Mapping the current status of vegetation in Nyandeni communal lands using high resolution SPOT imagery

Adolph Nyamugama*, Vhusomuzi Sithole*, Mathabo Dadasi*
* Nelson Mandela Metropolitan University, South Africa

Benefits and purpose of use

The study will seek to map communally-owned forests in the local municipalities of Nyandeni and Port St John's in Eastern Cape. The study will benefit community leaders, Nyandeni local municipality officials and government departments with interest in conservation of natural resources

Introduction

The study is done with idea of making resources maps available to local municipalities and community leadership to promote conservation. This project focuses on mapping vegetation within communal lands as way of an aid to community-initiated conservation programmes. The resulting map was measured for accuracy using the confusion matrix and with an overall accuracy of 0.733. We demonstrated use of SPOT 6 in vegetation resource inventory in communal lands. These maps may be used effectively by local government and community leaders in taking landuse and resource allocation decisions.

Nyandeni Local Municipality is the focus of this study. We selected the 11 wards in the middle portion of Nyandeni Local Municipality (see Fig 1) since they represent transitional zone between three vegetation biomes. According to the vegetation map of South Africa, the study is occupied largely by savannah vegetation and a small portion by Albany thicket biomes (SANBI, 2007). The northern part of the study has a grassland-savanna while the southern end has a savanna-albany thicket transition zones. Nyandeni Local Municipality is in the OR Tambo District, situated in the Eastern Cape of South Africa. Its administrative seat is the town of Libode. The entire municipal area falls within the former Transkei homeland area and has a population of 290 390 (StatisticsSA, 2013)..
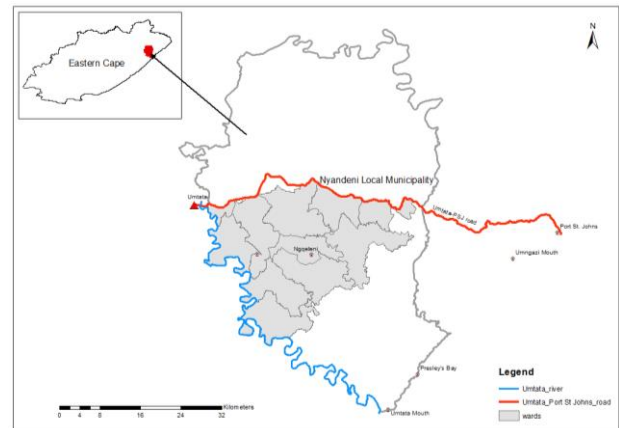

Figure 1: The location of study area in Nyandeni Local Municipality

Problem statement

Changing climatic trends, land degradation and lack of grazing land are some of the negative effects of over utilization of resources. Research in other parts of Eastern Cape have revealed strong relationships between soil erosion and land use changes (Kakembo et al., 2009). The government system allows local resource use decisions are made by local leaders who include chiefs and local municipalities. Both grasslands and forests that occur in communal lands are managed by community leaders via community trusts, chiefs and local municipalities.

Many people rely on savannas for provision of grazing and forests for fuel wood, it is important to determine the extent to which utilization affects woody vegetation resources (Wessels et al., 2011). Communal forests are managed in the country under either Community Forest Management (CFM), State Forest Management (SFM) or Participatory Forest Management (PFM) (Obiri and Lawes, 2002). Benefits of forests to local communities include; firewood, fruits, building materials and traditional medicines.

Biome transition zones are also hypothesised to have higher species diversity compared to neighbouring biomes and their studies are valuable to climate change and biodiversity studies (Gosz, 1992). General causes of forest degradation and fragmentation are activities such as road construction, logging, conversion to agriculture or wildlife and related human and natural land uses (Wade et al., 2003). Biome transition zones therefore need to be monitored to mitigate overexploitation of these species.

Overexploitation of available resources leads to negative effects to people living in these communal lands. The encroachment of woody plant species into the grasslands degrades rangelands quality (Munyati et al., 2011). The decline in forest resources do not only deprive humans of direct benefits but some bird species also decline (Trimble and van Aarde, 2011). Hence local leaders are often faced with the need to protect both grasslands and forests so as to avoid encroachment of shrub land and loss of forests. The extent of available resources is best presented in form of maps. In this study, we seek to map the current status of these forests in Nyandeni local municipalities. We will use SPOT imagery to produce high resolution maps showing the status of communally owned forests.

Timeline

Data collection	May-Sept 2013
Call for proposals	12 August 2013
Proposal submission	23 September 2013
Notice of approval	24 October 2013
Delivery of Images	13 November 2013
Data analysis and write-up	13-20 Nov 2013
Presentation of results	21 November 2013

Technical and scientific approach & methods proposed

In this study we managed to map vegetation within the study area using SPOT 6 imagery which was taken on the 26th of May 2013. We used the multispectral bands of SPOT 6, that is, Blue (0.45-0.52 µm), Green (0.53-0.59 µm), Red (0.625-0.695 µm), Near Infrared (0.76-0.89 µm). We used the vegetation delineation technique that is based on the Normalised Vegetation Index (NDVI) as a measure of vegetation vigour. We started with atmospheric correction (IAR Reflectance technique), then NDVI calculation, classification of NDVI image based on user defined threshold values (see table 2 in Appendix). We then performed accuracy assessment and visualisation. We used data collected for a related project, between May and July 2013, for accuracy assessment.

