

Creating a conceptual hydrological soil response map for the Stevenson Hamilton Research Supersite, Kruger National Park, South Africa

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ABSTRACT

The soil water regime is a defining ecosystem service, directly influencing vegetation and animal distribution. Therefore the understanding of hydrological processes is a vital building block in managing natural ecosystems. Soils contain morphological indicators of the water flow paths and rates in the soil profile, which are expressed as 'conceptual hydrological soil responses' (CHSR's). CHSR's can greatly aid in the understanding of hydrology within a landscape and catchment. Therefore a soil map could improve hydrological assessments by providing both the position and area of CHSR's. Conventional soil mapping is a tedious process, which limits the application of soil maps in hydrological studies. The use of a digital soil mapping (DSM) approach to soil mapping can speed up the mapping process and thereby extend soil map use in the field of hydrology. This research uses an expert-knowledge DSM approach to create a soil map for Stevenson Hamilton Research Supersite within the Kruger National Park, South Africa. One hundred and thirteen soil observations were made in the 4 001 ha area. Fifty-four of these observations were pre-determined by smart sampling and conditioned Latin hypercube sampling. These observations were used to determine soil distribution rules, from which the soil map was created in SoLIM. The map was validated by the remaining 59 observations. The soil map achieved an overall accuracy of 73%. The soil map units were converted to conceptual hydrological soil response units (CHSRUs), providing the size and position of the CHSRUs. Such input could potentially be used in hydrological modelling of the site.

Keywords: Digital soil mapping, terrain analysis, ecosystem services, conceptual hydrological soil responses, SoLIM

INTRODUCTION

Water is probably the defining element in all natural ecosystems. Hydrological processes determine the amount, seasonality and location of water, therefore rendering ecological system services, by directly influencing soils, wetlands and rivers controlling vegetation and animal distribution. The importance of a clear understanding of the hydrological processes in the management of water resources is augmented in the highly variable hydrological environment of southern Africa (Wenninger et al., 2008). The identification, definition and quantification of the flowpaths and residence times of the different components of flow are central to the understanding of hydrological processes. There exists an interactive relationship between soil and hydrology. As soil formation is influenced by climate, vegetation/land use, topography, parent material and time (Jenny, 1941), soil properties incorporate the influence of these factors in hydrologic flow paths. Therefore soil can be a first-order control in partitioning hydrological flow paths, residence times and distributions and water storage (Soulsby et al., 2006). Thus soil properties contain unique signatures of the hydrological regime under which they formed. Concepts developed about the soil water regime by field observations and quantification (Van Tol et al., 2011) make it possible to predict the conceptual response of different soil forms (Ticehurst et al., 2007; Van Tol et al., 2010; Kuenene et al., 2011). A soil map can

be the basis to provide both the size and position of conceptual hydrological soil responses (CHSR's). This information could potentially improve hydrological parameterisation for predictions in ungauged basins.

Unfortunately, conventional methods of soil mapping are time consuming and expensive, limiting the application thereof in hydrology. However, based on the rapid improvement in information technology, remote sensing, digital elevation models (DEM's), pedometrics and geostatistics, digital soil mapping (DSM) methods are available which reduce the cost and time needed for soil surveying (Hensley et al., 2007). In South Africa, such methods have rarely been applied, and there remains a large scope for DSM research in local geographical settings and application to local needs.

In the Kruger National Park the so-called 'Supersites' project (Smit et al., 2013) has been launched to combine the research done in many disciplines within the Park on specific representative sites. Four sites were chosen to represent the main climatic and ecological regions within the Park. This project is part of a baseline study on the hydrology of the Stevenson Hamilton Research Supersite. This paper explains how a DSM exercise was done to create a CHSRU map for the Supersite. The hypothesis expressed is that DSM could provide the input to determine the position and area of the CHSRs, creating conceptual hydrological soil response units (CHSRUs) cost effectively and within acceptable time limits.

SITE DESCRIPTION

The study site is the 4 001 ha Stevenson Hamilton Research Supersite, approximately 7 km south of Skukuza in the Kruger

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