INTEGRATING STREAM NETWORKS AND LANDSCAPE MOSAICS IN A NEW CONCEPTUALISATION OF SAVANNA LANDSCAPES

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ABSTRACT

Landscapes are highly organised, with recurring patterns of co-varying and interacting biotic and abiotic ecosystem components. Although there is a rising demand for landscape classifications and maps that describe these patterns, emerging conceptualisations of ecosystems as complex, open and inherently uncertain question the existence of geographically definable ecological regions. It is now well recognised that perceptions of ecological patterns are highly subjective, changing with the scale of observation and the particular combination of environmental attributes that are emphasised. Hence many different valid descriptions (and hence maps) of the same ecosystem are possible, each relating to different perspectives and issues.

This thesis aims to develop a conceptualization of the biophysical interactions that fashion the character and behaviour of water-dependent ecosystems in savanna landscapes that can be used to underpin land classifications and maps for transdisciplinary enquiry and the management and allocation of natural resources. Recent analytical approaches in geomorphology, hydrology, soil science and biogeography are synthesised in a heuristic landscape hierarchy that frames hillslopes within the context of a stream network that varies between different geological and climatic settings. Savanna landscapes offer excellent opportunities to develop this new approach, since many hydrological, geomorphic and biotic processes are tightly coupled around the limited availability of water. Thus many biotic and abiotic variables are spatially clustered, forming a biophysical template that constrains the character and behaviour of a wide range of organisms and processes. Maps of these clusters can therefore provide a platform for integrating a similarly wide range of scientific and managerial perspectives.

The credibility and relevance of the conceptualisation is assessed through its application to a land classification in Kruger National Park (KNP), South Africa. The approach is iterative and reflective, endeavouring to reconcile the impossibility of using traditional reductionist approaches to describe complex systems with the need for reductionist generalisations to describe and analyse complex systems. Assumptions and decisions form a narrative that expressly acknowledges the inclusion of normative values and subjective judgements in conceptualisations of complex systems.

Implementation is based around the use of generalised archetypes to navigate between general principles and particular instances and also between conceptualisations and their representation in a map. Rather than using standardised, pre-determined scales and attributes, archetype development is based on the extensive research that exists for KNP, together with observation and analyses that give the landscape a ‘voice’, using concepts such as hillslope catenas and topographic grain. Analytical lenses are reframed to reveal differences as well as similarities, recognising that not all instances of a class are equally similar to the class archetype, so that some locations may conform more than others to the anticipated class character and behaviour.

At regional scales, physiographic zones are characterised by particular geology, patterns of landscape dissection and catchments that contain certain repeating toposequences of catenal elements. Differences in topographic grain have substantial implications for the construction of ecological maps, since the optimum scales of observation for the same level of the landscape hierarchy differ between landscapes. The associated differences in catchment size, hillslope length and stream density also have profound impacts on the nature and scale of many ecological processes, such that differentiation between physiographic zones is vital for good science, modelling and management.

Two study sites were mapped at catchment and hillslope scales, serving to contrast landscape structures in the finely dissected granites and the coarsely dissected basalts. At both catchment and hillslope scales, the basalt site conformed well to the *a priori* archetype that described a vegetation toposequence. However, only about half the area of the granite study corresponded to the archetype. Many of these mismatches did not show any difference in vegetation between midslopes and crests, suggesting they lack the contrasting clay/sandy soils that are typical of catenas in this area. It was therefore concluded that these subcatchments are likely to be generated and sustained by a different suite of processes to those described by the archetype and may therefore warrant the development of new archetypes. These findings illustrate how the explicit mapping of catenal elements allows the variability within an area to be assessed, identifying anomalous areas and hillslopes that are likely to behave differently to the hillslopes that conform more precisely to archetypal conceptual models. Understanding the nature and extent of such variations will improve the performance of broad-scale extrapolations and models based on the behaviour of idealised archetypes.

Ultimately, end users will determine whether or not the conceptualisation of savanna landscapes developed in this thesis is capable of rising to the challenges posed by the complexity and heterogeneity of ecological systems in KNP (and elsewhere). Initial indications are positive, given the early uptake of the approach both by the South African Water Research Commission and South African National Parks (SANParks).