THE GEOGRAPHICAL STUDY ON DROUGHT ASSESSMENT OF THE CENTRAL DRY ZONE IN MYANMAR (CASE STUDY ON MINBU TOWN, MAGWAY REGION)

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ABSTRACT: Today, many places of different locations on Earth especially semi-arid areas face the risk of desertification due to severe drought. Minbu is a distinctive tourism area because famous pagodas and mud volcanoes. Central Myanmar is low rainfall and rain shadow area and deforestation is going to drought of study area. The main purpose of this paper is to analysis on spatial and temporal variations of drought event in central dry zone by using remote sensing data. The main data obtained from the Landsat 8 Operational Land Imager by downloading from U.S Geological Survey (USGS). Landsat satellite images 2013 and 2017 was downloaded from the official website of United States Geological Survey (USGS) and field survey data. Using the 1449 sample points without water body of field survey data with the correlation between the LST and NDVI. The combination of (NDVI) normalized difference vegetation index and LST provides very useful information for agricultural drought monitoring and early warning system for the farmers. By calculating the correlation between LST and NDVI, it can be clearly noticed that they describe a high negative correlation.

1. INTRODUCTION

Drought is expected to get worsen with predicted climate change, and the aerial extend of drought-affected regions are projected to increase, which could have adverse effects on agriculture, IPCC (2007). Agriculture sector is most affected by the onset of drought as it is highly depending on the weather, climate, soil moisture etc. Agricultural drought is nothing but the decline in the productivity of crops due to irregularities in rainfall, increase in the temperature rate etc., which causes a decrease in the soil moisture. The role of remote sensing and GIS in agricultural drought detection, assessment and management is becoming crucial these days as they provide up to date information in different range of spatial and temporal scales which is hectic and time consuming when done by traditional methods such as fields survey and sampling questionnaires, Thenkabail et al. (2004), Arshad et al (2008), Hasan and Saiful (2011), Brian et al. (2012). The vegetation index has been considered by numerous scientists as one of the important parameters for the mapping of agricultural fields estimating weather impacts, calculating biomass, crop yield, drought conditions and determining the vigor of the vegetation, Tucker et al. (1982); Justice et al. (1985); Hielkema et al. (1986); Kogan (1987a, b), (1995); Dabrowska-Zielinska et al. (2002), Narasimhan and Sriniyasan (2005), Chakraborthy and Sehgal (2010). Different kinds of vegetation indices are available but Normalized Difference Vegetation Index (NDVI) is the simplest, efficient and commonly used one, Liu and Huete (1995). NDVI was first suggested by Trucker in 1979 as an index of vegetation health and density. Using the NDVI data of the region, the changes in vegetation cover present in the area and also the trend in occurrence of agricultural drought can be studied, Sruthi and Aslam (2014). This index is not free form defects such as data error during rainy season, saturation effect on dense vegetation, etc. So it is always better to merge it with other parameters to ensure more accuracy. It is seen that there is a strong correlation between surface temperature and NDVI. LST is a good indicator of the energy balance at the Earth's surface which can provide important information about the surface physical properties and climate. Goetz (1997) reported that the negative correlation between LST and NDVI, Zhengming et al. (2004), observed at several scales ($25m^2$ to 1.2 km^2), was largely due to changes in vegetation cover and soil moisture, and indicted that the surface temperature. It is a drought prone region and falls among the most arid band of the country. Minbu weather remains almost dry throughout the year, a hot summer with mean monthly maximum temperature of 39˚C in May 2017 and a minimum of 21˚C in December 2017. Today, many places of central Myanmar especially dry zone areas face the risk of desertification due to serve drought. Actually, drought is natural hazard. But if the disaster risk management is good natural hazard will not become to natural disaster. Because, disaster risk management has three important stages such as early warning, real time response and rehabilitation. So, to reduce natural hazard, managements need to the mitigation and adaptation plans. However, for these plans, a large amount data is necessary for all these tasks and not easy to get all data in Myanmar. To fill this gap, this study can solve with the help of satellite data and remote sensing techniques.

2. STUDY AREA

Since the interest of the study is related to the drought prone region, the case study was selected for drought assessment, Minbu town, is located between 21˚ 10' 29.73" N and 94˚ 52' 55.18" E and which is within the Minbu district, Magway Division, Myanmar. The total area of the study is 1,661 km^2. The reason why selecting the area was it is the drought prone area among the most drought region of the central part of Myanmar, dry zone. The distinctive feature of study area can be found many mud volcanoes and hot springs. The reason why selecting the area was it is one of the drought prone area among the most drought region of the central part of Myanmar, dry zone.

