USING SPECTRAL VEGETATION INDEX (NDVI) TO CLASSIFY THE RANGELAND IN TERMS OF VEGETATION COVER AND WILDLIFE HABITAT SUITABILITY

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Abstract

In this study, rangeland condition was assessed by mapping vegetation productivity in the area of Hwange, Zimbabwe. The study also assessed the suitability of the rangeland to wildlife habitat. To determine rangeland condition, the Landsat Thematic Mapper (TM) image of Hwange 31 May 2011 was used to calculate Normalised Difference Vegetation Index (NDVI). NDVI was calculated from the reflectance of the RED and Near Infrared bands of the Landsat T.M image. To classify the rangeland according to different classes of vegetation productivity, the NDVI map was sliced into different vegetation cover classes based on the following quartiles: >0.25 Least Vegetated, 0.251-0.49 Moderately Vegetated, 0.51-0.75 Highly Vegetated and 0.75-1 Densely vegetated. The NDVI map was also sliced according to different classes of habitat suitability based on the vegetation cover classes as follows: >0.25 not suitable, 0.251-0.49 moderately suitable 0.51-0.75 suitable and 0.75-1 very suitable. The sliced NDVI maps were then crossed with the NDVI map in order to classify the rangeland area according to different vegetation cover classes and habitat suitability. Results showed that 0% which is 0km^2 of the total range area is very suitable for wildlife habitat implying that there is no area within this part of the rangeland which can be classified as densely vegetated. About 0.0009% which occupies 0.002km^2 of the total rangeland is suitable for wildlife habitat. In addition, 95% (182km^2) of the rangeland is least vegetated, making it not suitable for wildlife habitat. Results also indicated that 4% (7.9km^2) of the rangeland is moderately suitable for wildlife habitat since it is moderately vegetated. It can be concluded that the condition of the rangeland in Hwange is

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not very suitable for wildlife habitat since most parts of the rangeland have low NDVI values indicating low vegetation productivity. Future studies should focus on investigating why vegetation productivity rates are low to develop sustainable ways of increasing vegetation productivity to ensure continued existence of wildlife in the rangeland of Hwange.

Key words: NDVI, Remote Sensing, GIS, habitat suitability, rangeland, ecology,

Introduction

Wild life rangeland ecology remains a largely unexplored field of study in Zimbabwe. Several wildlife researches conducted were biased towards assessing the social effects of wildlife on the communities leaving closer to the conservation areas. Thus the major objectives of most of these researches were to change the attitudes of the local communities as well as developing ways of preventing wild animals from raiding crops from fields and grain stores (Dzingirai 2003) (Mapedza 2006) (Child 2004). These previous studies have researched more about the social template (human - wildlife relations) leaving the ecological template (wildlife habitat conditions) unaddressed. For wildlife managers in Hwange, the critical question is: What is the condition of the wildlife rangeland in terms of vegetation productivity? In other words: Is the rangeland suitable for wildlife habitat? Understanding the condition of wildlife rangeland in terms of vegetation productivity and its suitability for wildlife habitat is critical since it ensures the continued existence of wildlife in human landscapes. The current study therefore explored how Geographical Information Systems (GIS) and Remote Sensing can be used to assess the condition of the rangeland and its suitability for wildlife habitat.

Study area

The study was conducted in Hwange which is located on the western part of Zimbabwe at latitude 18^0 21S 26^0 24E.The size of the study area is $190km^{2.}$ The study area is part of the rangeland of Hwange which is located closer to the mining town, rural settlements and tourists resort areas.

Local geology and topography

The local geology constitutes shallow sandy soils of the Karoo origin (Chamaille- Jammes 2007). The main rock types in the area include coal, sandstones, sedimentary, mudstone and fire clay. The area also consists of the Batoka basalts which are dense fine grained, massive volcanic rocks of the Karoo volcanic outpourings that marked the end of the Karoo sedimentation (Mosuwe 2010). Escarpment grits which are associated with high ground, capping the plateaus in Hwange area are also common. The dominant soil types are the Kalahari sands (Mosuwe 2010). The surface topography is generally flat but rises in some sections between 775-1000m above sea level in response to the escarpment grits formation (Mosuwe 2010).

Climate

The study area is characterized by a semi-arid climate. The rain season is from October to April. Annual rainfall is below 600mm (Chamaille- Jammes 2007). Day temperatures can exceed 40^{o} during the hottest months of the year (Chamaille- Jammes 2007).

