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SPATIO-TEMPORAL MAPPING TO DETERMINE LST, MSI, NDVI AND SAVI OVER KALAT, PAKISTAN

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Abstract- In the world of Geographic Information Science (GISc) and Remote Sensing (RS) spatial evaluation of a particular area can be interpret in a manageable way. Spatial and temporal monitoring is effectively useful in assessing changes of an area that can be mapped. Main aim of this research is to determine Land Surface Temperature (LST) of Kalat Baluchistan, Pakistan along with the temporal estimation of Normalized Difference Vegetation Index (NDVI), Soil Adjusted Vegetation Index (SAVI) and Moisture Stress Index (MSI). Climatic variations has an impact on vegetation and soil moisture which are catalyzed by LST. These indexes were analyzed and their calculations were performed by using ArcGIS 10.5 and ERDAS 2014 and data acquired was of MODIS. From analysis it has been observed that temperature in Kalat has changed and ultimately soil moisture stress has been increased over the period of 2000 to 2017.

Keywords: LST, NDVI, SAVI, Climate Change, Soil Moisture and MSI.

1. INTRODUCTION

It is very necessary to monitor and temporally analyze climatic trend and variation in Kalat. Decrease in soil moisture content shows the arid conditions and increase of less vegetation areas shows ecological disturbances as well. In order to understand the dynamic phenomena of changing climatic patterns in Kalat, Pakistan temporally analysis were applied and several indexes were calculated keeping in mind the specifications of GISc and RS. Spectral, spatial and temporal resolution are the most useful concept for analyzing image data of same area with different period of time. Satellite images were enhanced for clear observation and analysis [1] Kalat is a district of Baluchistan Province in Pakistan. Its geographical coordinates are 28^{o} 57’ & 29^{o} 20’ North and 66^{o} 36’ & 67^{o} 30’ East, the study area map is shown in Fig. 1.1. Climate of this region is semi-arid with the variable rainfall of 15.24 mm annually [2]. Kalat has a dry temperate climate system with hottest months of June and July rises to more than 30^{o}C temperature. Whereas, Relative hummidity is lowest as 44% in June and highest as 60% in January [3].

