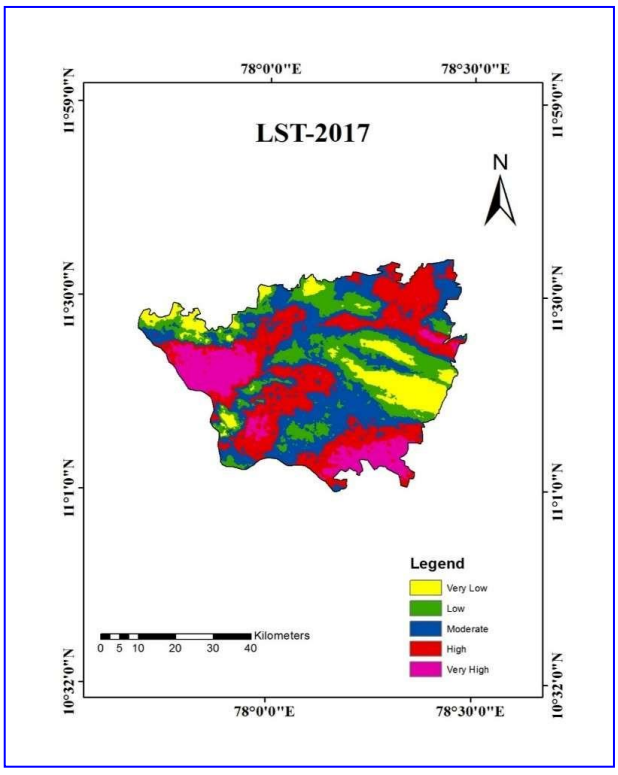
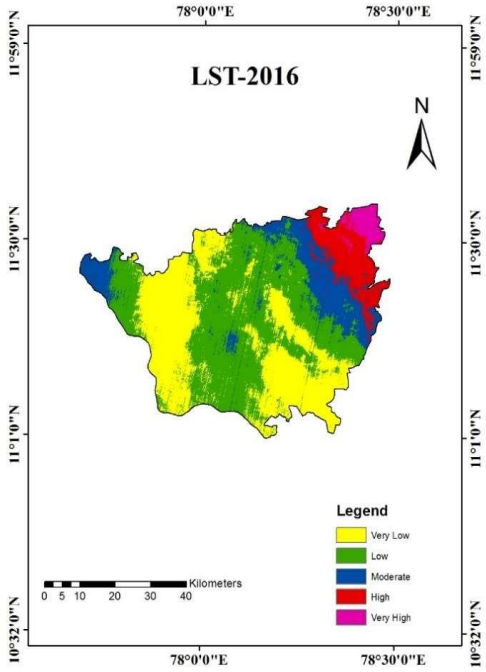
C. LAND SURFACE TEMPERATURE MODEL



The most of the land surface tends to be high in nature due to the excess temperature during the year 1993. This period shows the starting of increase in temperature for the future upcoming years.





The LST model for the year 2017 clearly shows that the the temperature has increased around 38ºC to 45ºC in the major parts of the district. The LST model clearly shows that the temperature is tending to be additive in nature and hence environmentalists has to take necessary actions to make the study area sustainable.

ACKNOWLEDGMENT

The present paper contains the data that are very useful for the environmentalists to find a solution for the booming temperature and gives clear idea of the present land use and land cover pattern of Namakkal district.

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