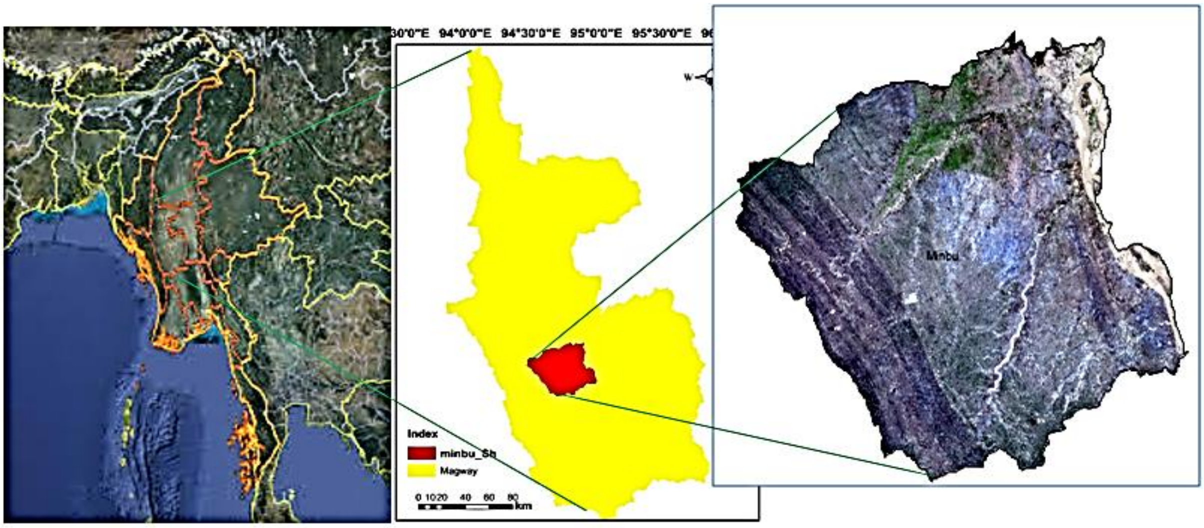

Figure 2.1 Study area map (Minbu Town)

1.1 Objectives

The objectives of the study were set up below:

- To estimate the calculation of NDVI and retrieve of LST
- To analysis on drought assessment by the spatial variation and correlation of NDVI and LST
- To produce by Remote sensing data and Geographic Information Techniques are very useful and effective tools of reliable results for disaster management

1.2 Research Design

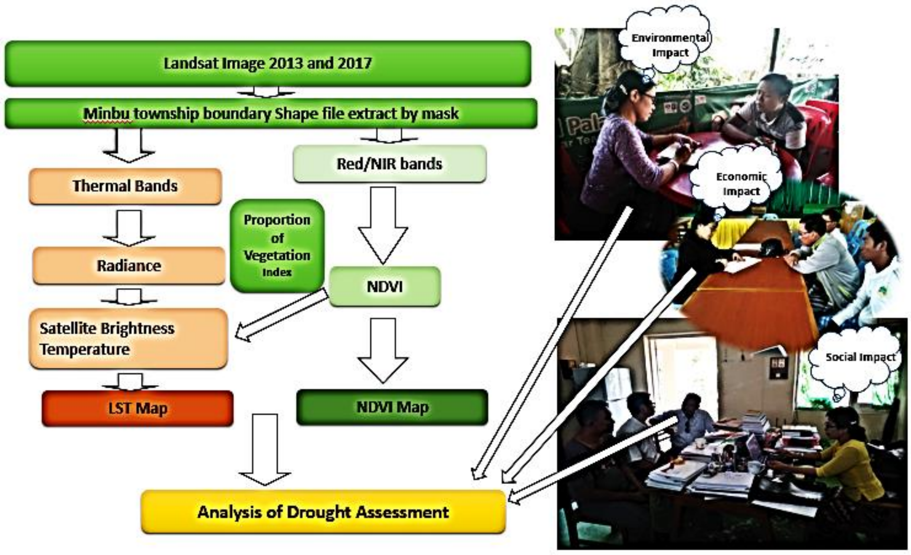

Figure 2.2 Research Frame

Data and Methodology

The procedures of this paper consist of three phases. Firstly, Landsat 8 multispectral image series was used as remote sensing data source for the study. Landsat satellite images (2013 and 2017) were downloaded from the official website of United States Geological Survey (USGS) and used in order to reach the research objectives. The data used in the study includes Landsat 8 (OLI) 2013 and 2017 which were cloudless area (less than 10 %). Spatial resolution is 30x30 m. UTM zone is 47 and Datum is WGS 84.

