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ESTIMATE THE TEMPERATURE OF AN-NAJAF CITY BY USING REMOTE SENSING TECHNIQUES AND SATELLITE IMAGES

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Abstract:

The temperature is of high importance on the climate change. It is the most important climate elements which in turn affects on other climatic elements. You can rely on remote sensing techniques in many fields, including in estimating the degree of the earth's surface temperature and to know the effect of land use in temperature distribution .The surface temperature of An-Najaf City and surroundings have determined by lunar satellite images (Landsat_8), where both packages 10 and 11 thermal using special mathematical relationships concerning temperature to calculate the Land Surface Temperature (LST). The study of remote sensing indices has proved the effective discrimination of land use applications.

Introduction:

It is not surprising that the negative impact related to urbanization is an increasing concern capturing the attention of people worldwide. Though heat islands may form on any rural or urban area, and at any spatial scale, cities are favoured, since their surfaces are prone to release large quantities of heat (Al-Kurdi, Net.al 2015).

The deterioration of air quality in built up, dense urban regions is considered primarily a health and an environmental issue. It contributes to the increase in temperatures and consequently on a wider scale the effects of global warming. Current scientific evidence has associated exposure to air pollution with a wide array of human health effects. There is serious health impediments associated with exposure to roadway emissions such as respiratory diseases. These diseases are more pronounced in high risk groups such as children, old people, and persons with respiratory complications (Jansen, K.L., et al, M2005)

In recent years, the strength of the relationship between climate change and health has become clearer, with new research further elucidating the complex influences of climatic variation on health and disease, as well as the specific vulnerabilities of certain population groups, such as young children (Paulson, J. A., 2015). The health problems expected to increase due to climate change are diverse, ranging from direct threats such as heat (Braithwaite, I. 2015)

Previous Studies:

- ✓ Jose´ A. S, et al, 2004study three methods to retrieve the Land Surface Temperature (LST) from thermal infrared data supplied by band 6 of the Thematic Mapper (TM) sensor onboard the Landsat 5 satellite. They present a comparison between the LST measured insitu and the retrieved by the algorithms over an agricultural region of Spain.(Jose,´ A. S.2004)
- ✓ Sun, Y., 2008 reviews the state of the science of land surface temperature (LST) estimates from remote sensing platforms, models, and in situ approaches, and review the current LST validation and evaluation method.Then the requirements for LST products are specified from the different user communities.Finally he identifies the gaps between state of the science and the user community requirements, and discuss solutions to bridge these gaps.(Ying, S.2008)
- ✓ Alshaikh, A.Y., 2015 find that land use plays an important role in the ecosystem, and it could be the reason of variation in the Land Surface Temperature (LST).

Also, the abundance of water and vegetation is one of the most influential in controlling (LST), where is observed the large variability between (LST) values imply that an increase in vegetation cover and water bodies abundance would generally reduce land surface temperatures in the study area (Alshaikh, A.Y. 2003).

Study Area:

An_Najaf city is subject to geographical location, as it is located far from the Euphrates River about 12 km, 160 kilometers from the capital Baghdad. Al-Kufa city, Al-Hira city and Al_Hydareya city are located on the Euphrates River, they shires of An_Najaf city. Its plain land, are high-elevated, and then descends steeper strongly toward the south-west to shallow salt lake that defined Bahr An-Najaf (Figure 1). Besides the topographic maps of the study area with the scales of 1:500,000 are available.

