A SPATIAL MODEL TO DETERMINE THE LOCATION AND EXTENT OF SODIC SITES IN THE SHINGWEDZI AND RIPAPE RIVER CATCHMENTS OF THE KRUGER NATIONAL PARK USING REMOTE SENSING CLASSIFICATION TECHNIQUES AND SATELLITE IMAGERY

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ABSTRACT

Sodic soils are salt-affected soils which are high in sodium in relation to magnesium and calcium. Commonly called sodic sites in the Kruger National Park (KNP), these patches exhibit unique functional characteristics due to the high levels of sodium which cause surface crusting, cracking and the dispersion of clay particles. The aim of this study is to use satellite imagery to map sodic sites in the KNP at different spatial and spectral scales, giving the best option for a repeatable, semi-automated classification. The resultant map of sodic sites for the KNP will be used as a management tool and for future research projects.

A field test for sodicity was necessary to collect sufficient ground truth samples for robust accuracy assessment of the image classification. Sodic soils are identified by measuring EC, pH and SAR which are highly variable within site and between testing methods, and therefore not useful for rapid ground truth classification of sodic soils in the field. The sodium level at which clay particle dispersion takes place varies between soils, but is measurable in the field using the Emerson dispersion test. Laboratory tested sodic soil sites from previous research re-tested in this study showed positive results for dispersion of clay particles in water. The physical properties of sodic sites described in the literature and observed in the field were applied to classify sodic sites in the KNP in the field using a decision tree, together with results from the dispersion test and the observed presence of the grass species *Sporobolus iocladus*.

Landsat 7 and SPOT 5 imagery cover the whole park, with ASTER, CAO hyperspectral, LiDAR and black and white orthophotos available for selected areas. The topography elements of crest and footslope were derived from the STRM 90m digital elevation model (DEM). Image preprocessing to top of atmosphere reflectance was performed where necessary and visual

enhancement techniques and transformations were applied to derive the normalised difference vegetation index (NDVI) and other indices. Spectral signatures were checked against spectral signature libraries, and the class separation was tested using the cluster analysis of spectral signatures. MODIS NDVI averages placed the imagery in phenological context.

Object-based image analysis using eCognition was applied to classify the sodic sites of the Shingwedzi and Ripape River catchments. The input imagery was segmented into ecologically meaningful patches and classification accuracy was assessed using the field samples collected using the decision tree to identify four classes: sodic sites (bare and woody), river sand, riverine vegetation and savanna areas. Comparison of the accuracy assessments for the Shingwedzi study site showed that the Landsat 7 and SPOT 5 classification algorithms gave an overall kappa index accuracy of 89% and 78% respectively, and a sodic site kappa index of 90% and 89%. Validation results using the ground truth samples gave an overall kappa index accuracy of 61% for Landsat 7 and 52% for SPOT 5, with a sodic site kappa index of 49% and 39% respectively. The classification algorithms were applied to the Ripape study site for Landsat 7 and SPOT 5 with repeatable results for the SPOT 5 imagery of 88% overall kappa index and 81-93% kappa index for sodic sites using similar seasonal imagery in the wet to early dry season. The Landsat 7 classification algorithm was applied to the entire KNP based on the repeatability results of 56% overall kappa index and 60% sodic site kappa index for the Ripape site. The quest for a repeatable algorithm to classify sodic sites from satellite imagery has been met by the SPOT 5 imagery using scenes acquired at similar seasonal stages. The late wet season or early dry season imagery was used to apply the classification algorithm with the best success. Changes in size or shape of sodic sites over time requires very high resolution imagery and further studies to understand where the edge of sodic sites are detected from imagery, and how the phenology of the vegetation growing on these sites affects detecting any change in size of the sodic site.