

SPECTRAL TRANSFORMATION OF IMAGE DATA: VEGETATION REMOTE SENSING FOR FOREST MONITORING

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Abstract

This study analysed the vegetation status of mining concession area, Zimbabwe. To achieve this, Normalised Difference Vegetation Index (NDVI) was used to assess vegetation condition of area. NDVI was calculated using the Landsat Image of Hwange 31 May 2011. The red and nearinfrared wave bands were used to determine NDVI. Results indicate that about 117km² of the mining concession area is least vegetated and 5km² moderately vegetated. There are no areas which can be classified as highly and densely vegetated in the area. The conclusion is that the area is generally devoid of vegetation because of the vegetation clearing which is taking place to pave way for open cast and underground mining activities. In light of these findings, it is therefore recommended that there should be afforestation and reforestation programmes to rehabilitate the mined areas. Such developments are crucial as the area is located close to one of the largest wildlife sanctuaries in the country.

Key words NDVI, Remote sensing, spectral transformation, image data

Introduction

Remote sensing is one of the most important tools used by environmental scientists to monitor vegetation status. This is mainly achieved by manipulating the reflectance characteristics of the leaves which are mostly affected by leaf pigment or chlorophyll in the leaves. The amount of chlorophyll in the leaves varies greatly from time to time. This makes remote sensing of chlorophyll in vegetation a critical tool in the analysis of vegetation condition in agriculture, natural forests and woodlands. Such information is critical in environmental management as it can be used to detect plant stress. Vegetation remote sensing is crucial in environmental planning and management as it provides useful information used for habitat classification. The use of remote sensing in evaluating vegetation condition in Zimbabwe remains largely unexplored despite its importance in evaluating the vegetation status of a place. For an area like the concession area which is dominated by mining activities, understanding the vegetation condition of a mined out area is important as it reveals the extent to which mining activities impact vegetation in the area. In this study, NDVI was employed to assess the vegetation characteristics of the mining concession area. This is because NDVI is one of the most common vegetation indices.

Method

The Integrated Land and Water Information System software (ILWIS) was used for calculations of NDVI. NDVI was calculated using the following formulae: $\text{Nearinfrared-Red}/\text{Nearinfrared+Red}$. This is because NDVI uses the reflectances of the wave lengths from the red and nearinfrared region of the electromagnetic spectrum. Red wave band was used to calculate NDVI as chlorophyll has been noted to absorb a lot of radiation in the red wave length while reflecting green wave lengths. The nearinfrared wave band was also used to calculate NDVI reflectance of healthy leaves tends to be higher in this wave length. Rouse et al (1974) also noted that in the red edge of the electromagnetic spectrum, vegetation tends to be sensitive to factors such as canopy cover and senescence. Senescence is the degradation of chlorophyll pigments which results from seasonal changes (Carter, 1994). Thus NDVI becomes a useful tool in forest monitoring or detection of vegetation stress. (Sims and Gammon, 2002). Landsat Thematic Mapper image of Hwange 31 May 2011 was used to calculate NDVI. The Landsat Thematic mapper was used because of its finer spatial resolution (Sibanda and Murwira, 2012).

The NDVI map was sliced to determine the least vegetated, moderately vegetated, highly vegetated and densely vegetated sections across the study area. Such information is critical for an area dominated by open cast mining activities as it reflects on the extend of the vegetation clearances which occur during mining operations.

Results

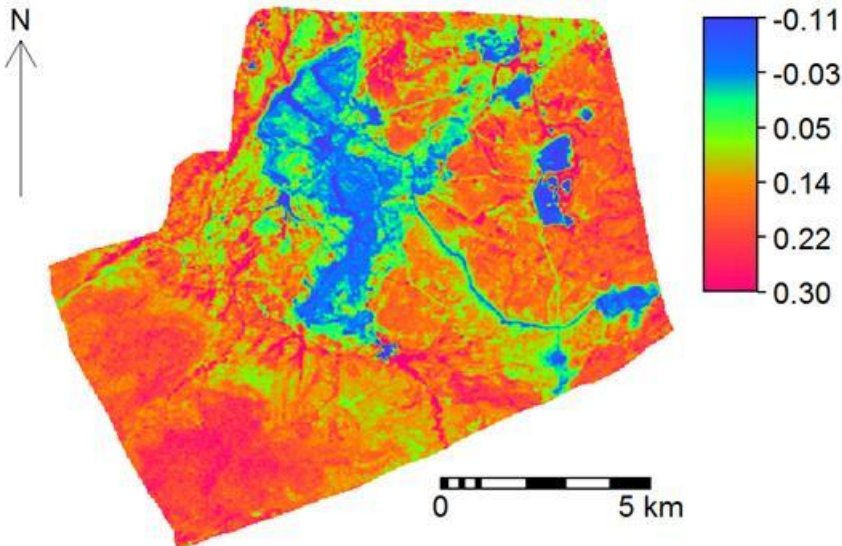


Figure 1: Normalised Difference Vegetation Index map of Hwange mining concession area

Figure 1 depicts the NDVI values for the mining area in Hwange. As shown on figure , the NDVI values of the area are very low ranging from -0.11 to 0.3. The negative values are a result of the water that has accumulated across the mined areas. Most of the water is pumped out from the underground mining activities and open cast mining activities especially if the miners mine in sections below the water table. NDVI values are negative for water bodies because water reflects electromagnetic energy in the visible spectrum up to nearinfrared. After that, all the energy is absorbed (Kerle et al, 2004). Water generally have lower reflctance which is about 10%.

