STUDY OF URBANIZATION AND URBAN HEAT ISLANDS OF UDUPI TALUK, KARNATAKA STATE

Thukarama M[1], Usha[2]

[1]*International Center for Applied Sciences, Manipal, Karnataka*

[2]*Dept. of Physics, Govt. P U College for women, Udupi, Karnataka*

I INTRODUCTION

The population growth and socio-economic developments resulted in a rapid increase of urban built-up area and morphological changes which in turn affected the microclimate of the region all over India, in recent years. Use of agricultural land for infra structure developments results in the reduction of vegetation cover and water pervious surfaces, increase in land surface cover by artificial materials having high heat capacities. The net effect is increase of surface temperature, pollution of the atmosphere and hence risk of health hazards. Unplanned urbanization will directly affect the Land Use, Land Cover (LU/LC) of the area and thereby distribution of Land Surface Temperature (LST). Research in this area of environment providesnecessary data needed for effective planning of heat island mitigation strategies, implement climate friendly policies apart from providing base line data for future reference.

Geo-informatics deals with the acquisition of spatial data, its processing, analysis, classification, storage and dissemination. It encompasses a broad range of disciplines such as surveying, remote Sensing, Geographic Information System and the Global Positioning System. Remote sensed satellite data has the advantages of providing synoptic view, repeatability and capability to study large and inaccessible areas on a regional scale. These data can be used for constructing accurate LU/LC maps, profiling Land surface temperature(LST) etc. which serves as input for the city planner.

II DATA AND STUDY PARAMETERS

In this work an attempt has been made to study urbanization of Udupi taluk, Karnataka State, India, using optical and thermal remote sensing datafrom various sources such as LANDSAT, IRS LISS-III, Cartosat-1, Moderate-resolution Imaging Spectro-radiometer (MODIS) for the month of March 2000, 2006, 2010 and 2014. These data are processed using IDRISI Software developed by Clark university lab.The various urbanization parameters studied are explained below.

2.1 Land Use, Land Cover (LU/LC)analysis

Land use is related to the human activities such as habitation, cultivation, vegetation, industrial structures etc. Land cover is an essential attribute in the surface of the earth that is shaped by geologic, hydrologic, climatic, atmospheric, and land use processes that occur at a range of spatial and temporal scales. In recent decades, the anthropogenic impact on land cover changes has unprecedentedly accelerated due to technological development and increase in human population. The information on these land-use/land-cover permits a better understanding of the land utilization forcropping patterns, fallow lands, forest, wastelands and surface water bodies for developmental planning. Based on data available we have divided our study region into a total 19 land types. These various classesand their transformation over the years are shown in Table 1.

2.2 Normalized difference vegetation index (NDVI)

Status of the vegetation cover is a good indicator of the prevailing climatic conditions of a particular area. Satellite remote sensing facilitates the identification of vegetation cover and the changes over time very effectively compared to the conventional field surveying techniques. Rouse *et al*., (1974) defined the NDVI as :**NDVI = (NIR-R)/ (NIR+R) .** where, NIR and R are the radiances or reflectance in the near- infrared and red spectral channels respectively.Chlorophyll in plant leaves causes considerable absorption in the red light region while plant spongy mesophyll leaf structure creates considerable reflectance in the near infra-red region of the spectrum (Tucker, 1980; Jackson *et al.*, 1983). As a result, healthy vegetation has lower reflectance in the red light region and a higher reflectance in the near infra- red region of the spectrum. This ultimately results in higher NDVI values for the healthy vegetation and it tends to become lower as the greenness of the vegetation decreases. TheseNDVI values range from -1.0 to 1.0. Increasing positive NDVI values indicates increasing amounts of healthy, green vegetation. The values closer to zero and decreasing negative values indicate non-vegetated features such as barren surfaces and water, snow, ice and clouds. Vegetation cover over the land surface is a good indicator of the occurrence of rainfall over an area. Therefore, NDVI values can also be used in monitoring the occurrences of rainfall at different spatial and temporal scales. The combination of NDVI and LST was also proposed as a method for assessing the surface moisture status and fractional vegetation cover over non-uniform land surfaces (Carlson *et al.*, 1994; Nemani*et al*., 1993). Bayarjargal*et al*., (2000) have used the NOAA/AVHRR data for the detection of drought-affected regions by calculating the NDVI and the LST values for the drought and wet years separately. The calculated NDVI values are also given in Table 2.