Vegetation

The vegetation type in the area is influenced by the semi-arid climate in the area. The area is characterized by mixed woodland and open savanna . The Kalahari sands tend to have high woody species biomass and sparse grass . The dominant vegetation types in the study area include baikiaea plurijuga, terminalia sericea and burkea africana open woodlands (Mukwashi 2012). The area also constitutes baphia massiensis, bauhinia macrantha and acacia fleckii .

Water resources

Water is a scarce resource in this region due to low rainfall amounts and high evaporation rates. The main rivers in the area are Gwaai, Deka and Lukosi.These rivers and the natural pans dry up during the dry season (Chamaille-Jammes, 2007). The absence of permanent surface water means the animals rely on man-made water-holes.

Wild life

The area is one of the largest wild life sanctuaries in Zimbabwe, estimated to have 100 mammal species constituting 19 large herbivores and 8 large carnivores. Bird species are about 400. The area also harbours the largest populations of wild dogs. Large prides of lions and buffalo herds are also found in the study area (Mukwashi, 2012). Mammal species include

elephant, buffalo, lion, leopard, bat-eared fox, and warthog, white and black rhino, painted hunting dog, cheetah, hyena, giraffe, sable, kudu, eland, water buck, wild beast, impala, zebra, baboon and jackal. (Mukwashi, 2012). During the summer, the thick bush and abundant food resources forces animals to disperse. During the dry period, animals are easy to spot since they aggregate at few water holes left. Hwange National Park has an estimated 44 492 elephants (Chamaille- Jammes 2007). The elephants represent more than 85% of the herbivore populations.

Mining, settlement, agricultural activities in the study area

The study area constitutes companies like Hwange Colliery Company Limited; Makomo Resources and W & K .The companies extract coal from the Mid Zambezi Basin which is part of the Karoo super group. The main mining method used is the open cast mining. This mining activity involves the extraction of large pits which reach the permanent water table (Tiwary 2000). When the coal is exhausted, heaps of excavated soils (mine dumps) and pits remain and water also accumulates within these huge pits since pumping ceases as soon as mining stops (Geller 1998). The conservation area of Hwange National Park is also surrounded by communal areas, urban settlement and agricultural fields.

Materials

The following softwares were used for data collection and analysis: ILWIS, Arcview, Arc GIS, Microsoft Excel.

Methods

The Landsat Thermatic Mapper image of 31 May 2011 was used to calculate NDVI. The Landsat T.M image was used since it has a finer spatial resolution (Sibanda, 2012).The image of 31 May was used so as to exclude NDVI values for crops. This is because in Zimbabwe most crops grown during the rainy season would have been harvested by 31 May. The image was radiometrically corrected and georeferenced to UTM WGS 1984 zone 35 before NDVI was calculated. NDVI was used to assess the condition of the rangeland since it gives strong estimates of vegetation productivity and standing plant biomass (Chamaille- Jammes, 2007).Vegetation is a critical factor in wildlife rangelands since it provides habitat for several

animals. Vegetation also provides food for most animals which are browsers and grazers. The NDVI vegetation index uses reflectances from a RED (R) and Near Infrared (NR) bands of the Landsat image. The red band is located in the strong chrolophyll absoption region while the IR is located in the high refelectance plateau of vegetation canopies (Gao 1996). NDVI was calculated in ILWIS using the following formulae: NDVI=(Near Infrared-RED) / (Near Infrared+RED).

Classifying rangeland condition in terms of vegetation productivity

Inorder to classify the rangeland in terms of vegetation productivity, the NDVI map was sliced into different quartiles of vegetation classes as follows: >0.25 Least Vegetated 0.251-0.49 Moderately Vegeteted 0.5-0.75 Highly Vegetated and 0.75-1 Densely Vegetated. To determine the area of the rangeland under different vegetation classes, the sliced map was crossed with the NDVI map.

Classifying rangeland condition in terms of wildlife habitat suitability

Inorder to classify the rangeland in terms of wildlife habitat suitability, the NDVI map was sliced into different quartiles of habitat suitability classes as follows: >0.25 Not suitable 0.251-0.49 Moderately Suitable 0.5-0.75 Suiatable and 0.75-1 Very Suiatable. To determine the area of the rangeland under different wildlife habitat suitability classes, the sliced map was crossed with the NDVI map.