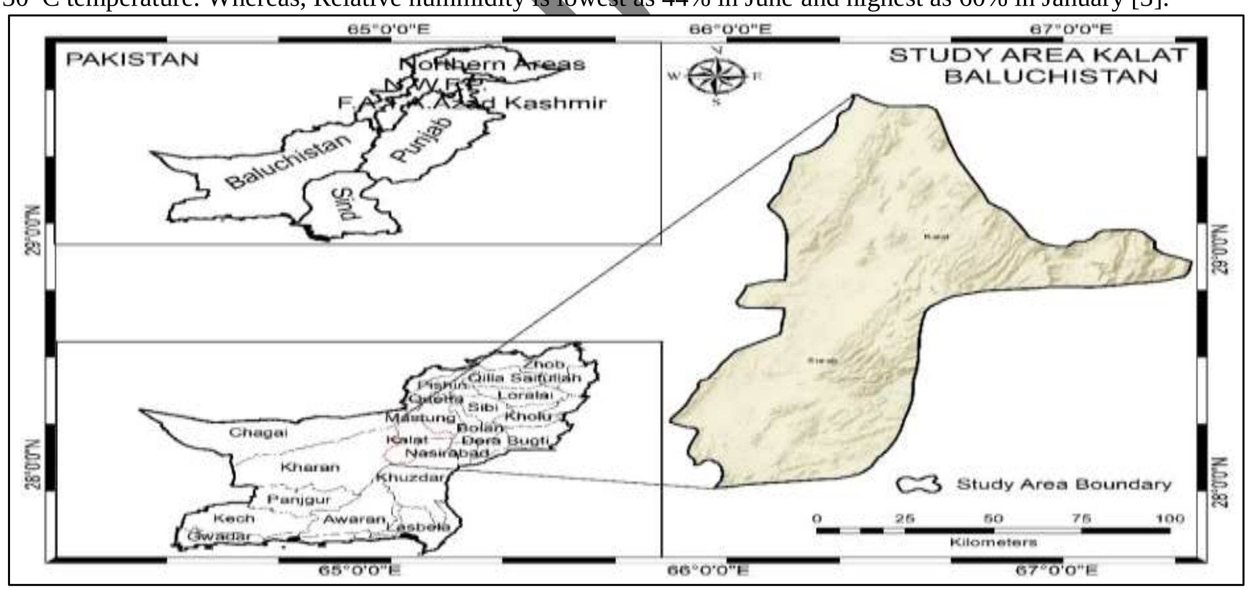

Fig. 1.1 Map Showing Study Area Kalat Baluchistan, Pakistan

2. RESEARCH ELABORATIONS

Geographic Information System (GIS) and Remote Sensing (RS) applications were used to evaluate LST and other indexes over Kalat, Pakistan. Research tools, software and methods described were used to find and analyze results. Satellite data captured was of huge area that is precise to particular area of study which is refers to ‘Data Handling’

[4] Various indexes were used to conduct study by using different research articles, base maps and internet resources since mapping is the most generalized estimation of any problem going in field of study area by using sensor networks [5]. NDVI index was correlated with SAVI for the determination of vegetation in Kalat for comparative study from 2000 to 2017. On the other side, LST was calculated and MSI was analyzed for the assessment of moisture and temperature in study area. For the calculation of LST, NDVI, SAVI and MSI MODIS data was used for both of the years while MODIS imagery was used. The spatial map making of indexes consists of integrating analysis and results were computed in GIS. These tools are very helpful in evaluation, assessment and monitoring of climate change in an area. Indexes were calculated by using data acquired from satellite images of MODIS for year 2000 and 2017. Final results were presented as maps using ArcGIS 10.5.

3. RESULTS AND DISCUSSIONS

3.1 Land Surface Temperature (LST)

LST is one of the crucial problem faced globally it is highly accelerated by loss of vegetation, loss of soil moisture content, increased temperature and activated with anthropogenic activities [6]. LST is one of the global challenge that is directly involved with urban developing activities and hinders sustainable development growth [7].

$$\mathbf{DN * 0.02 - (273.15)} \qquad 3.1$$

In above equation (Eq. 3.1) calculated Digital Number (DN-values) acquired from United States Geological Survey (USGS) was collected and average was taken out. Firstly, DN was converted to Radiance by multiplying with (0.02) as shown in Eq. 3.1. Secondly for the conversion of radiance kelvin values into degree Celsius values are subtracted with (273.15).

In Fig. 3.1 maps showing comparative LST for both years elaborates that in year 2000 areas with high temperature (48^o to 56^o) were not found and results clearly shows that moderate temperature was experienced in Kalat whereas in year 2017 results has been changed. The mean temperature (LST) record of LST for year 2017 shows that moderate temperature of (38^o to 47^o) has been reduced and areas of north-west and south-west are mapped as high temperature (48^o to 56^o). On the other side, the low temperature values (18^o to 27^o) were also calculated and shown in year 2017.