The highest NDVI value for the area is 0.3 indicating that the amount of vegetation is very low in the area. Most of the vegetation was cleared during the mining processes.

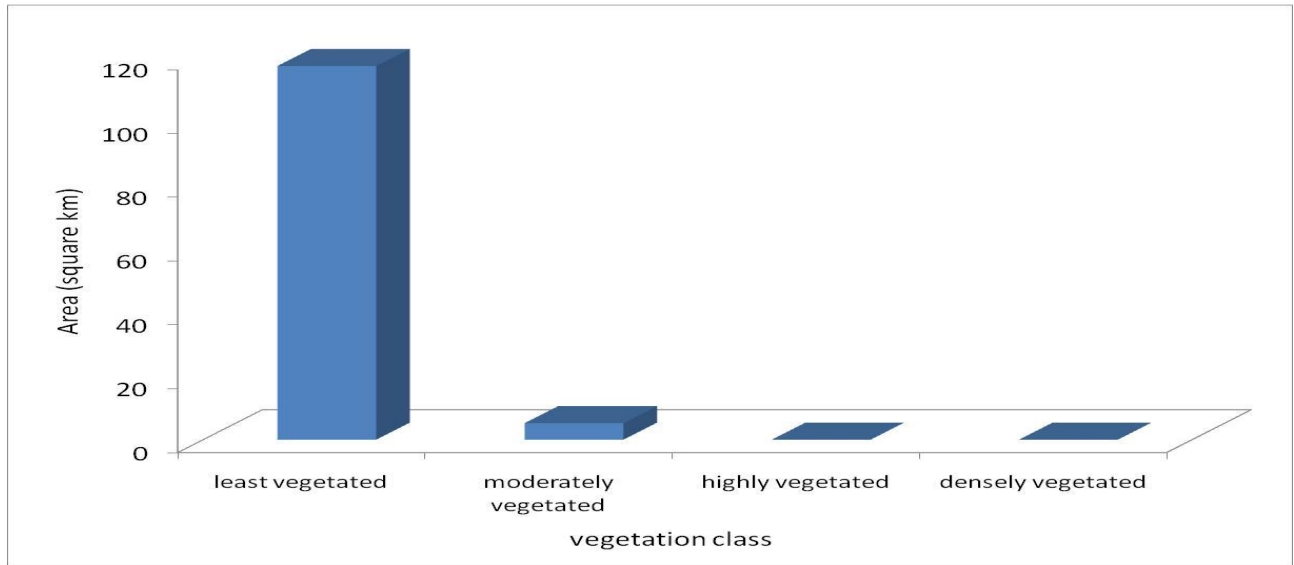


Figure 2 Vegetation classes in the study area

As illustrated in figure 2, the area is devoid of vegetation since the least vegetated area is about 117km^2 . There is no section which is densely or highly vegetated in the study area as depicted in figure 2. This indicates that the area generally have low vegetation.

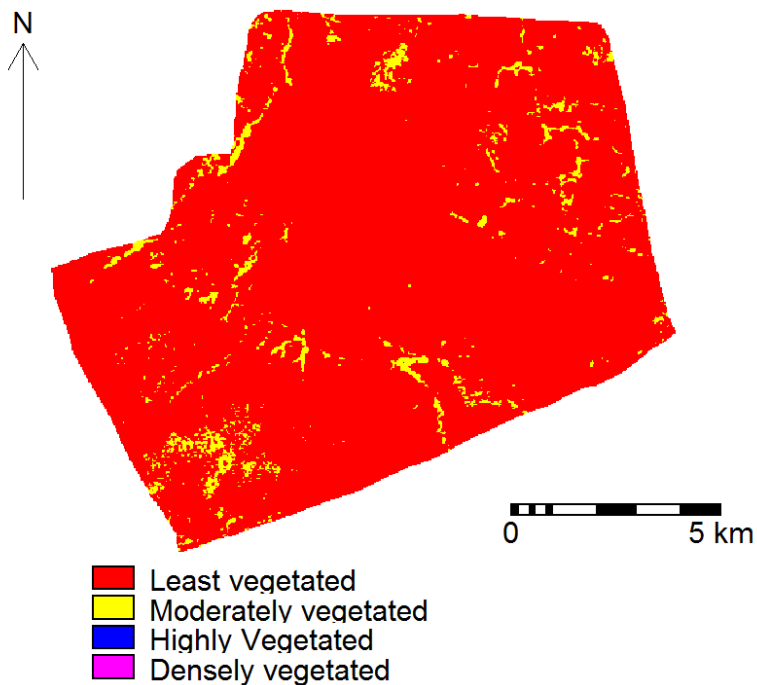


Figure 3 Spatial distributions of vegetation classes across the study area.

Figure 3 shows the spatial distribution of vegetation classes across the study area. As figure 3 illustrates, a large part of the area is least vegetated, with a few patches of areas falling under the

category of moderately vegetated. Figure 3 depicts that there are no sections which are highly or densely vegetated in the study area. The vegetation status of the area is a major cause for concern as the area is situated closer to one of the largest wildlife sanctuaries in the country. This is because vegetation is critical for wildlife as it provide food as well as habitat for wildlife. Thus continuous destruction of vegetation may have long and short term negative implications to the wildlife which depend heavily on vegetation as a source of survival.

Conclusions and recommendations

It can be concluded that the mining area is generally least vegetated as indicated by low NDVI values, suggesting that a lot of vegetation is being cleared to pave way for mining activities. The study therefore recommends that reforestation or afforestation programmes should be put in place to make sure that the vegetation in the area is restored.

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