EXECUTIVE SUMMARY

The intertwined landscape patterns of water, soil, vegetation and topography are not easy to disentangle, since they occur across many scales and are influenced by the local characteristics of each factor as well as by the climate, geology and relief of the setting in which they occur. However, despite this landscape complexity, in semi-arid environments the distributions of vegetation and soils are often spatially aligned and occur in patterns that are both cause and consequence of topographically controlled water fluxes.

Although the coupling of soils, vegetation, hydrology and topography has long been recognised and forms the basis for the mapping of both soils and ecological regions, there is no standardised approach to such tasks. Indeed, many of these efforts struggle to find appropriate scales and variables to describe landscape patterns and the processes that give rise to them. The framework presented in this report aims to resolve these issues by introducing a hierarchical approach that facilitates the synthesis of knowledge across many disciplines.

The framework is based on an integration of aquatic and terrestrial perspectives, viewing a drainage network as composed of both hillslopes and channels that are intimately connected. Four principles underpin the framework (Figure E1.1). In semi-arid landscapes many geomorphological and ecological processes are tightly coupled to the spatial and temporal distribution of water at various scales. This coupling results in the formation of patches with characteristic water budgets, soils and vegetation. Topography is an important control on the distribution of water and hence on the distribution of landscape patches. Topography is not random, but is highly organised in space, with the hillslopes and channels that makeup a drainage network forming patterns of landscape dissection that vary systematically between different geological and climatic settings.

Based on these principles, we have developed a landscape hierarchy that focuses on spatial and temporal scales relevant to conservation management (10^{1}-10^{3} km^{2} and seasons to decades). *Physiographic zones* are with similar geology and patterns of landscape dissection. Each physiographic zone is characterised by *catchments* with hillslope and channel morphology that form repeating patterns throughout the zone. Repeating patterns are also seen in the assemblages of *catenal elements* that occur within catchments. Catenal elements are associated with particular hillslope positions and each has distinct soils, vegetation and water budgets. Both terrestrial landforms, such as crests or toeslopes and fluvial features, such as banks, channels or islands can be described as catenal elements.

We illustrate an approach to landscape classification based on our conceptual framework by delineating physiographic zones within Kruger National Park in terms of catchment morphology and by mapping catenal elements in two contrasting study areas: the N'waswitshaka site covers a fourth order catchment on the southern granites, whilst the Lower Sabie site, situated on the southern basalts, covers most of a third order catchment drained by the Nhlowa river.

These classifications demonstrate how our framework addresses landscape complexity that involves multiple feedbacks within and across scales. Recognising that the processes responsible for generating and sustaining landscape patterns operate at different scales and involve different controls in different contexts, the framework allows for the use of different suites of variables and scales of analysis to describe hierarchical elements in different settings. The choice of scales appropriate to each organisational level is informed by our hierarchy, being largely driven by the intrinsic scales associated with catchment morphology in each physiographic zone
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The classification does not consist merely of statistical constructs, but is purposefully designed within the context of the framework to relate to the processes that generate and sustain the observed patterns. In other words, the classification is based on forms that the framework suggests are reliable indicators of process, such that areas that are grouped into a particular class can be expected to respond in similar ways to a wide range of events, be they natural disturbances, climate change or scientific manipulations. This means that the classification can be used to stratify samples for ecological, hydrological or management experiments or modelling.

Accuracy assessment of the classifications have not been undertaken to establish the degree to which classes have been accurately assigned compared to an expert assessment of reality. Instead,

we suggest that the emphasis should be on testing the applicability of the classification scheme itself and its adoption by end users. Ultimately, the validity of our approach can only be demonstrated through its practical application in science and management, proving its usefulness and relevance to various communities of users.

Spatially explicit landscape classification lies at the very heart of both systematic conservation planning and strategic adaptive management. Both activities aim to conserve the heterogeneity of ecological patterns and processes that generate and sustain the compositional, structural and functional dimensions of biodiversity. In order to achieve this objective, spatially explicit landscape classifications are needed that describe ecological patterns and processes at multiple scales. Currently, many different approaches are used to assess spatial biodiversity, reflecting the large variety of ecosystem patterns and processes that can be considered, the multiplicity of datasets available and the fact that the terrestrial, river, estuarine and marine components of biodiversity are assessed separately, by different groups of experts. We suggest that our approach to landscape classification could offer a way of integrating many of these perspectives, at least in water controlled ecosystems such as KNP, where the spatial and temporal distribution of water generates and sustains a multitude of ecological patterns and processes.

The approach to landscape classification developed in this project has great potential application, not only for informing conservation management and planning, but also in providing a framework for organising the repository of knowledge that underpins successful strategic adaptive management. The framework provides a consistent frame of reference for gathering and communicating information on ecological structure, function and dynamics that can be used for scenario building, envisioning the different risks, threats, vulnerabilities and responses of landscapes in different settings and at scales appropriate to the organisational levels of the hierarchy. Furthermore, the holistic standpoint of this classification facilitates the coupling of terrestrial and aquatic systems, offering a framework that can be used and contributed to by scientists and managers from a wide range of perspectives.