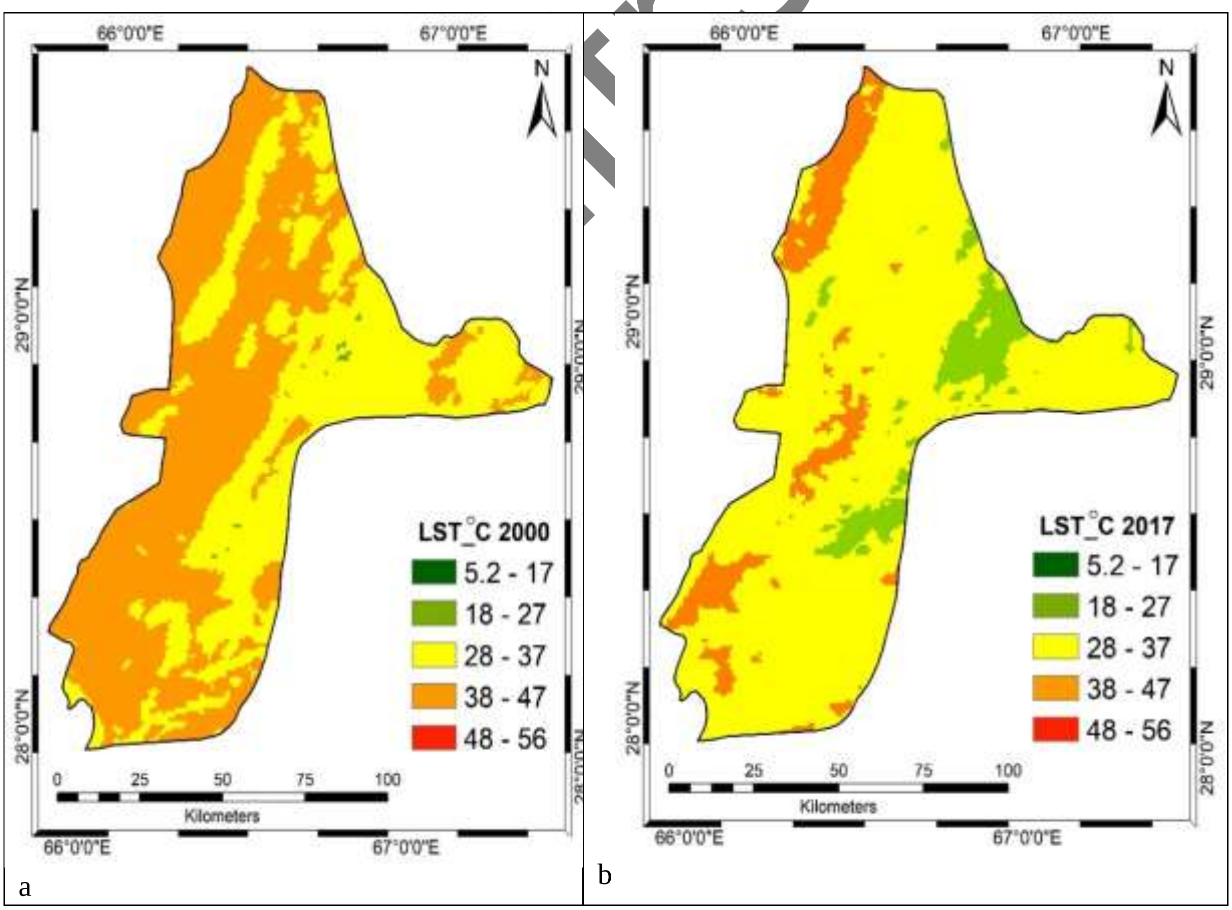

Fig. 3.1 Map Showing Temperature Classification Over Kalat Baluchistan, Pakistan Based on Land Surface Temperature (a) Year 2000 (b) Year 2017

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3.2 Moisture Stress Index (MSI)

Moisture Stress Index (MSI) is a water ratio index that determines water content in vegetation or leaf relative. Soil moisture plays an important role in growing vegetation from roots rather precipitation [8] .It is usually calculated from MODIS data uses SWIR band instead of MIR because of band's sensitivity for moisture. Ratio between SWIR and MIR reduces scattering effect and dominate water variation in vegetation [9].

$$MSI = R_{SWIR6} / R_{NIR} \quad 3.2$$

In above equation (Eq. 3.2) shows the ratio between Short Wave Infra-Red (SWIR) and Near Infra-Red (NIR). From Fig. 3.2. Map shows Moisture Stress Index (MSI), this map shows that in year 2000 soil moisture was sufficient whereas in year 2017 stress was increased. In Fig. 3.2 (a) year 2000 high moisture content was 484 count according to analysis while in Fig. 3.2 (b) stress has been increased as shown with red color as highly moisture stressed and yellow area as moderate moisture stressed.