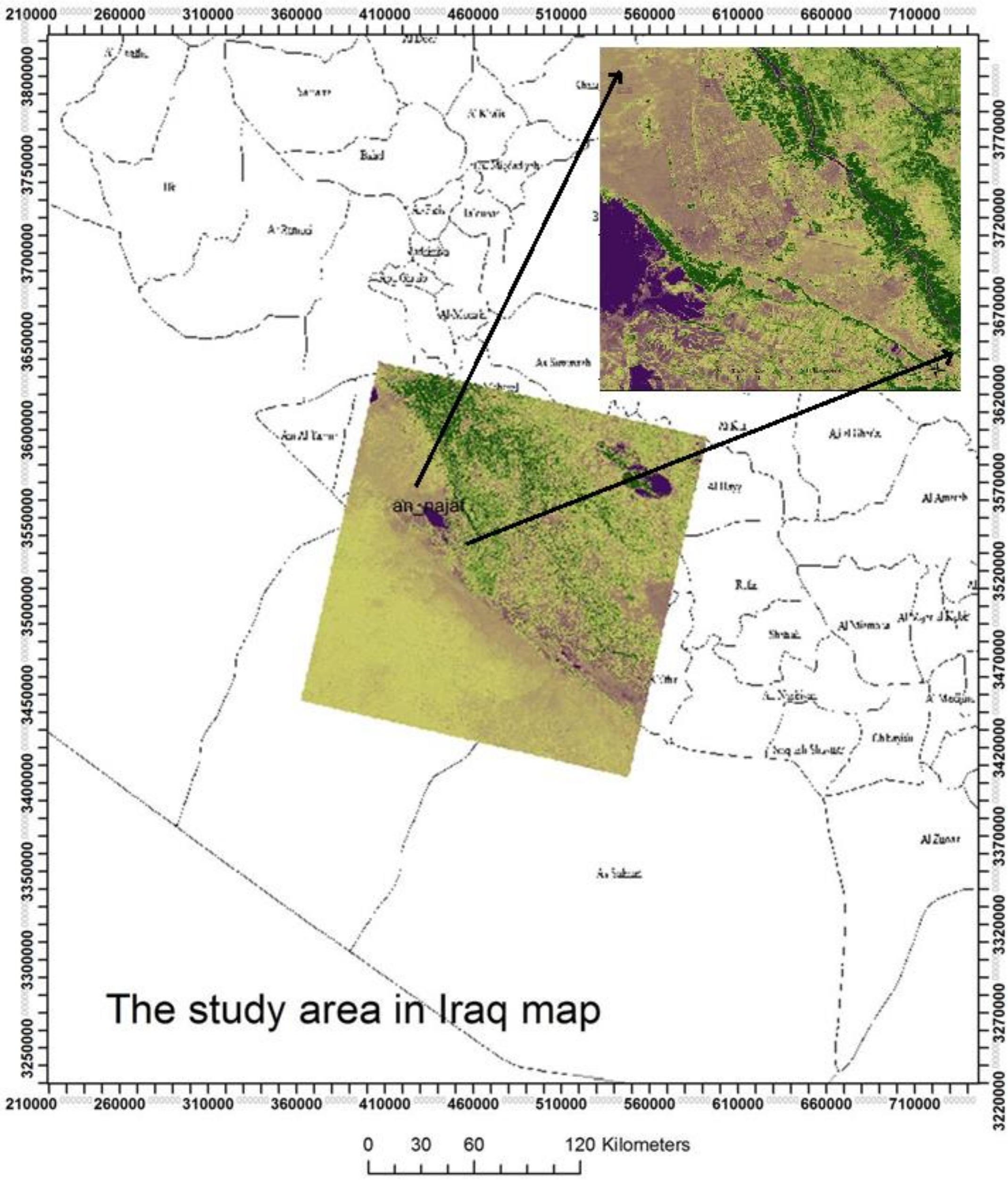

Figure1: The Study Area

Materials and Methods:

In this research a multispectral Landsat_8 +ETM for an_najaf city in date (2014-MAY-10) (LC81680382014130LGN00) & (2014-AUG-16) (lc81680382014226lgn00) images was taken. Band 10 and 11 which is a thermal bands was used for Land surface temperature and bands (5&4) for NDVI generation, The bands (6&3) for NDWI & NBAI generation, bands (10&7) for NDSI generation . The wave length of band 10 is 10.6 - 11.19 µm and band 11 is 11.5 –12.51µm .These images were processed using Erdas Imagine 2013 and ArcGIS 10.2. Besides the topographic maps of the study area with the scales of 1:50000 are available.

Theory:

Can the temperature of the space satellites calculated using the known laws we have, but we must extraction and know the number of information to get to temperature equalization, first, that we know the band within the thermal spectrum used in the images Landsat 8 is both bands (10 & 11) and then calculate spectral radiance value by equation (1) (CHANDER, G.*et al.* 2007).

$$\mathrm{R} = \mathrm{G} * \mathrm{TM} + \mathrm{B} \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where R is the Radiance and units (Watts / (m2 * sr * µm))

And Gain represents a (G) and B Bias, can be obtained from the raw data to the satellite image from Landsat Header attached with the image file. In which

$$\mathrm{B} = \mathrm{Lmin}$$

$$G = (\mathrm{Lmax} - \mathrm{Lmin}) / \mathrm{Qcalmax} - \mathrm{Qcalmin})$$

$$\mathrm{TM} = \mathrm{DN} - \mathrm{Qcalmin}$$

Where Qcalmax and Qcalmin is the highest value and the lowest value of the pixel, And Lmax and Lmin Radiance highest value and lowest value and TM represents the thermal band and here represents a band 10 and band 11. DN value of the pixel DN = Raster image thermal and thus the equation (1) as follows:

$$R = \left(\left(\frac{(\mathrm{Lmax} - \mathrm{Lmin})}{\mathrm{Qcalmax} - \mathrm{Qcalmin}}\right) * (\mathrm{DN} - \mathrm{Qcalmin})\right) + \mathrm{Lmin} \ldots\ldots(2)$$

Can be made Radiance to At-Satellite Brightness Temperature conversions using the Planck equation or the Landsat specific estimate of the Planck curve [Planck's law. A mathematical expression relating spectral radiance emitted from an ideal surface to its temperature, in the entry Land Surface Temperature](Chander, G. 2003)(Alan, G. 2014)

$$(\mathrm{SBT}) = \frac{\mathrm{K2}}{\ln((\mathrm{K1} / \mathrm{Radiance}) + 1} \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

As the the normative for thermal band 10 are constants K1 & K2 and are equal:

K1_CONSTANT_BAND_10 = 774.89

K2_CONSTANT_BAND_10 = 1321.08

The unit of Satellite Brightness Temperature (SBT) is Kelvin (K °)