Results

Rangeland condition in terms of vegetation productivity

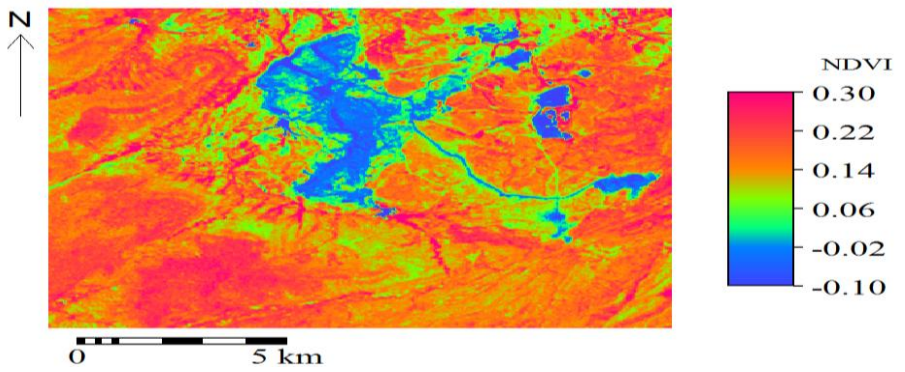

Figure 1: Map of vegetation productivity of part of the Hwange rangeland

Figure 1 illustrates that the NDVI values for the study area ranges between -0.02 to 0.3. This implies that the area`s vegetation productivity is low.

Table 1: Wildlife habitat suitability based on vegettation cover classes (NDVI)

NDVI (vegetation cover)	Vegetation classes	Elephant habitat suitability	Area (square kilometres)	% Area
>0.25	Least vegetated	Not suitable	182	95
0.251-0.49	Moderately vegetated	Moderately suitable	8	4
0.5-0.75	Highly vegetated	suitable	0.002	0.0009
0.75-1	Densely vegetated	Very suitable	0	0

Table 1 shows the suitability of different areas to wildlife habitat based on vegetation cover (NDVI). It can be observed from table 1 that 95% (182km^2) of the total area within the rangeland is not suitable (figure 4 and 5) for wildlife habitat. This is because such areas are the least vegetative as evidenced by the low NDVI values which are less than 0.25 (figure 2 and 3). Table 1 also depicts that about 4% (8km$^{2)}$ of the total area of the rangeland is moderately suitable (figure 4 and 5) for wildlife habitat as the areas are also moderately vegetated (figure 2 and 3). Results also indicated that only 0.0009% (0.002km^2) within the rangeland is classified as suitable for wildlife habitat (figure 4 and5) since it is the area which is classified as highly vegetated (figure 2 and 3). Table 1 also depicts that densely vegetated area (figure 2 and 3) which is classified as very suitable for wildlife habitat only constitutes 0% of the total area of the rangeland. Results imply that part of this rangeland is not suitable for wildlife habitat as a large percentage area is least vegetated.

Classification of the area of the rangeland into different quartiles of vegetation classes