2.3 Emissivity

Emissivity of a surface is the measure of energy reflected and is a function of wavelength, defined as :**Emissivity** $\mathbf{R(\lambda) = E_r (\lambda)/E_i (\lambda)}$**,** where E_r (λ), the energy reflected and E_i (λ) energy incident. Emissivity enables us to identify various land cover types and its variation reflectsurbanization processes.The calculated emissivity values are given in Table2.

International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.08, March 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

2.4 Land surface temperature (LST)

Land Surface Temperature (LST) is the radiative skin temperature of the earth surface. The knowledge of the temporal and spatial variations of LST is of fundamental importance in many applications such as climate change, hydrological cycle, vegetation monitoring, urban climate and environmental studies. Due to the complexity of land surface characteristics such as vegetation, topography, soil, geomorphology, LST changes rapidly in space as well as in time. Given the complexity of surface temperature over land, field measurements cannot practically provide values over wide areas. With the development of remote sensing from space, satellite data offer the only possibility for measuring LST over the entire globe with sufficiently high temporal resolution. Satellite-based thermal infrared (TIR) data is directly linked to the LST through the radiative transfer equation.

The land surface temperature (LST) is a fundamental factor that regulates most physical, chemical and biological processes of the earth and is controlled by the surface energy balance, atmospheric state, thermal properties of the surface, and subsurface mediums. The physical properties of different types of surfaces, such as color, sky view factor, street geometry, and anthropogenic activities are important factors that determine LSTs in the surface of the earth. Therefore, the LST corresponds closely to the land cover characteristics and their distribution. Numerous factors need to be quantified in order to estimate the LST accurately from satellite thermal data and therefore algorithms must be developed by taking all these factors into account. The temperature variation with spatial distribution of study area is given in Table 3.

III URBAN HEAT ISLAND (UHI)

It is documented that urbanization can have significant effects on local weather and climate. Of these effects one of the most familiar is the urban heat island (UHI) (Streuker, 2002). The increase of urban surface temperature compared with suburban areas is called heat island (Fig 1). With the urbanization disturbance began in natural habitats, soils, soil cover and vegetation. These original features have been replaced with impervious areas in the form of buildings, parking lots, roads and highways as cities, towns, and suburbs develop. The urbanization is taking place in rapid pace in recent times. The thermal characteristics of materials such as asphalt, brick, concrete, glass, metallic/asbestos sheets etc. used in the city differ greatly from those found in the countryside such as trees, grass, water bodies, bare soil etc. During the day time the solar energy is trapped by structures of high heat capacity is then reradiated as long-wave radiation less efficiently than in rural areas during the night (Solecki*et al.*, 2005) keeping the urban areas warmer than the surrounding rural areas. The buildings play a role in reducing wind speed and hence the dispersion of heat. Heat magnitudes are largest under calm and clear weather conditions. Increasing winds mix the air and reduce the heat island.

IV RESULTS AND DISCUSSIONS

4.1 Table1 shows 19 land types identified in the study area and their changes over 2000 to 2010. One can notice a drastic increase in the built-up land at the cost of crop land. The change is more vigorous from 2006 onwards. This is nothing specific for Udupi alone but true of every small and large city of India. Though the result is obvious, the quantification of urbanization is the main advantage of remote sensed data.