Needed a extract land use, water and demographic expansion of the satellite image and bring down the LST on image to complete the study, so we need to apply the following rates on the image to get a Land use:

$$NDVI = \frac{(\mathrm{NIR_{b5}} - \mathrm{Red_{b4}})}{(\mathrm{NIR_{b5}} + \mathrm{Red_{b4}})} \ldots\ldots\ldots(4)$$

We need equation (4) to find a Proportion of Vegetation symbolized by Pv and be (Carlson & Ripley, 1997)(Singh, R. P.et .al 2003) :

$$Pv = \frac{NDVI - NDVI_{min}}{NDVI_{max} - NDVI_{min}} \ldots\ldots\ldots(4a)$$

The emissivity e be equal to

$$e = 0.004\, Pv + 0.986 \ldots\ldots\ldots (4b)$$

$$\mathrm{NDWI} = \frac{(\mathrm{Green}_{\,b3} - \mathrm{MIR}_{b6})}{(\mathrm{Green}_{\,b3} + \mathrm{MIR}_{b6})} \ldots\ldots\ldots (5)$$

Modified Normalized Difference Water Index (MNDWI) = NDWI (Komeil .R et al 2014)(McFeeters, S.K 1996)

$$\mathrm{NBAI} = \frac{\left[(\mathrm{Mid}-\mathrm{IR})_{b6} - \frac{\mathrm{Mid}-\mathrm{IR}_{b6}}{\mathrm{green}_{b3}}\right]}{\left[(\mathrm{Mid}-\mathrm{IR})_{b6} + \frac{\mathrm{Mid}-\mathrm{IR}_{b6}}{\mathrm{green}_{b3}}\right]} \ldots\ldots\ldots (6)$$

(NBAI) New Built-up Index (ZHA,Y et. al 2003)

$$NDSI = \frac{(\mathrm{TIR}_{\,b10} - \mathrm{SWIR2}_{b7})}{(\mathrm{TIR}_{\,b10} + \mathrm{SWIR2}_{b7})} \ldots\ldots\ldots (7)$$

(NDSI) Normalized Difference Soil Index

And thus the Land Surface Temperature) LST)(:Liang. S, Li. X et.al 2012)

$$LST = SBT\ /\ (1 + \lambda)(SBT/p)Ln(e)\ldots\ldots\ldots(8)$$

Where SBT according to equation (3) and λ the wavelength band (11.5 µm), a thermal band here means the bands (10 & 11) of the satellite Landsat_8. (p = hc / s), (h) is Planck's constant and (c) the speed of light and s Boltzmann's constant and equal (p = 14380)

Methods:

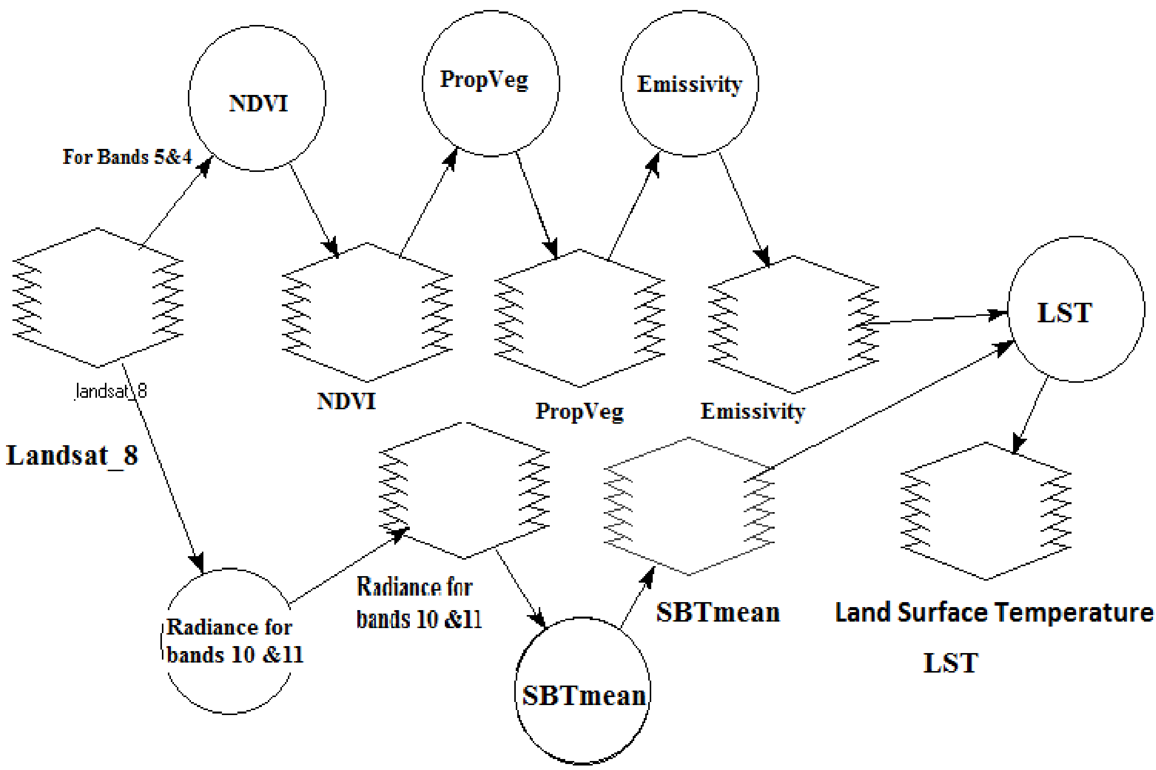

Figure 2: Shows the model, which employs in order to reach the surface temperature