The second phase is retrieval of the LST of 2013 and 2017. To operate the retrieve for the LST, the calculation of NDVI and Land Surface Emissivity (LSE) were necessary to apply to estimation of LST. The principal of NDVI is that the reflexes rates are differ at the Near Infrared (NIR) and RED band. This equation is denoted as the following formula. Healthy vegetation absorbs most of the visible light that hits it, and reflects a large portion of the near-infrared light. Sparse vegetation reflects more visible light and less near-infrared light. NDVI ranges from minus one (-1) to plus one (+1).

$$NDVI = (NIR-R) / (NIR+R)$$

ε is land surface emissivity, which was obtained using NDVI Threshold Methods. The formula of P_v is the vegetative proportion as following;

$$P_v = \{(NDVI - NDVI_{min}) / (NDVI_{max} - NDVI_{min})\}^2$$

Where P_v indicated the vegetation proportion, ε due to $\varepsilon_{veg} P_v + \varepsilon_{soil} (1- P_v)$, where ε_{veg} is vegetation emissivity, ε_{soil} means soil emissivity.

The most appropriate procedure to retrieve LST from a Single Channel located in the TIR region. The main goal of the Single Chennel method is to obtain an algorithm to retrieve LST from one thermal band of the sensor. The processing for Calculation of LST, LST was retrieved from the thermal infrared band (TIR) of Landsat 8, the digital numbers of TIRS band data were transform OLI and TIRS band data was converted to Top of Atmosphere (TOA) spectral radiance using the radiance rescaling factors provided in the metadata file with the following equation;

$$L_\lambda = M_L Q_{cal} + AL$$

Where, L_λ means TOA spectral radiance and M_L is band specific multiplicity rescaling factor from the metadata, AL indicates for band specific additive rescaling factor from the metadata and Q_{cal} can be Quantized and calibrated standard product pixel values. Brightness temperature (T_b) is the microwave radiation radiance traveling upward from the top of Earth's atmosphere. The calibration process has been done for converting thermal DN values of thermal bands of TIR to T_b. For finding T_b of an area the TOA spectral radiance of (L_λ) was needed.

The second step, the radiation luminance of the all satellite images were converted to at-satellite brightness temperature in Kelvin, T (K), using the following formula for all Landsat images.

$$Tb = \frac{K_2}{\text{In}\left(\frac{K_1}{L_\lambda} + 1\right)}$$

Where, T_b defines the meaning of the effective at satellite brightness temperature in Kelvin (K), $\mathbf{L_\lambda}$ is TOA spectral radiance and K_1 and K_2 are the band specific thermal conversion constant from metadata (pre-launch calibration constants). The following Table 2.2 distinguished the respective value of band conversion constant from metadata.

Table 2 Band Specific Thermal Conversion Constant from metadata

Sensor	K_1 (watt/ (m^2 x ster x μm))	K_2 (watt/ (m^2 x ster x μm))
Landsat 8 OLI	BAND_10 = 774.8853	BAND_10 = 1321.0789
	BAND_11 = 480.8883	BAND_11 = 1201.1442

The calculated radiant temperatures were corrected for emissivity by using the NDVI. The emissivity corrected LST were computed with the following formula;

$$\text{LST} = \frac{T_B}{1 + \left(\lambda \times \frac{T_B}{p}\right) \ln \varepsilon}$$

Where, T_B is at-satellite brightness temperature (K), w (**λ**) indicated wavelength of emitted radiance (wavelength of emitted radiance) (11.5 μm), and P can calculate from the formula of h*c / s (σ) (1.438* 10^{-2} m K). H is Planck's constant (6.626* 10^{-34} J S), S defines the Boltzmann constant (1.38* 10^{-23} J/K), C means velocity of light (2.998* 10^{-8} m/s), the value of P is 14380.

The third phase is the data analysis on the land use/land cover and land surface temperature changes.