Sl. No	Class Name	Area in 2000		Area in 2006		Area in 2010		Change in area 2000-2006		Change in Area 2006-2010	
		Sq.km	Percentage	Sq.km	Percentage	Sq.km	Percentage	Sq.km	Percentage	Sq.km	Percentage
1	Built-up land	17.81	1.90	85.29	9.08	310.45	33.05	67.48	7.18	225.16	23.97
2	Crop land	610.35	64.97	564.72	60.11	381.51	40.61	-45.63	-4.86	-183.21	-19.50
3	Agricultural plantation	141.31	15.04	123.50	13.15	94.39	10.05	-17.81	-1.89	-29.11	-3.10
4	Acacia plantation	0.69	0.07	0.60	0.06	0.52	0.06	-0.09	-0.01	-0.08	0.00
5	Cashew plantation	11.81	1.26	10.90	1.16	9.51	1.01	-0.91	-0.10	-1.39	-0.15
6	Casurinas plantation	6.55	0.70	6.45	0.69	6.24	0.66	-0.10	-0.01	-0.21	-0.03
7	Mangroove	0.77	0.08	0.76	0.08	0.75	0.08	-0.01	0.00	-0.01	0.00
8	Eucalyptus plantation	0.19	0.02	0.14	0.02	0.12	0.01	-0.05	0.00	-0.02	-0.01
9	Mining/Quarrying	0.51	0.05	0.52	0.05	0.52	0.05	0.01	0.00	0.00	0.00
10	Areca nut plantation	0.58	0.06	0.52	0.06	0.50	0.05	-0.06	0.00	-0.02	-0.01
11	Mixed plantation	1.43	0.15	1.23	0.13	1.54	0.16	-0.20	-0.02	0.31	0.03
12	Moist deciduous	43.83	4.67	41.83	4.45	32.61	3.47	-2.00	-0.22	-9.22	-0.98
13	Rubber plantation	0.30	0.03	0.25	0.03	0.22	0.02	-0.05	0.00	-0.03	-0.01
14	Barren rocky	12.49	1.33	12.49	1.33	12.40	1.32	0.00	0.00	-0.09	-0.01

15	Semi evergreen	14.56	1.55	14.05	1.50	13.23	1.41	-0.51	-0.05	-0.82	-0.09
16	Sandy area	0.74	0.08	1.32	0.14	0.98	0.10	0.58	0.06	-0.34	-0.04
17	Scrub forest	17.59	1.87	17.19	1.83	16.32	1.74	-0.40	-0.04	-0.87	-0.09
18	Scrub land	7.98	0.85	7.73	0.82	7.58	0.81	-0.25	-0.03	-0.15	-0.01
19	Water bodies	49.92	5.31	49.92	5.31	49.99	5.32	0.00	0.00	0.07	0.01
	Total	939.40	100.00	939.40	100.00	939.40	100.00				

Table 1 : Land types, LU/LC changes from 2000 to 2010.

4.2 Table2 shows NDVI, emissivity and temperature of some important locations of study area. One can see gradual decrease in NDVI and emissivity of a particular location as the LU/LC changes towards urbanization. On the other hand there is a sharp increase in the temperature, as high as 9K in a span of 14 years. Such a high temperature is combined effect of decrease in NDVI and increase of built-up land area. In Yelloor and Nandikoor the increase in temperature is due commissioning of a thermal power station.