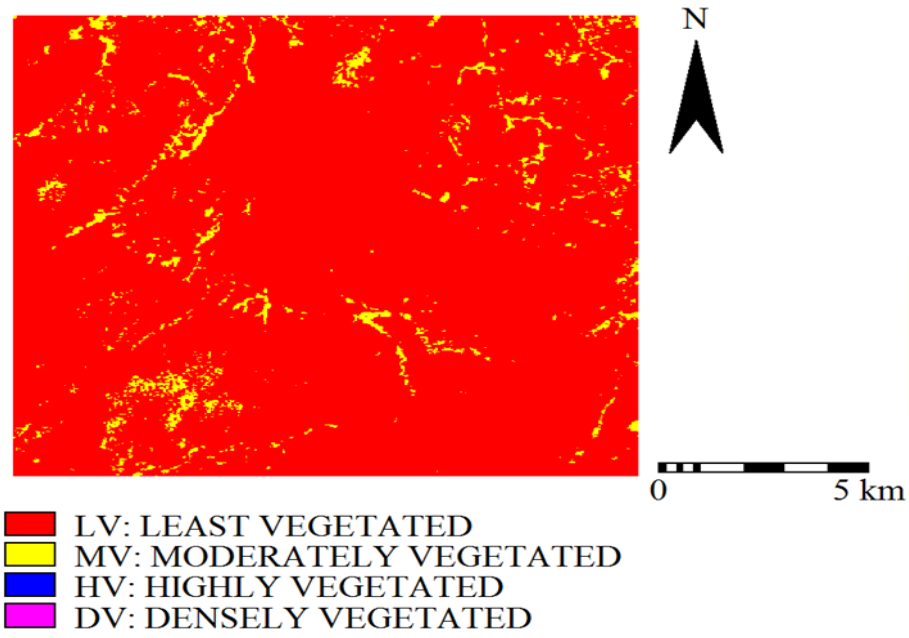

Figure 2: Vegetation productivity classes for the rangeland of Hwange

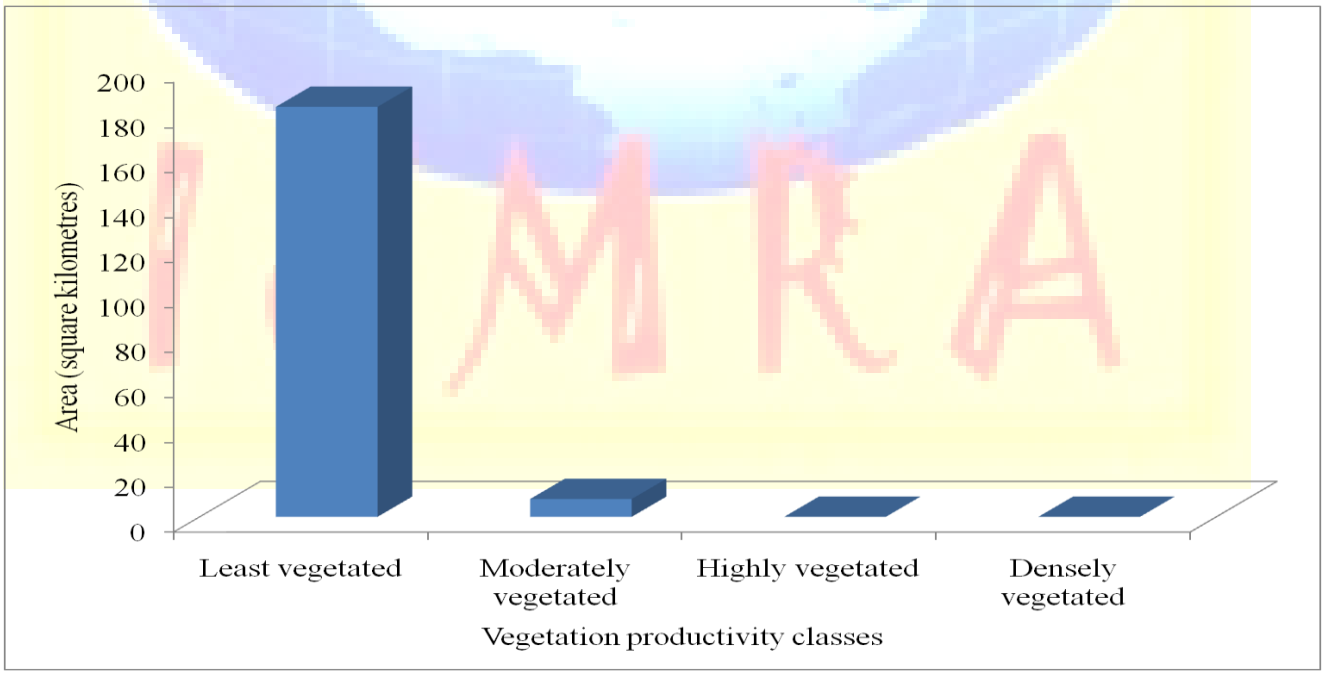

Figure 3: Area under different classes of vegetation productivity for the rangeland of Hwange

Classification of the area of the rangeland into quartiles of wildlife habitat suitability classes