Results

We have managed to map the vegetation resources within the ten wards of Nyandeni Local Municipality. The map for vegetation resources is shown in Figure 1 below:
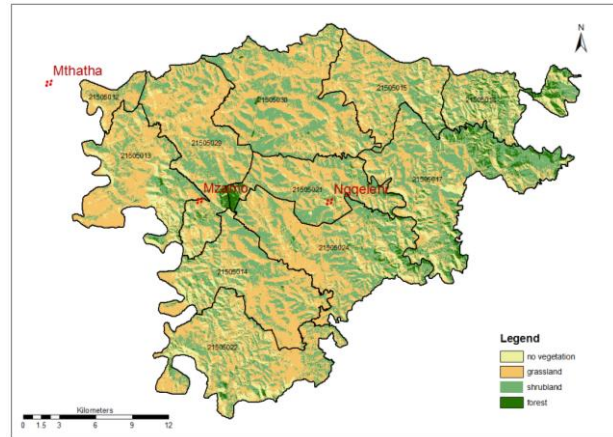

Figure 2: The status of vegetation in ten wards of Nyandeni Local municipality.

All in all the area is covered by grassland (48%) which used for grazing by local communities. The proportions of vegetation resources are shown in the graph below (Figure 2).
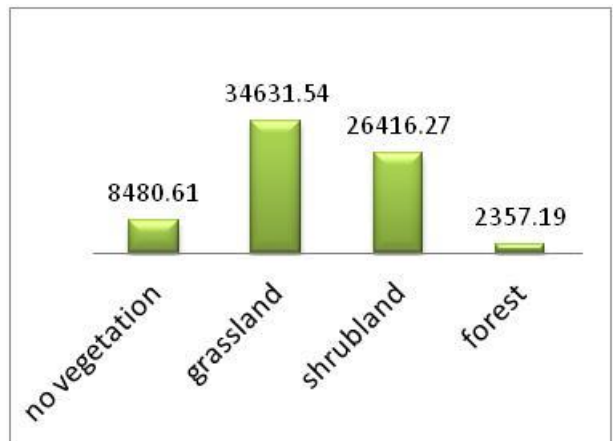

Figure 3: Area covered by different vegetation classes in the Nyandeni study area

According to the error matrix we managed to map the vegetation resources within the study area with an accuracy of 73.33% (see Table 1 in the Appendix section showing the Error Matrix). This indicates that our final map has mapped vegetation 73.33% correctly.

Conclusion

We have demonstrated that high spatial resolution SPOT 6 images can be successfully used to map and communicate the status of resources in communal areas. Indications are that terrain in the caused some misclassification of forests on south-facing slopes. Therefore in areas which are not steep, the method is capable of producing vegetation maps with higher accuracy. Multispectral remote sensing has been successfully used for mapping vegetation before but in this article we explored using high spatial resolution SPOT 6 imagery. The final map is a tool that may be used to support decision making in local communities. With a spatial resolution of 6m, SPOT 6 can be used for mapping and monitoring grasslands, shrub lands and forests in communal lands for use in resource allocation. Issues such as grazing land and building stand allocation can therefore be improved and monitored using SPOT 6 in communal lands. The dynamics of vegetation within biome transition zones can also be monitored using these image products.

Reference

GOSZ, J. R. 1992. Ecological Functions in a Biome Transition Zone: Translating Local Responses to Broad-Scale Dynamics. *In:* HANSEN, A. & CASTRI, F. (eds.) *Landscape Boundaries.* Springer New York.

KAKEMBO, V., XANGA, W. W. & ROWNTREE, K. 2009. Topographic thresholds in gully development on the hillslopes of communal areas in Ngqushwa Local Municipality, Eastern Cape, South Africa. *Geomorphology,* 110.

MUNYATI, C., SHAKER, P. & PHASHA, M. 2011. Using remotely sensed imagery to monitor savanna rangeland deterioration through woody plant proliferation: a case study from communal and biodiversity conservation rangeland sites in Mokopane, South Africa. *Environmental monitoring and assessment,* 176**,** 293-311.

OBIRI, J. & LAWES, M. J. Challenges facing new forest policies in South Africa: Attitudes of forest users toward management of the coastal forests of the Eastern Cape. Natural Forests and Woodlands Symposium, 2002 Port Elizabeth. DWAF.

SANBI. 2007. Biomes of South Africa, Lesotho and Swaziland. Available: http://bgis.sanbi.org/vegmap/biomes.asp.

STATISTICSSA 2013. Nyandeni Local Municipality. *In:* AFRICA, S. S. (ed.). Pretoria.

TRIMBLE, M. & VAN AARDE, R. 2011. Decline of birds in a human modified coastal dune forest landscape in South Africa. *PloS one,* 6.

WADE, T., RIITTERS, K., WICKHAM, J. & JONES, K. 2003. Distribution and Causes of Global Forest Fragmentation.

WESSELS, K. J., MATHIEU, R., ERASMUS, B. F. N., ASNER, G. P., SMIT, I. P. J., VAN AARDT, J. A. N., MAIN, R., FISHER, J., MARAIS, W., KENNEDY-BOWDOIN, T., KNAPP, D. E., EMERSON, R. & JACOBSON, J. 2011. Impact of communal land use and conservation on woody vegetation structure in the Lowveld savannas of South Africa. *Forest Ecology and Management,* 261**,** 19-29.

Appendix

		Ground truth data				
		no vegetation	grassland	shrub land	forest	**Total**
classified map	no vegetation	3	0	0	2	**5**
	grassland	1	10	1	0	**12**
	shrub land	1	1	7	1	**10**
	forest	0	0	1	2	**3**
	Total	5	11	9	5	30

Table 1: Accuracy assessment results.

Classification	NDVI range
No vegetation	-1 to 0
Grassland	0 to 0.25
Shrub land	0.25 to 0.5
Forest	0.5 to 1

Table 2: Classification threshold used