					NDVI			EMISSIVITY		Temperature (in K)	
SL.NO	LOCATION	LU/LC in 2000	LU/LC in 2006	LU/LC in 2014	2000	2006	2014	2000	2014	2000	2014
1	SYNDICATE CIRCLE	SPARSE FOREST	SPARSE VEGETATION	URBAN BUILT-UP	0.38	0.33	0.18	0.985	0.946	310	316
2	VIDYA RATNA NAGARA	WASTE LAND	WASTE LAND	URBAN BUILT-UP	0.23	0.19	0.16	0.950	0.946	308	316
3	PERAMPALLY	WASTE LAND	WASTE LAND	URBAN BUILT-UP	0.23	0.21	0.19	0.950	0.946	309	315
4	MADHAVA NAGAR	VEGETATION	BARE SOIL	COMMERCIAL BUILT-UP	0.41	0.32	0.21	0.985	0.946	308	316
5	VP NAGARA	PLANTATION	WASTE LAND	URBAN BUILT-UP	0.31	0.23	0.11	0.985	0.946	307	316
6	INDUSTRIAL AREA	BARREN ROCKY	URBAN BUILT-UP	INDUSTRY BUILT-UP	0.13	0.11	0.10	0.950	0.946	309	316
7	ADARSHA NAGRA	SPARSE VEGETATION	URBAN BUILT-UP	URBAN BUILT-UP	0.33	0.17	0.13	0.985	0.946	309	316
8	ISHWARA NAGARA	DENSE VEGETATION	PLANTATION	URBAN BUILT-UP	0.47	0.42	0.17	0.985	0.946	308	316
9	INDRALI	PLANTATION	SEMI-URBAN	CONCRETE URBAN	0.31	0.13	0.11	0.985	0.946	306	315
10	MGM_KUNJIBETTU	SPARSE VEGETATION	BARE SOIL	BUILT-UP	0.33	0.31	0.13	0.985	0.946	308	316
11	DODDANAGUDDE	BARE SOIL	BARE SOIL	BUILT-UP	0.17	0.15	0.12	0.950	0.946	308	316
12	UDUPI BUSSTOP	ASPHALT ROAD	CONCRETE ROAD	CONCRETE URBAN	0.12	0.12	0.12	0.950	0.946	314	316
13	BRAHMAGIRI	VEGETATION	VEGETATION	BUILT-UP	0.38	0.36	0.18	0.985	0.946	308	316
14	KUNJIBETTU	PLANTATION	PLANTATION	BUILT-UP	0.43	0.42	0.13	0.985	0.946	308	316
15	YELLOOR(PDB1)	BARE SOIL	BARE SOIL	BARE SOIL	0.17	0.17	0.17	0.950	0.950	308	317
16	NANDIKOORU(PDB2)	WASTE LAND	WASTE LAND	INDUSTRY BUILT-UP	0.23	0.19	0.13	0.950	0.950	308	317
17	PALIMAR	CROP LAND	CROP LAND	BARE SOIL	0.47	0.37	0.17	0.972	0.950	308	310
18	HEJAMADY	AGRICULTURAL LAND	AGRICULTURAL LAND	WASTE LAND	0.38	0.37	0.28	0.974	0.950	307	308
19	PADUBIDRI	FALLOW LAND	FALLOW LAND	BUILT-UP	0.23	0.19	0.13	0.950	0.899	307	310
20	UCHILA	WASTE LAND	WASTE LAND	BARE SOIL	0.23	0.23	0.13	0.950	0.950	307	310
21	KAUP	PLANTATION	PLANTATION	BUILT-UP	0.43	0.42	0.13	0.985	0.950	309	310
22	BRAHMAVARA	FALLOW LAND	FALLOW LAND	BUILT-UP	0.18	0.17	0.13	0.950	0.945	309	312
23	MALPE	WATER BODIES	WATER BODIES	WATER BODIES	0.02	0.02	0.02	0.989	0.989	294	302

Table 2. NDVI, emissivity and surface temperature of some important regions as a function LU/LC for 2000, 2006 and 2014.

4.3 Fig 2 and 3 shows UHI distributions for 2000 and 2014 respectively. Considerable increase in temperature and its spatial extent is obvious.