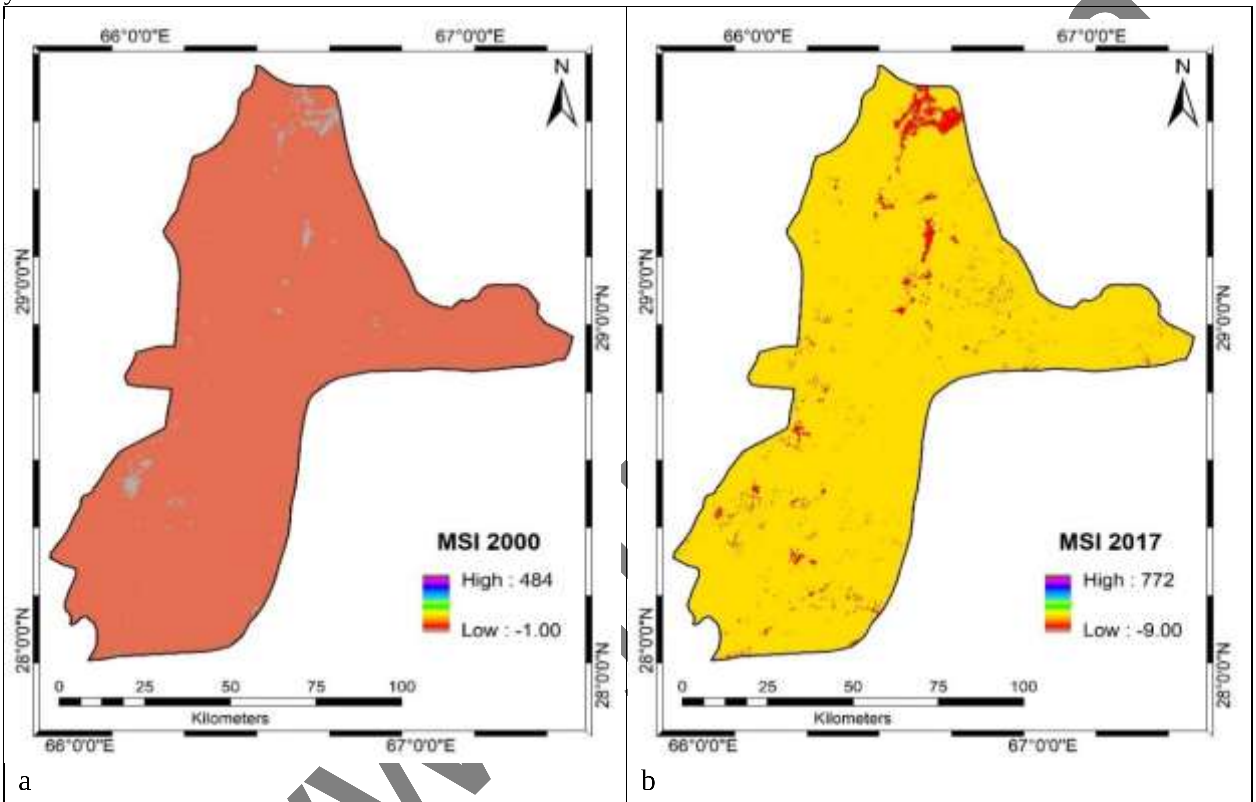

Fig. 3.2 Map Showing Moisture Stress Index (MSI) Over Kalat Baluchistan, Pakistan (a) Year 2000 (b) Year 2017

3.3 Normalized Difference Vegetation Index (NDVI)

NDVI in remote sensing is the estimation for greenery in a particular region or area. It is the combination of spectral bands that depends upon reflection, absorption and transmission of vegetation. It is derived from satellite-based optical sensor images allow us to monitor the growth of green vegetation in land surfaces over large areas and a quantitative index of the relative abundance and natural action of green vegetation. NDVI employs the red (R) and infrared (NIR) wavelengths and its value ranges from -1 to +1 [10].