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3. RESULTS AND DISCUSSION

3.1 Analysis on LST

The spatial variation LST of study area can be found in Fig. 3.1. The minimum LST shows 25.29 ºC and the maximum LST trend 43.88 ºC in 2013 increased to the minimum LST is 26.17 and

43.88 ºC in 2017. The temperature increased 1 ºC within 5 years. Hotter areas are occupied at the northern part of the study area. The hotter area can be seen at the harvested area of the seasonal crops' field and fallow land. All mud volcanoes and heat springs area are also high LST condition.

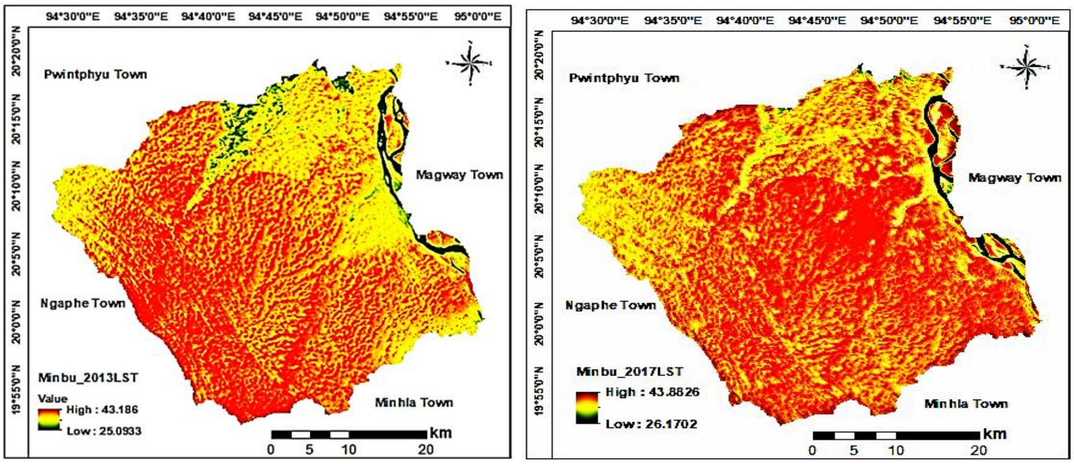

Figure 3.1 Spatial Variation of LST in Minbu (2013 and 2017)

3.2 Analysis on NDVI

Fig. 3 shows the spatial distribution of NDVI situation. The minimum NDVI was (-0.193233 and maximum NDVI was 0.506181 in 2013 and decreased to -0.174075 (min) and 0.488249 (max) in 2017. The minimum NDVI can be found at the water body (Ayeyarwady River) and the maximum NDVI cover vegetation mixed with residential area.

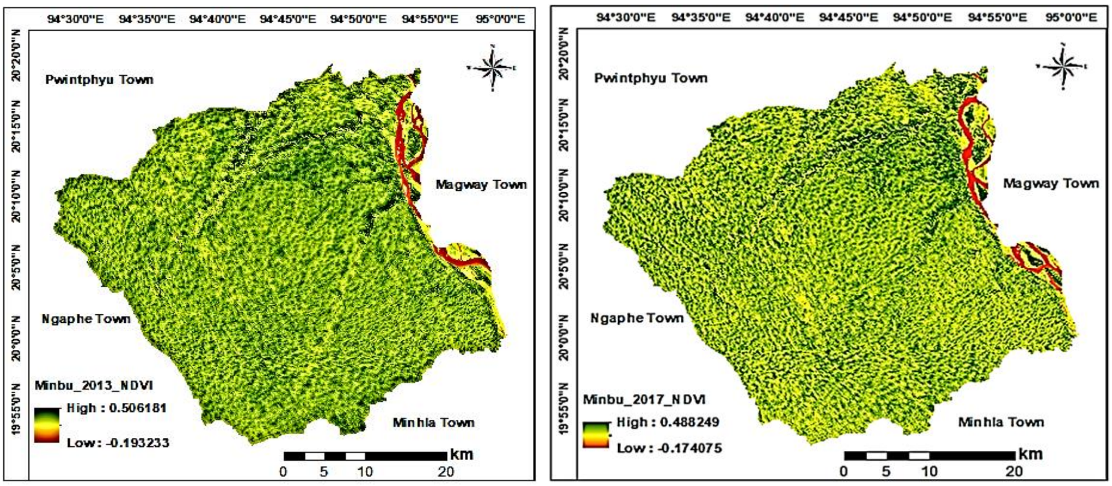

Figure 3.2 Spatial Situation of NDVI in Minbu (2013 and 2017)