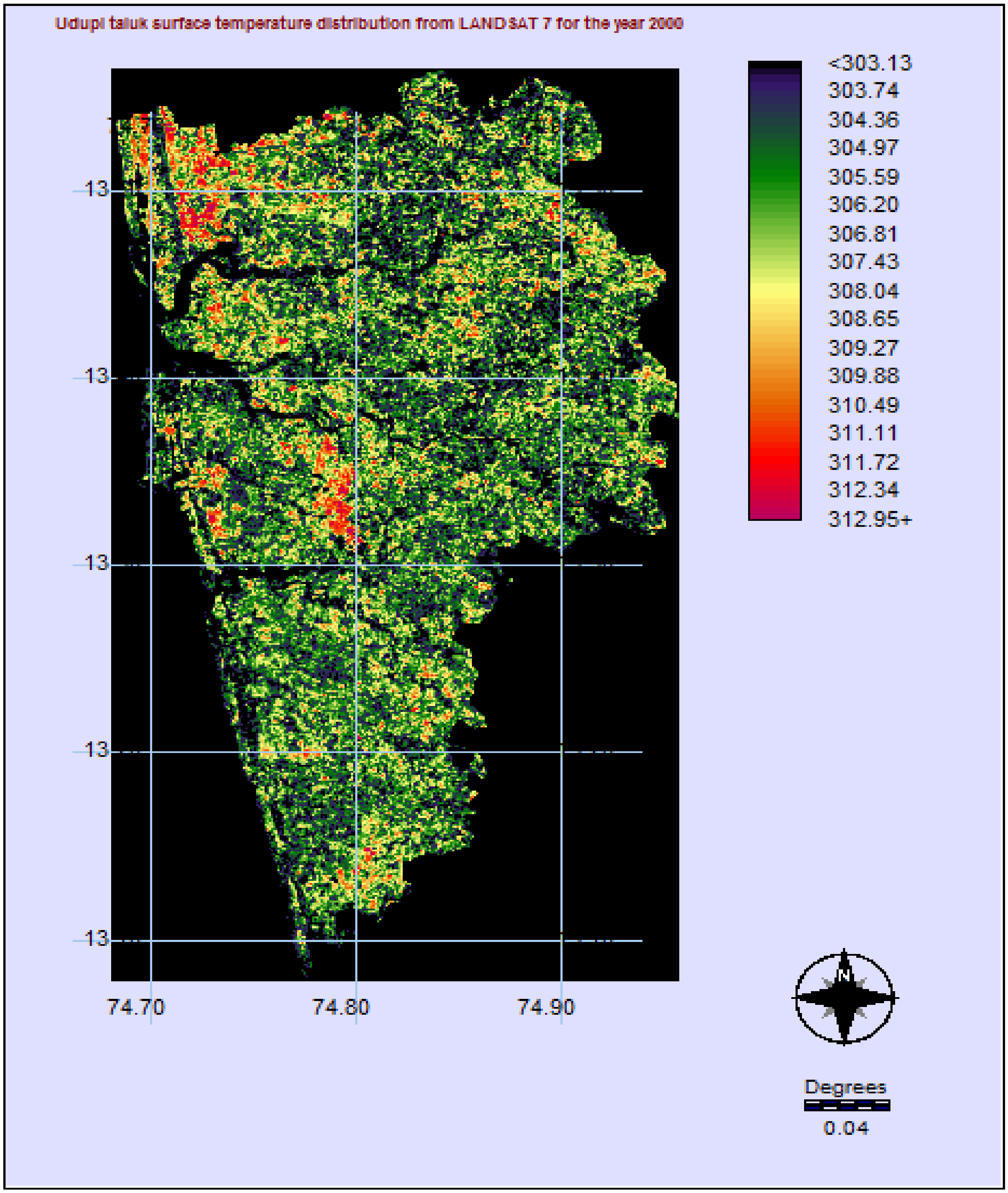

Fig.1. Temperature distribution during 2000. Note that highest temperature is 313K.