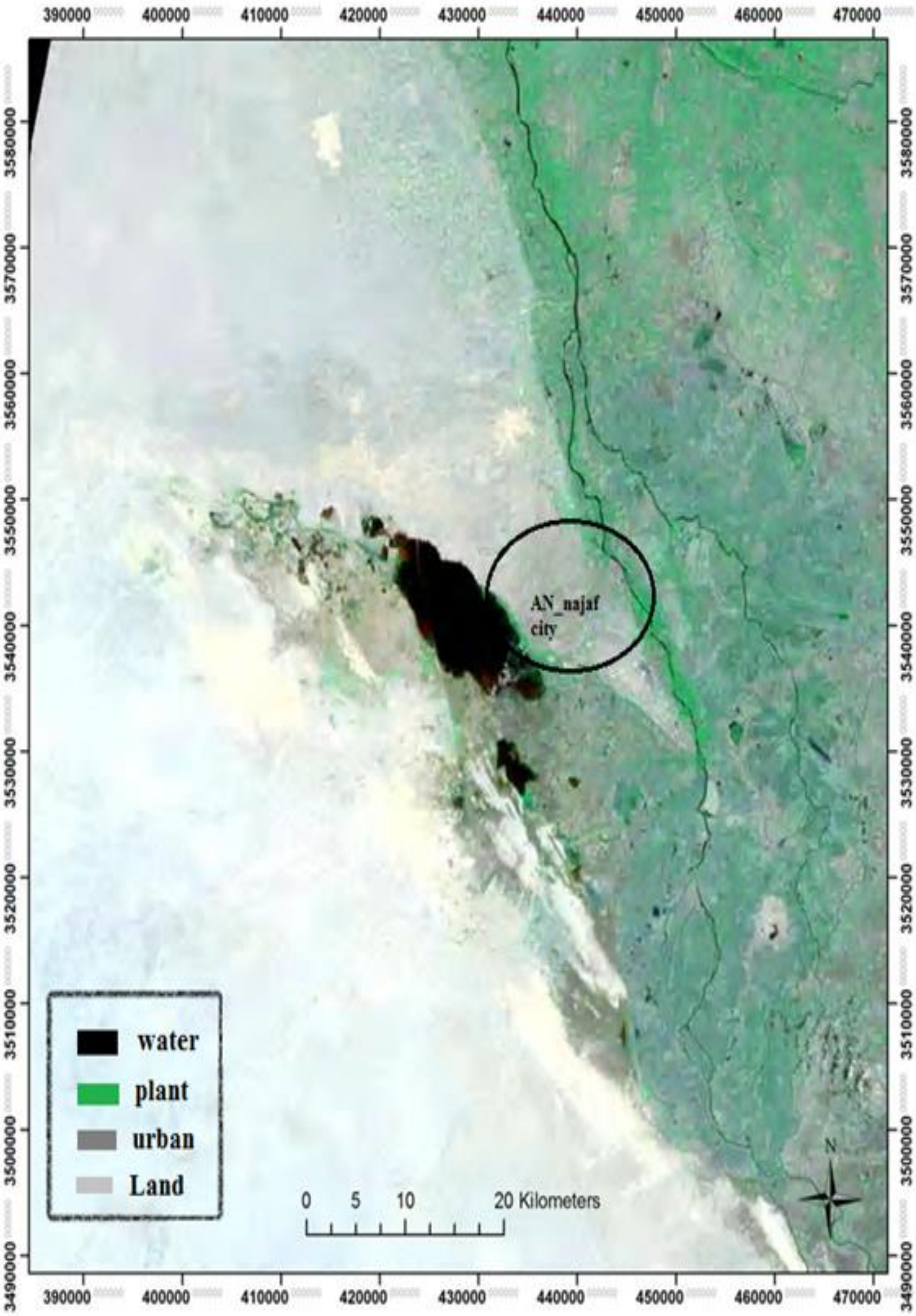

Figure (3) image of bands 45 and 6 of an_najaf city landsat_8 2014130