$$NDVI= (NIR-R) / (NIR+R) \quad 3.3$$

In above equation (Eq. 3.3) it shows the calculative measure of vegetation index by NDVI, Near Infra-Red (NIR) is first subtracted with Red (R) wavelength than divided by Near Infra-Red (NIR) with the addition of Red (R) wavelength. In Fig. 3.3 (a) Map shows the vegetation cover assessment based on NDVI, it explains that high vegetation cover was very less in year 2000 and equally much of the region was covered with low or no vegetation in Kalat. Whereas in Fig. 3.3 (b) in year 2017 vegetation has shown its increased trend and on same regions high vegetation is analyzed but on the other side, less or no vegetation has also increased its value and NDVI remains same in both ways. This comparative analysis has shown interesting fact about Kalat, Pakistan that vegetation has not changed or shift it's trend rather climatic variations has increased values in both positive and negatives ways. The southern and north-western part of Kalat remain less vegetated or no vegetated throughout the time period of study. Central parts of Kalat were mainly vegetated and mapped as highly vegetated in both years.

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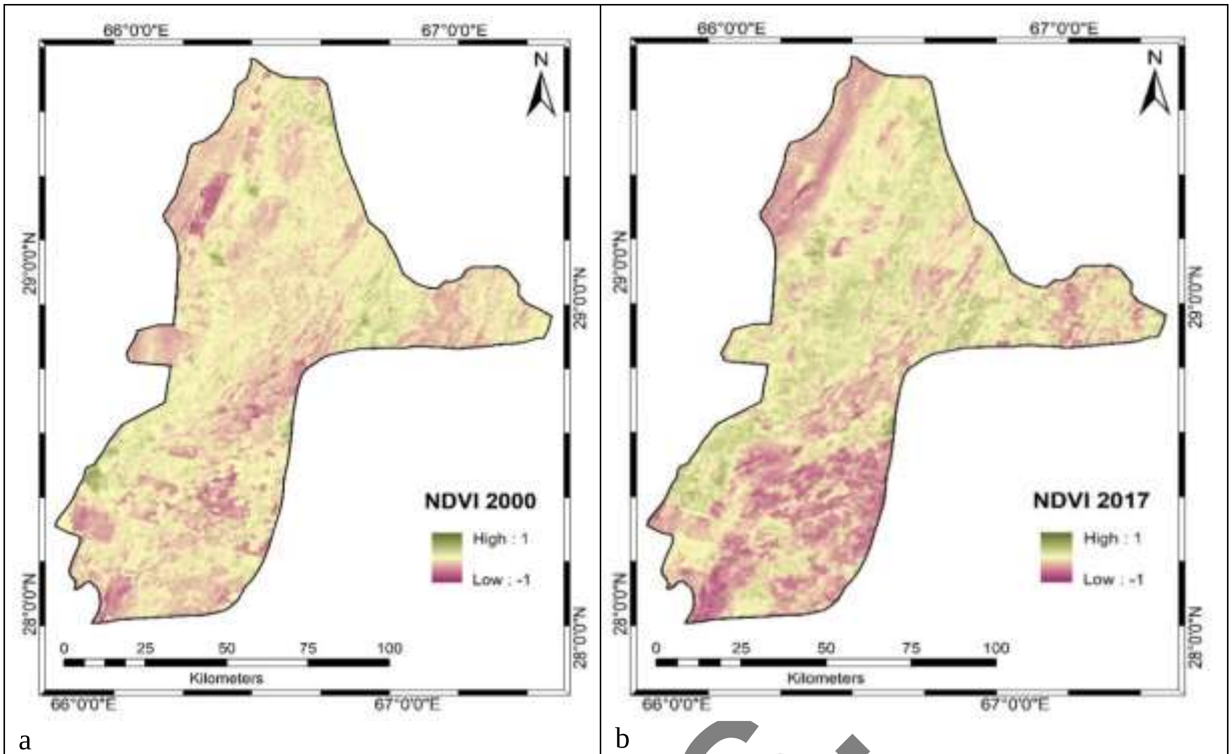

Fig. 3.3 Map Showing Normalized Difference Vegetation Index (NDVI) Over Kalat Baluchistan, Pakistan (a) Year 2000 (b) Year 2017