3.2 Drought Analysis

For the drought analysis, there are two points. Firstly, correlation between LST and NDVI is one of the points for drought assessment with the help of random sample 1556 points without water body. The relationship of LST and NDVI, the pixel values of LST and NDVI values were based on the random samples of the study area without water body. The association of correlation coefficient of linear regression relationship between LST and NDVI (Fig 3.3). To improve understanding of the LST and NDVI relationship, selected the values of LST and NDVI of 1449 samples points without water body. The correlation coefficient of scatter plot of linear regression is (-0.727 in 2013) and (0.837 in 2017). The reverse correlations show that, the correlation between LST and NDVI of 2017 is stronger negative correlation than 2013. Negative correlation distinctly effects for the drought condition.

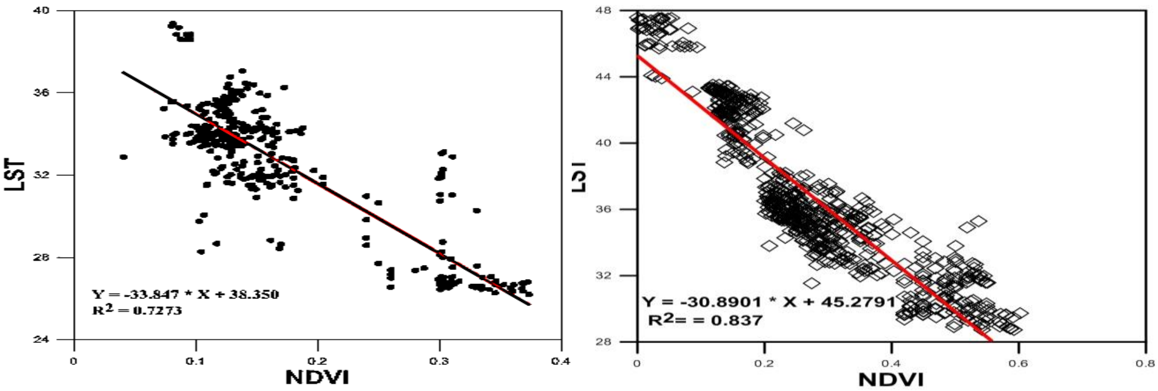

Figure 3.3 linear regression relationship between LST and NDVI (2013 and 2017)

The second point of drought analysis is human concept. Human concept can manage to mitigation and adaptation for the climate change and disaster management. The responses of the resident' opinion, there are three important impacts such as environment, economy and social impacts.

Environment impacts

1) Insufficient food and drinking water for human and animals
2) Low water levels in reservoirs, lakes and ponds
3) Wind erosion of soil and torrential rain
4) Forest fire and residential fire
5) Degraded vegetation cover
6) Limited transportation
7) Limited services

Economic Impact

1) Lose money when a drought destroys their crops
2) Spend more money on food and water for their animals
3) Businesses that depend on farming, like companies that make tractors and food, lose business when drought damages crop or livestock
4) Unstable their jobs (mobile work)
5) Unstable their income

Social impact

1) Health problems related heat stoke, skin diseases, eye, danger of snake, direahia, kidney, etc.,
2) Threat to pubic safely from an increased number of fires
3) Seasonal labour migration to other regions of Myanmar (Chin, Shan, Mandalay, Yangon)
4) Internal and international migration (local and foreign investments…ect.,)

4. CONCLUSION

Satellite remote sensing technology is largely used for monitoring agricultural drought assessment. Different indices of vegetation are available today, but none of the major indices is considered inherently superior to the rest in all circumstances, some indices are better suited than others for certain uses. According to its simple calculation, NDVI is widely used for the vegetation studies in a township, regional as well as global level. It is always advisable to combine the NDVI along with other parameters to get better results. The LST when correlated with the vegetation index it can be used to detect the agricultural drought of a region. Myanmar's dry zone covers about 13 % of the country. Minbu Township is one drone prone of the dry zone area in Myanmar. The result of this paper shows that the LST is increasing and decreasing NDVI. The negative correlation points out the challenge of climate change and natural disaster at present and future. Remote Sensing data and Geographic Information Techniques are very useful and effective tools in disaster management. So, the appropriate remotely sensely data can be used very effectively for quickly assessing severity and impact of damage due to, earthquake, landslides, flooding, forest fires, cyclones and other disaster risk management.

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