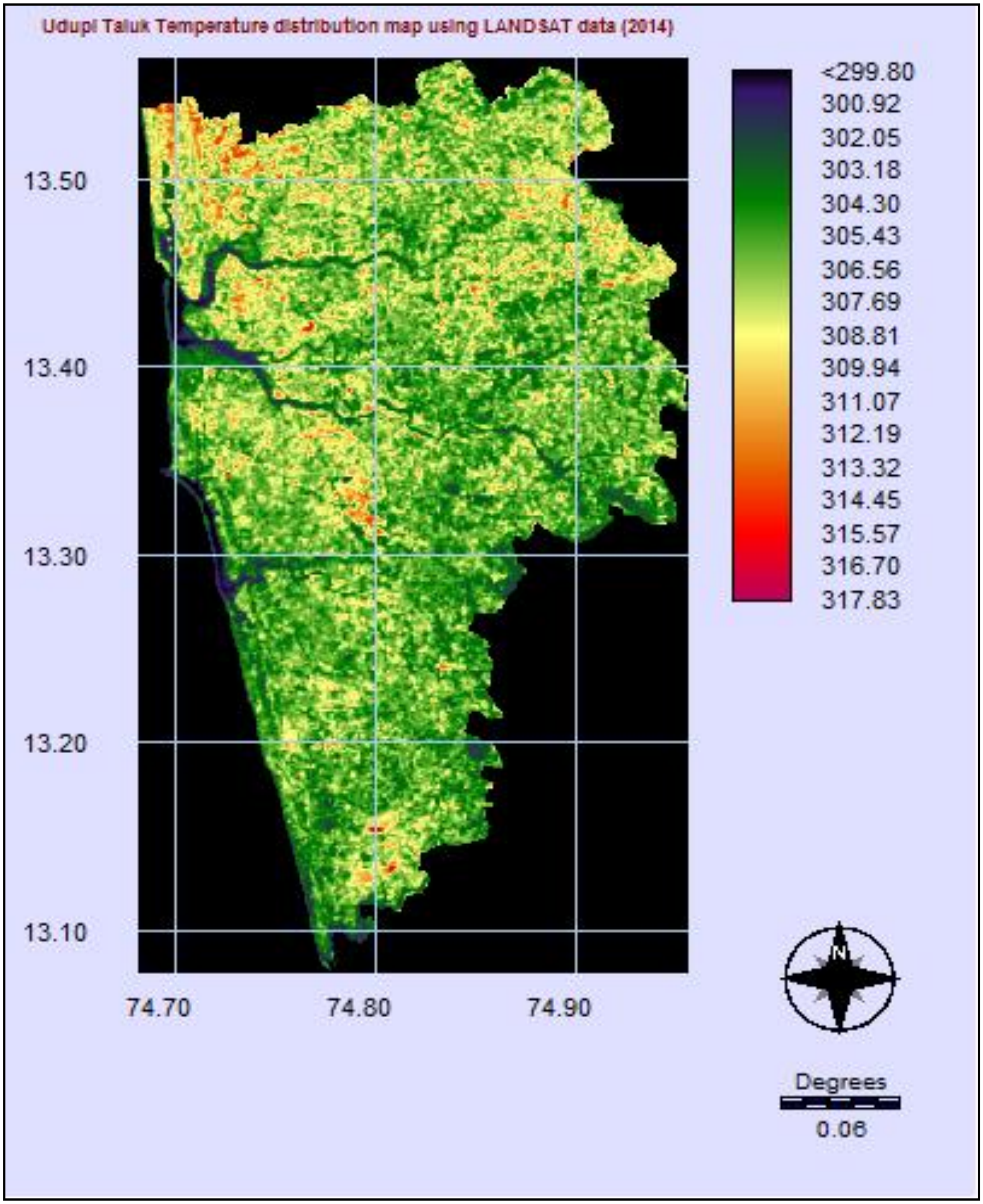

Fig.2. Temperature distribution during 2014. Note that highest temperature is 318K.