3.4 Soil Adjusted Vegetation Index (SAVI)

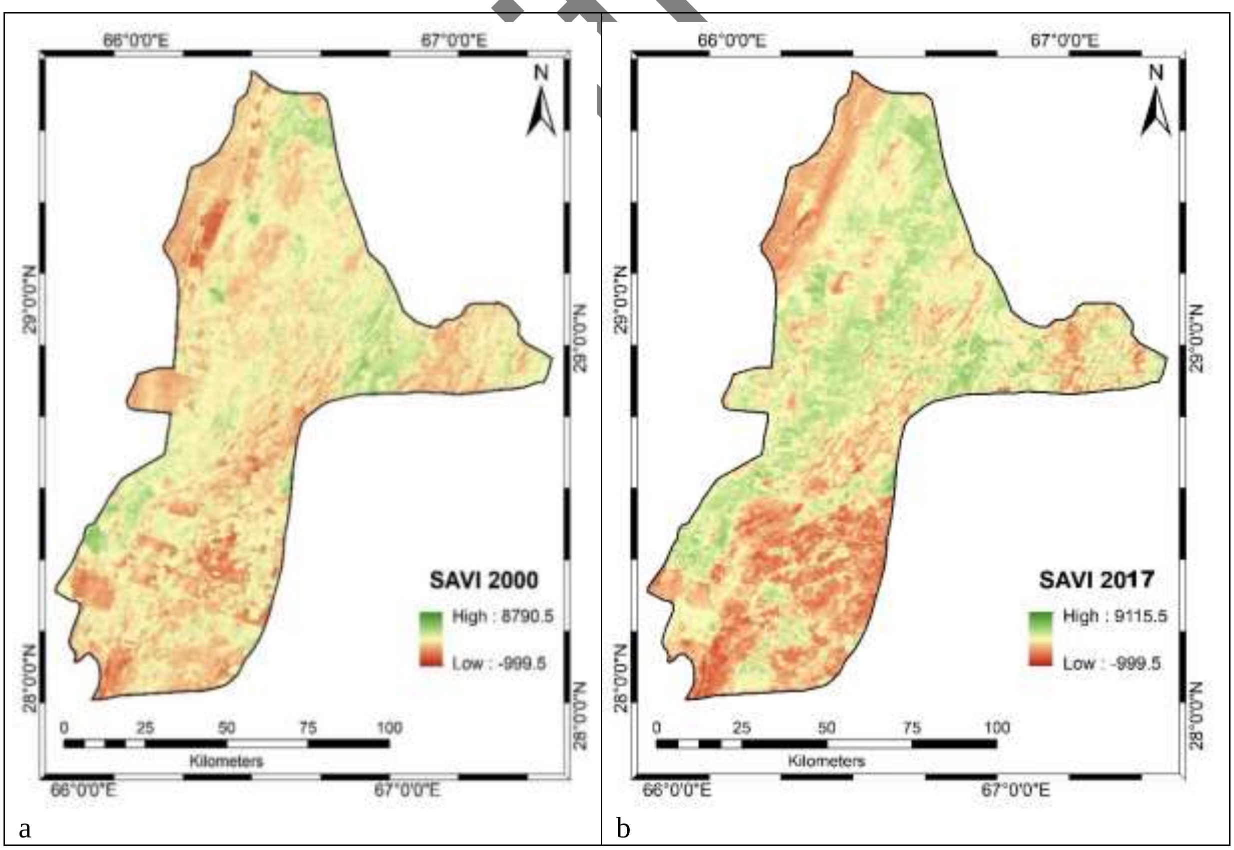

Fig. 3.4 Map Showing Soil Adjusted Vegetation Index (SAVI) Over Kalat Baluchistan, Pakistan (a) Year 2000 (b) Year 2017

In this research article, NDVI is correlated with Soil Adjusted Vegetation Index (SAVI). SAVI is an alteration of NDVI that shows vegetation as soil, it is a key index for compensating soil brightness where vegetation cover is low. It is as same as NDVI but with the addition of Red wavelength as 'Soil Brightness Correction Factor' [11].

$$SAVI = NIR - (RED/NIR + RED + L) * (1 + L) \quad 3.4$$

In the above equation (Eq. 3.4) NIR is the reflectance value of the near-infrared band, RED is the reflectance of the red band, and L is the soil brightness element. The value of L varies by the amount or cover of green vegetation: in very high vegetation regions, L=0; and in areas with no green vegetation, L=1. Generally, an L=0.5 works well in most conditions and used as default value. When L=0 makes SAVI equivalent to NDVI.