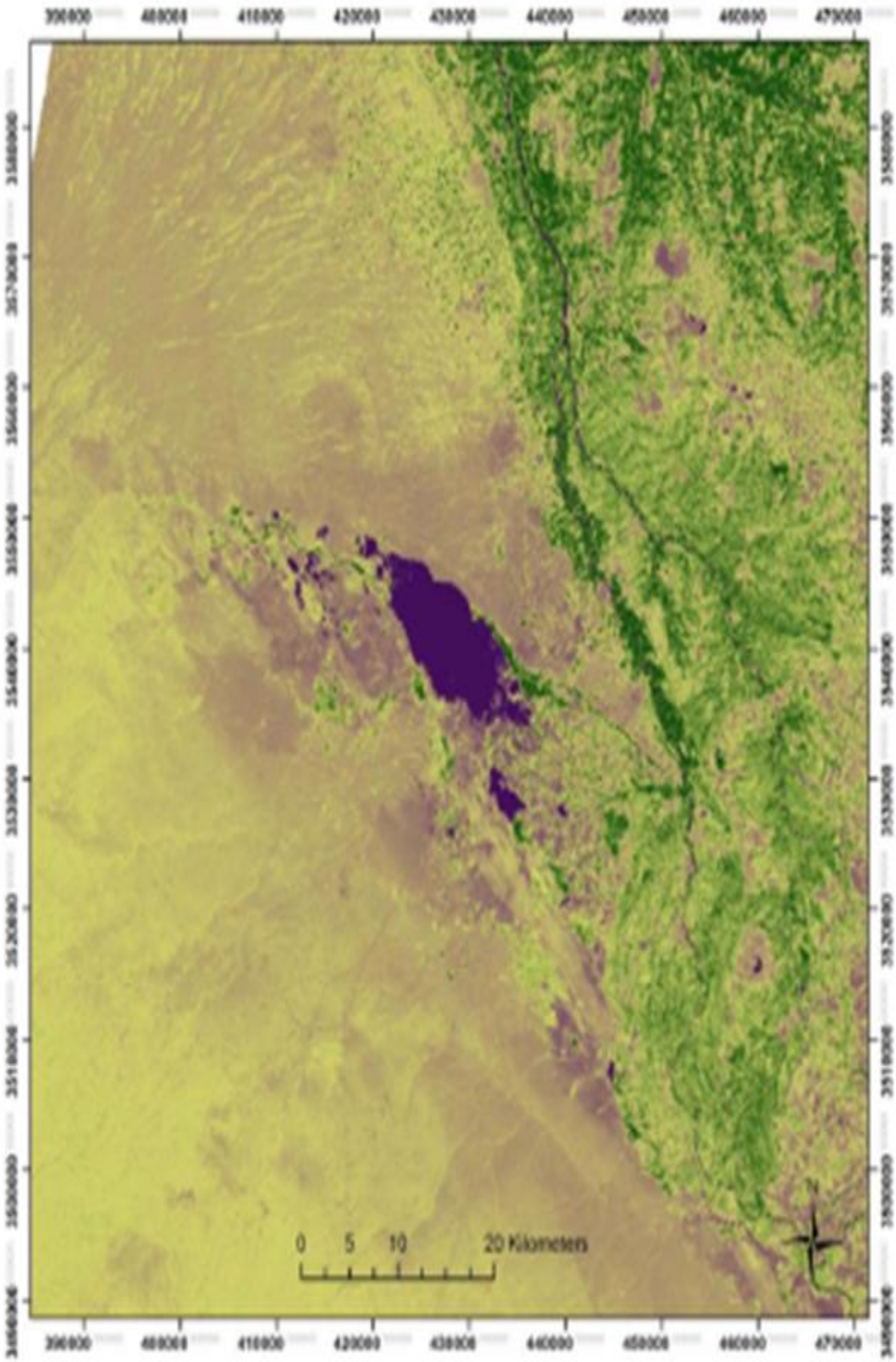

Figure (4) NDVI of annajaf city landsat_8 2014130

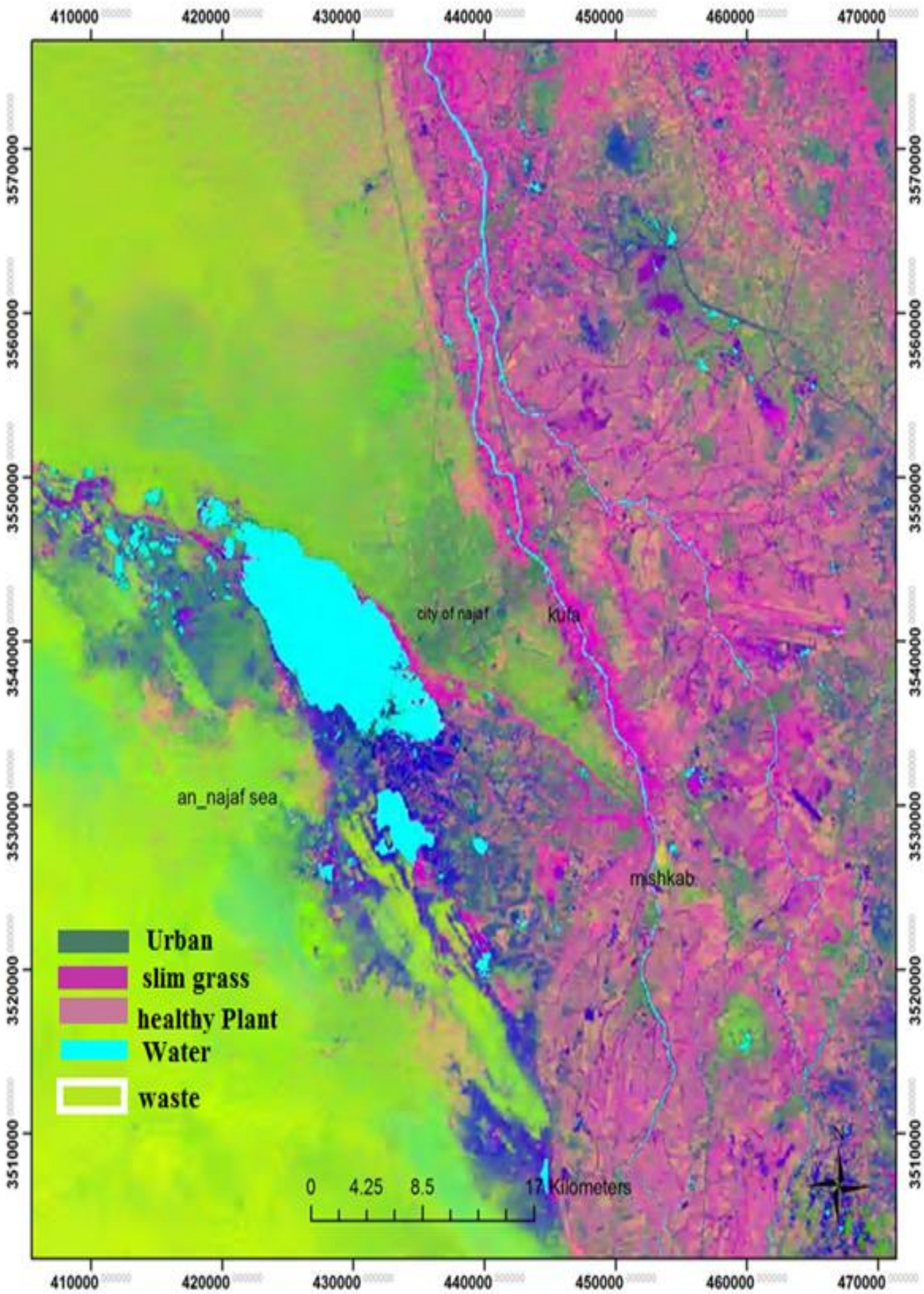

Figure (5)