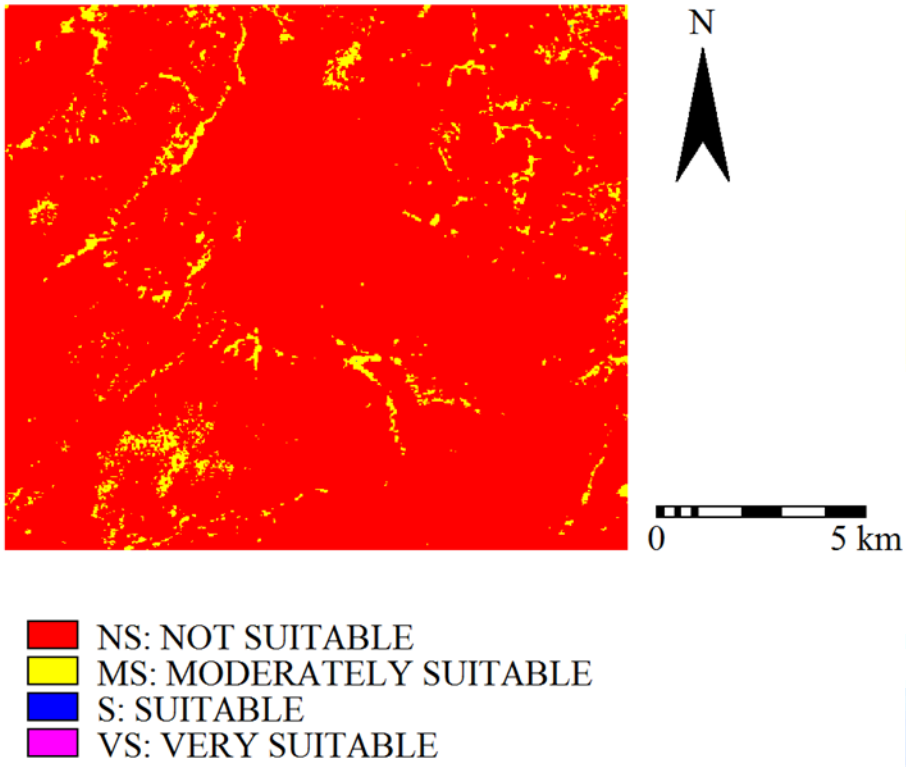

Figure 4: Wildlife habitat suitability classes for the rangeland of Hwange

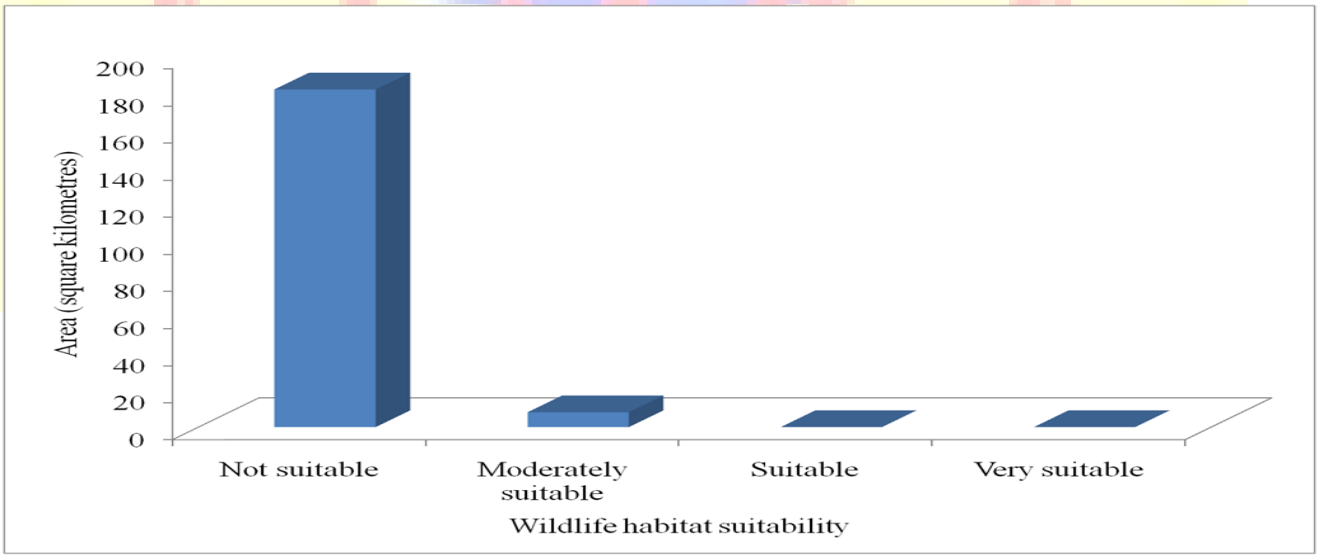

Figure 5: Area under different classes of wildlife habitat suitability for the rangeland of Hwange

Discussion

Results of this study indicated that NDVI can be used to classify the rangeland into different classes of vegetation productivity and habitat suitability.This is not surprising since several authors have used vegetation productivity (NDVI) to measure vegetation productivity and wildlife habitat suitability (Osterheld 1998, Budde 2004, Ramsey 2004, Hobbs 2007, Muella 2008). However, for wildlife managers in Hwange, this study is relevent since it is for the first time that rangeland condition in this area have been assessed using satellite based estimates of vegetation productivity (NDVI).

Conclusion and recommendations

The main objective of this study was to assess the condition of the rangeland using remotely sensed Landsat TM image. It can be concluded that a large percentage area of the range land is not suitable for wildlife habitat as the area has low vegetion cover (NDVI).This becomes a major cause for concern considering the fact that Hwange is the largest wildlife sanctuary in Zimbabwe. Future studies are therefore recommended to find out why there is low vegetation productivity within the area of Hwange.

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