In the above Fig. 3.4 Map shows Soil Adjusted vegetation Index (SAVI) for both year 2000 and 2017. It shows same results as of NDVI as shown in Fig. 3.4, the correlation of NDVI with SAVI for the monitoring and assessment of vegetation has been analyzed. SAVI has shown the similar results to NDVI, the high values of vegetation cover remains same in central region of Kalat whereas in Southern and north-western parts of Kalat dead or no-vegetation were resultantly found.

CONCLUSION

This study is a comprehensive and applicable approach for monitoring and mapping of several indexes for the sake of climate change. All analysis and techniques are patently understandable and can be applied in any region of interest. This approach will help the geo-scientific community to better understand the correlation of NDVI with SAVI on MODIS imagery while for the LST MODIS data is more comprehend. This article concludes that Kalat is a region with multiple climatic ranges, it is considered as coldest in winters and reaches to maximum temperature in summers. The soil moisture content has been constantly decreased in these 17 years and LST has been also increased to maximum. This study is also beneficial for the planning of vegetation in Kalat to make it pollution free as well as ecological strong enough to cope up with disaster like Land Surface Temperature (LST). For future planning it has been suggested that the use of GISc and RS with MODIS data for monitoring and evaluation of climate change needed to be mapped.

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REFERNCES

[1] Kaur, A. & Rani, J, "Digital Image Forgery and Techniques of Forgery Detection: A brief review", International Journal of Technical Research and Science, 2016.
[2] Tareen, R. B. Bibi, T. Khan, M. A. Ahmad, M. & Zafar, M, "Indigenous Knowledge Of Folk Medicine By The Women Of Kalat And Khuzdar Regions Of Balochistan, Pakistan", Pakistan Journal of Science, 2010.
[3] Hussain, F. & Durrani, M. J, "Forage Productivity of Arid Temperate Harboi Rangeland, Kalat, Pakistan", Pakistan Journal of Science, 2007.
[4] Zia, U. A. & Khan, D. N, "An Analysis Of Big Data Approaches In Healthcare Sector", International Journal of Technical Research and Science.
[5] Gao, X. & Levent, A, "Using Sensors Network to Map and Localize Odor Propagation for Airborne Chemical Source", International Journal of Technical Research and Science (IJTRS), 2016.
[6] Xiao, K. & Xu, H, "Rs And Gis Based Analysis Of Urba Heat Island Effect In Shanghai", Geoinformatics, 2010.
[7] Baba, A. N. Tifwa, H. Y. & Achoba, M. I, "A Synergy Between Urban Planning And The Public Towards Achieving Sustainable Development Goals (SDGs)", International Journal of Technical Research and Science (IJTRS), 2017.
[8] Soni, C. Vaishnav, D. D. Bairwa, D. Mittal, H. Vijayvargiya, H. Vijavargiya, A. & Singh, V, "Automatic Irrigation System", International Journal of Technical Research and Science (IJTRS), 2017.
[9] Zhang, N. Hong, Y. Qin, Q. & Zhu, L, "Evaluation Of The Visible And Shortwave Infrared Drought Index In China", International Journal of Disaster Risk Science, 2013.
[10] Epiphanio, J. N. & Huete, A. R, "Dependence Of Ndvi And Savi On Sun.Sensor Geometry And Its Effect On Fapar Relationships In Alfalfa", Remote Senisng of Environment, 1995.
[11] Gilabert, M. Piqueras, J. G. Garciaa-Haro, F. J. & Melia, J, "A Generalized Soil-Adjusted Vegetation Index", Remote Sensing of Environment, 2002.