color image(false) to ndvi,ndwi,ndsi &nbai of annajaf city landsat_8 2014130

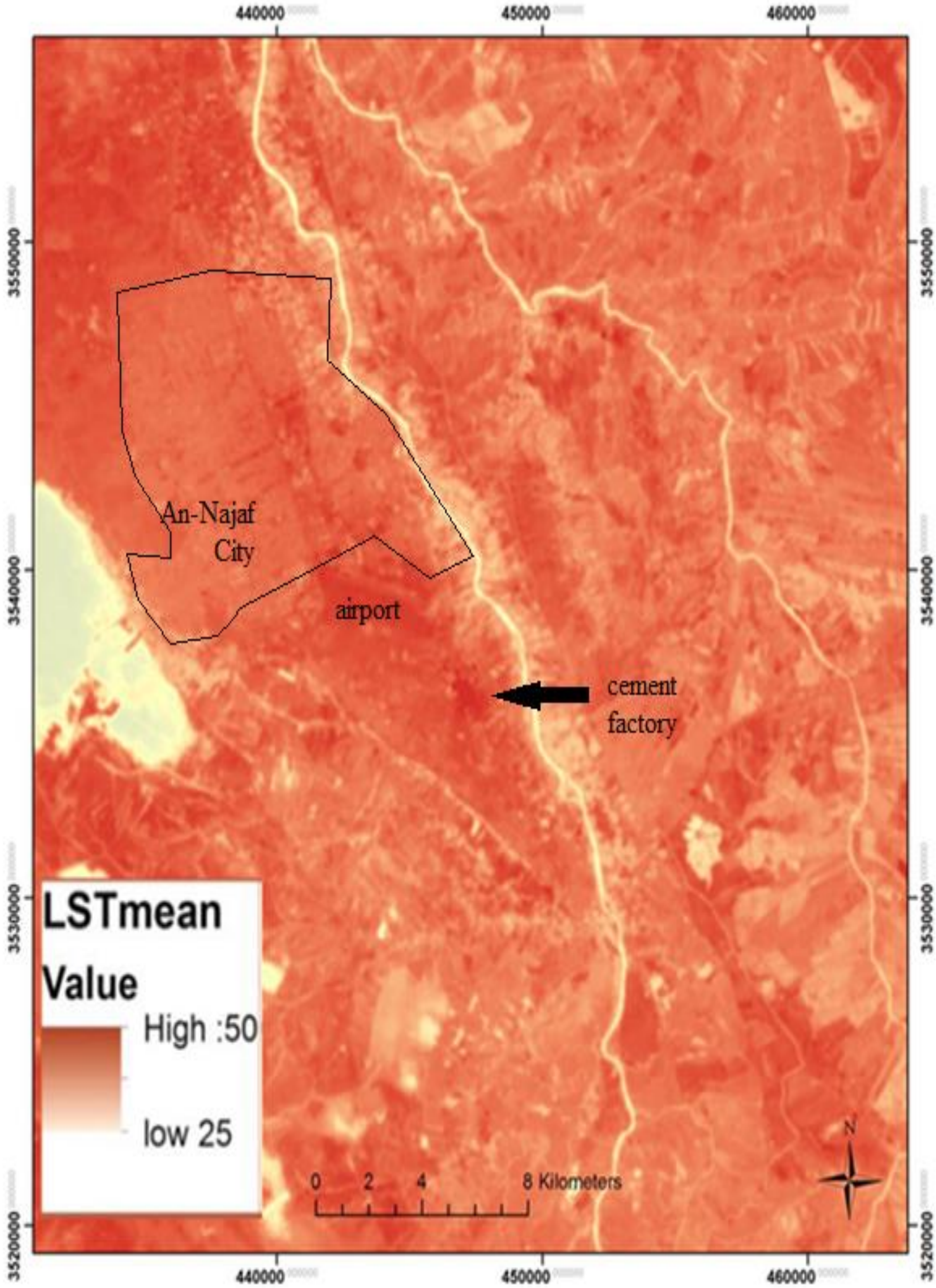

Figure (6)Land Surface Temperature (LST) zoom of image lc81680382014130lgn00_Mean of b10& b11

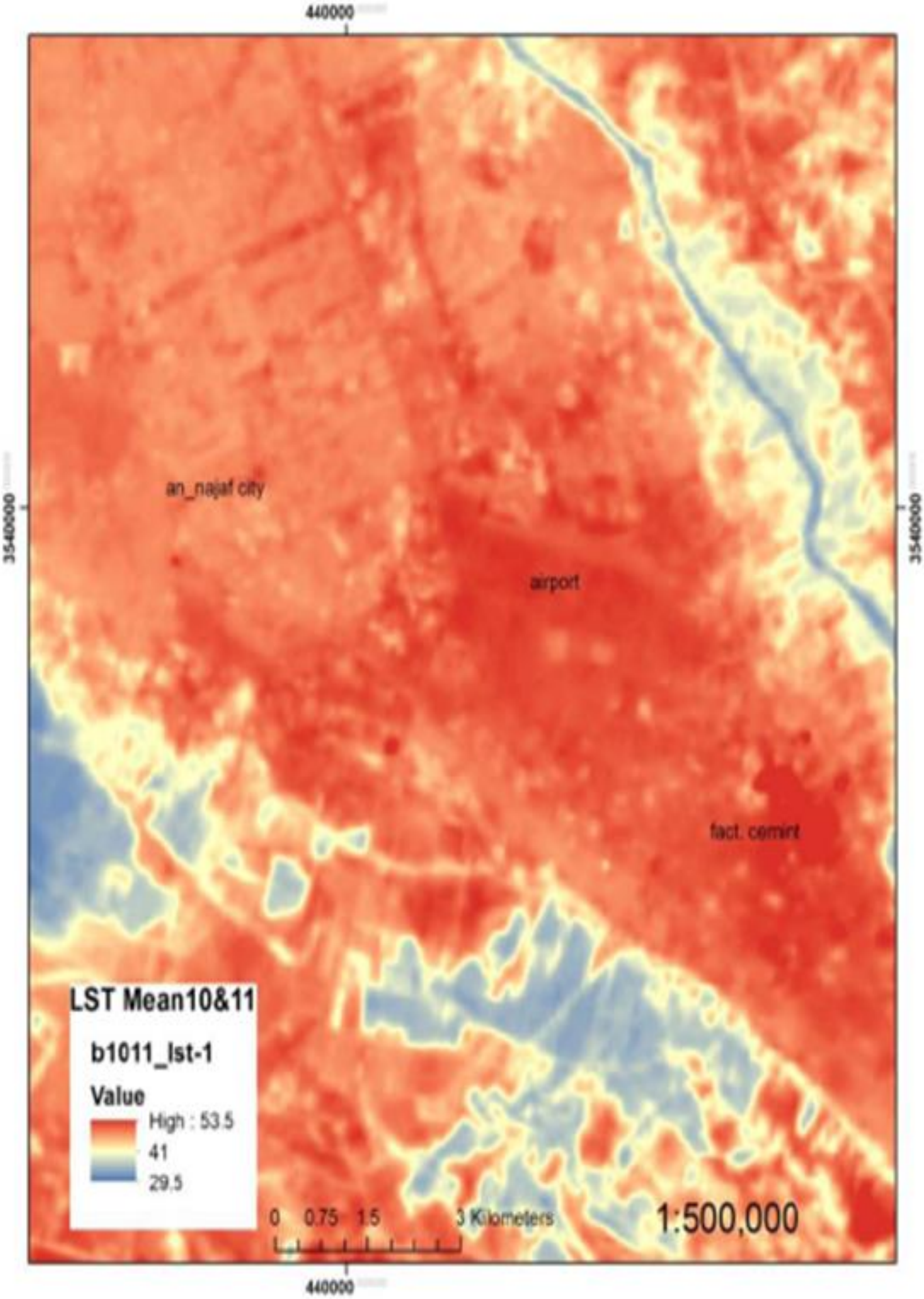

Figure (7)Land Surface Temperature (LST) zoom of image lc81680382014226lgn00_Mean of b10& b11

Discussion and Conclusion:

NDVI values have demonstrated the dense and moderate area of vegetation cover so, the NDWI have determined the water bodies, including Al-Kufa stream (Shatt Al-Kufa) and the depression to the west of An-Najaf city, NBAI values showed the cities within An-Najaf Governorate, While NDSI values determined the desert areas that contain soft soil and the other types of soil in the adjacent area of agricultural lands.

