

## Landsat TM image segmentation for delineating geological zone correlated vegetation stratification in the Kruger National Park, South Africa

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### ABSTRACT

Image classification approaches are widely used in mapping vegetation on remotely sensed images. Vegetation assemblages are equivalent to habitats. Whereas sub-pixel classification approaches potentially can produce more realistic, homogenous habitat maps, pixel-based hard classifier approaches often result in non-homogenous habitat zones. This salt-and-pepper habitat mapping is particularly a challenge on images of savannas, given the characteristic patchy texture of scattered trees and grass. Image segmentation techniques offer possibilities for homogenous habitat classification. This study aimed at establishing the extent to which established, field surveyed and geology-related vegetation types in South Africa's Kruger National Park (KNP) can be reproduced using image segmentation. Rain season Landsat TM images were used, selected to coincide with the peak in vegetation productivity, which was deemed the time of year when discrimination between key habitats in KNP is most likely to be successful. The multiresolution segmentation mode in eCognition 5.0 was employed, object classification accomplished using the nearest neighbour (NN) classifier, using object texture and training area mean values in the NN feature space.

Compared to delineations of the vegetation types of KNP on a digital map of the vegetation zones that was tested, image segmentation successfully mapped the zones (overall accuracy 85.3%,  $K^* = 82.7\%$ ) despite slight shifts in the location of vegetation zone boundaries. Maximum likelihood classification (MLC) of the same images was only 37% accurate ( $K^* = 24.2\%$ ). Whereas the vegetation zones resulting from MLC were non-homogenous, with considerable spectral confusion among the vegetation zones, image segmentation produced more homogenous vegetation zones, comparably more useful for conservation management, because realistic and meaningful habitat maps are important in biodiversity conservation as input data upon which to base management decisions. Image segmentation appears to be a useful approach in mapping savanna vegetation.

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### 1. Introduction

Accurate and updated habitat spatial data are a fundamental requirement in conservation management of the varied biodiversity in protected areas (Mehner et al., 2004; Weiers et al., 2004). The spatial technologies of remote sensing and GIS provide possibilities for production, storage and rapid updating of habitat maps (Weiers et al., 2004; Lucas et al., 2007), given the threats to the stability of habitats from human and natural factors (Bock et al., 2005).

Although terrestrial habitats are generally delineated based on vegetation and topography, vegetation types are the equivalent of habitats (Lucas et al., 2007) and can be taken as surrogate indi-

cator of habitat quality in habitat mapping using remotely sensed images. Both vegetation and topography are related to geology, the former through the nutrients in the soil from the parent rock material, and the latter through inherent geological resistance to lithospheric-altering agents of weathering, mass wasting and erosion that create various relief features. Therefore, there is a close relationship between the underlying geology and vegetation as indicator of habitats.

One of the most widely used methods of vegetation type mapping on remotely sensed images is pixel-based image classification (e.g. Ringrose et al., 1988, 2003; Sader et al., 1991; Congalton et al., 2002) using 'hard classifiers' such as the maximum likelihood classifier (MLC) (Lillesand et al., 2008). Pixel-based image classification using hard classifiers assigns a pixel to only one class even when the pixel belongs to two or more classes on the ground, the result of which is that hard classifiers tend to impose distinct habitat

