Influential ecological factors to be considered when mapping grass biochemical concentration in an African savanna system.

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The current multi-spectral satellites available have thus far been found wanting when it comes to mapping of biochemical concentrations. The bands available appear to be too broad and not in the ideal regions of the spectrum to be able to detect fluctuations in biochemical concentrations. Hyperspectral imagery offers the potential, and has been shown to be capable, of detecting the fluctuations observed in the nutrient concentrations across a savanna system (Mutanga & Skidmore 2004; Mutanga *et al* 2004; Ferwerda *et al* 2005;Ferwerda *et al* 2006; Mutanga & Kumar 2007). Currently the available hyperspectral satellites have proved unsuitable for pursuing continuous monitoring because of their problems with atmospheric corrections and several other image correction issues. Thus the use of airborne hyperspectral imagery is the only potential way of monitoring biochemical fluctuations, however that would come at prohibitive costs, particularly if one wanted to study seasonal fluctuations across a large area. Thus large scale repeated monitoring of biochemical fluctuations, which could be used to study nutrient fluxes, ecosystem processes (including wildlife movement) have not been possible. In this study we have taken into account the fact that one might have to use imagery that is not current and have studied the ecological factors linked to fluctuations in nutrients to determine if older imagery could potentially be used to monitor fluctuations across a broader landscape. If hyperspectral models can be adjusted to take into account fluctuations observed in relevant ecological factors (that can be more accessibly and regularly mapped) then the possibility of using older hyperspectral imagery can be investigated.

Within the Northern Plains area of the Kruger National Park (KNP) a temporal study has been made to investigate nutrient fluctuations within the system. Repeated measurements of plots have been made during different years and capturing two different phenological stages of the vegetation. Field studies involved collecting of spectra, and grass samples which were later analysed for their nutrient contents. These field sessions took place in winter 2003, summer and winter 2007 and 2008. During the winter of 2003 only nitrogen and phosphorous were analysed, this was extended to include fibre and lignin in the 2007 and 2008 field sessions. Using environmental data obtained from the KNP GIS and RS centre, and including some further data created from ASTER imagery we investigated which environmental factors are important to explaining fluctuations in the nutrient concentrations. We investigated temporal changes in terms of changes between years (but constant season), and seasonal changes within the same year.

Our findings highlight that certain environmental factors are of greater significance in explaining nutrient levels. Geological effects are of importance, but the effect of the geology is more pronounced during summer season than winter. A comprehensive soil map though was found to be useful in all seasons to explain differences. These were important in explaining nutrient contents in general, but when looking at temporal effects and fluctuations in nutrient levels it is evident that an up to date species map is essential. Grasses, in comparison to trees are susceptible to management practices and in this area this includes fire management, these practices influence the species composition of grasses. Different species also fluctuate in their nutrient contents, thus it cannot be assumed that any single variable can be used to explain changes in nutrient levels, but by including a recent species map in conjunction with ecological data you would come a far way in being able to monitor nutrients over time without up to date hyperspectral imagery.

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