The urban heat islands can best be described as a dome of stagnant warm air that looms over the built-up areas which cause high temperature differences between urban and rural areas. Depending on the size, location and other urban characteristics. The modification of temperature can vary from city to city. The deterioration of urban air quality is considered a worldwide environmental issue. The LST maps showed the spatial extent of the urban heat islands and how they have grown and changed, especially doing the spring and summer months.

The cooler spots in all the selected LST images were consistently the rural areas such as (AL-Kufa and Al-Mishkhab) along with all the water areas (like Kufa Stream).The LST maps also highlighted the "hotspots" in the study area, especially in the desert lands, desertification and salty land like (desert of An-Najaf to the west ,airport of An-Najaf to the south) as shown in the previous LST maps, so the cement factory to the south ofAn-Najaf City that recorded biggest value of LST (heat island effects).The impact of heat islands is also clear in the airport area, while the urban areas have recorded little than from highlighted value. The study has proved that there was strong negative relationship between LST and water bodies and vegetation cover.

These "hot spots" represents probable heat islands and significant thermal climate activity. This means that regional temperature rise seems to be contributable to thermal climates in various locations throughout the corridor area.

References:

1. Alan, G.; 2014;" Land Surface Emissivity"; E.G. Njoku (ed.), Encyclopedia of Remote Sensing© Springer Science+Business Media New York; pp304-311.
2. Al-Kurdi, N. Awadallah,T, 2015." Role of Street-Level Outdoor Thermal Comfort in Minimizing Urban Heat Island Effect by Using Simulation Program, Envi-Met: Case of Amman, Jordan", Research Journal of Environmental and Earth Sciences 7(3):pp 42-49.
3. Alshaikh, A.Y.2015," The Effect of Land Use on Land Surface Temperature Based on Remote Sensing Indices and GIS in Al-Jouf Northwest, KSA;;Life Sci J;12(9):pp1-11.
4. Braithwaite, I. 2015; Healthand Climateat cop21 and beyond ; the global climate & healthalliance.16p
5. Carlson, T. N., & Ripley, D. A. (1997). On the relation between NDVI, fractional vegetation cover, and leaf area index. Remote Sensing of Environment, 62, pp241– 252.
6. Chander, G., & Markham, B. (2003). Revised Landsat-5 TM radiometric calibration procedures and postcalibration dynamic ranges. IEEE Transactions on Geoscience and Remote Sensing, 41(11), pp2674–2677.
7. CHANDER, G. Markham B.L., Barsi J A., 7007 "Revised Landsat-5 Thematic Mapper Radiometric Calibration", IEEE Geoscience And Remote Sensing Letters, Vol. 4, NO. 3, pp 490-994.
8. Jansen, K.L., Larson, T.V., Koenig, J.Q., Mar, T.F., Fields, C., Stewart, J. and Lippmann, M. (2005). Associations between health effects and particulate matter

and black carbon in subjects with respiratory disease, Environmental Health Perspectives, 113(12): pp1741–1746.

9. Jose´ A. S, Juan C. J, Leonardo P; 2004; " Land surface temperature retrieval from LANDSAT TM 5"; Remote Sensing of Environment ©Elsevier Incpp 434–440.
10. Komeil .R; Anuar. A; Ali .S; Sharifeh .H. 2014;"Water Feature Extraction and Change Detection Using Multitemporal Landsat Imagery".jRemote Sens, 6, pp4173-4189.
11. Liang. S, Li. X., Wang, J.; 2012;"Advanced Remote Sensing. Terrestrial Information Extraction and Applications"; Academic Press. Amsterdam.. 799pp.
12. McFeeters, S.K; 1996; the use of the normalized difference water index (NDWI) in the delineation of open water features. Int. J. Remote Sens., 17, pp1425–1432.
13. Paulson, J. A., Ahdoot, S., Baum, C. R., Bole, A., Brumberg, H. L., Campbell, C. C., ... &Trasande, L. (2015). Global Climate Change and Children's Health. Pediatrics, 136(5), pp992-997.
14. Singh R. P., Roy S., and Kogan F, 2003. "Vegetation and temperature condition indices from NOAA AVHRR data for drought monitoring over India," International Journal of Remote Sensing, vol. 24, no. 22, pp. 4393–4402.
15. Ying S; 2008;" Retrieval and Application of Land Surface Temperature"; Term Paper Ying Sun Department of Geological Sciences University of Texas at Austin, Austin, Texas 78712, USA.
16. ZHA,Y.;GAO,J.NI,J. 2003 "Use of Normalized Differenet Built-up index in automatically mapping urban areas from TM imagery". INT. J. Remote Sensing. Vol.24, pp583-594.