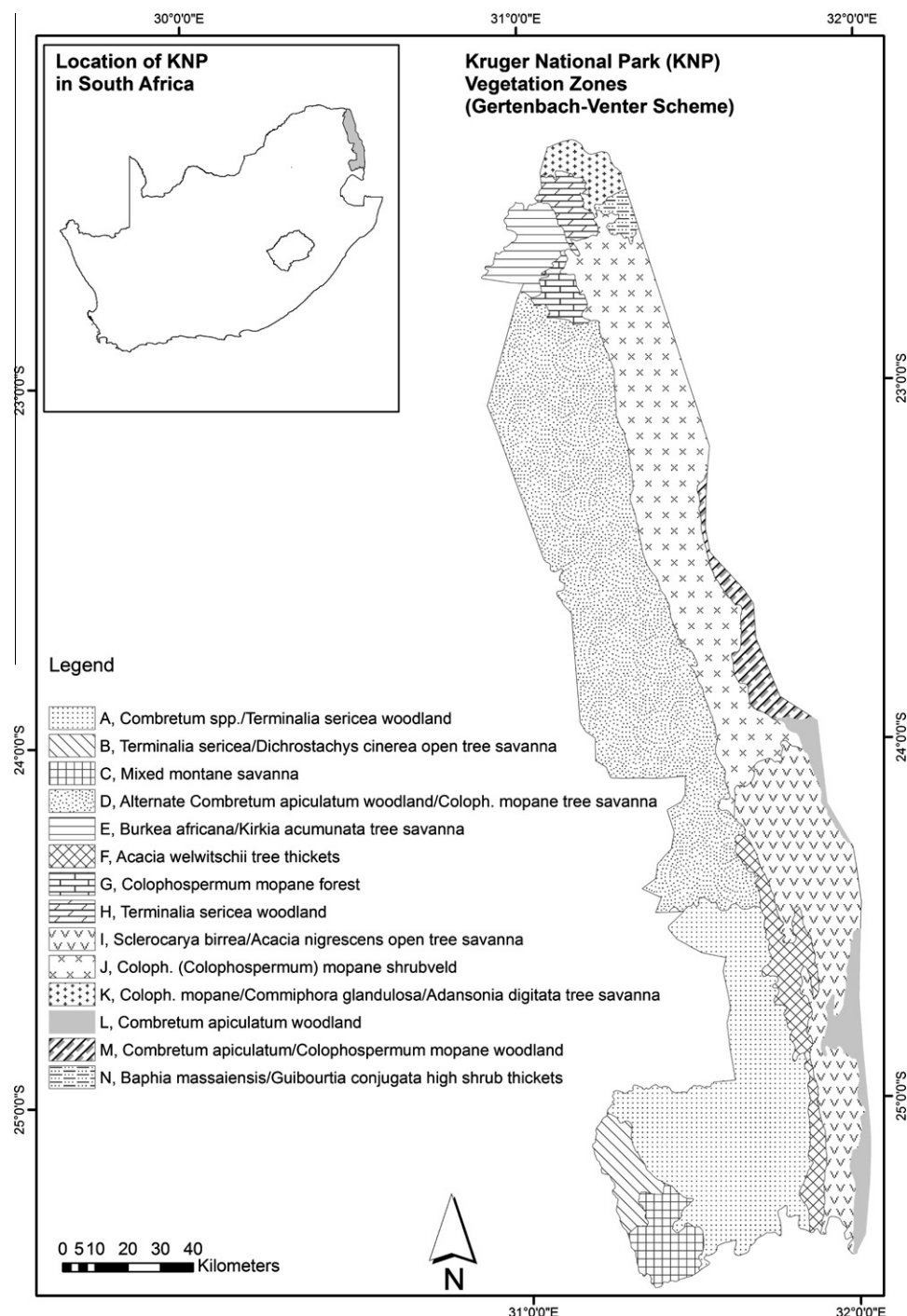
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boundaries when in reality zones of intersection between different vegetation types separate the habitats. A further disadvantage of the traditional hard classifiers approaches is that they result in non-homogenous, 'pixelised' (salt-and-pepper) vegetation cover mapping, as opposed to solid (homogenous) habitat zones (Bock et al., 2005). This salt-and-pepper habitat mapping problem on remotely sensed imagery using hard image classifiers is particularly acute in savannas, given their characteristic mixture of trees and grass. Soft classifier (sub-pixel) approaches such as spectral mixture analysis, on the other hand, produce more realistic habitat maps with the percentage of each class found in each pixel (Meh-

ner et al., 2004). To the tropical ecologist or conservation planner, mapping at the level of reliable ecologically defined classes is valuable (Hill, 1999).

Although also pixel-based, image segmentation overcomes the salt-and-pepper effect in habitat mapping on remotely sensed imagery (Bock et al., 2005; Yu et al., 2006) in that it divides the image into more or less homogenous regions of spatially connected pixels that refer to meaningful objects in the real world (Bock et al., 2005). Various segmentation algorithms have been developed, which rely on edge, region or texture-based methods (Hill, 1999; Laliberte et al., 2004; Bock et al., 2005). A number of studies



**Fig. 1.** Location and vegetation classification of the Kruger National Park. Letters in the legend are the established abbreviated references to each of the respective full class descriptions in Table 1. Legend symbols do not refer to their geologic conventional meanings. Vegetation map source: SANParks, 2008.

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