# THE MAPPING AND MODELLING OF SOIL PATTERNS BY APPLYING SPATIAL DATA INTEGRATION TECHNIQUES ON VARIOUS RASTER LAYERS

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## 1. INTRODUCTION

South Africa is fortunate in having a national soil database in the form of land types. Land types are delineated areas, at a 1:250 000 scale such that each land type displays a marked degree of uniformity with regard to terrain form, soil pattern and climate [1]. Each 1:250 000 map sheet is accompanied by a memoir describing the soil patterns per land type on a probability basis. The percentage distribution of various soil attributes is linked to the following terrain units: Crests, scarps, midslopes, footslopes and valley bottoms.

There are limitations in the available national soil coverage. These are primarily the reconnaissance level of the data and the fact that the soil components are defined, but not individually mapped. There is a wealth of information on soils available in the memoirs, but unfortunately it requires extensive alphanumeric database modelling to translate land types to various user requirements in terms of soil potential. Furthermore the spatial output layers can be a product of averaging of certain critical soil attributes for relatively large areas [2]. Conventional semi-detailed and detailed soil surveys, as a means of supplying baseline and planning information, are time consuming and expensive and often land type information must be relied on in the absence of more detailed spatial information.

## 2. OBJECTIVE

The objective of this study was to create independently from the land type maps spatial raster layers representing soil attributes usable at a 1:50 000 – 1:100 000 scale. These raster layers must have short standardized legends to facilitate easy data manipulation in a multi-layer decision support environment.

## 3. STUDY AREAS

Soil attributes and associated layers were created for three priority tertiary catchments in South Africa targeted by the national soil degradation protection strategy namely T35 in the Eastern Cape, V32 in KwaZulu-Natal and B51 in Limpopo Province.

## 4. METHODS

The soil modelling process relied on a combination of relationships derived from statistical analysis of soil observation sites and various spatial data layers (e.g. geology, terrain units, elevation, slope, topsoil colour and rock outcrops) and expert knowledge of soil and landscape relationships. These two aspects were used to optimize the spatial modelling and data integration processes. In addition to this, the methodology is based on the following conditions and assumptions:

Terrain units as defined by the Land Types Survey [1] were created from Shuttle Radar Topography Mission (SRTM) - data [3]. Slope classes were also derived from the SRTM data. Soil colour was mapped from Landsat images and correlated with soil colour from field data. Vector geology data was reclassified according to clay formation potential and rasterised.

8925 Field observations over the three catchments were digitized from the 1:50 000 field sheets of primarily the Land Type Survey [1]. In addition to this Field Observation Database (FOD), approximately 500 laboratory analysed sites per catchment were extracted from the Soil Profile Information System (SPIS) at the ARC - Institute for Soil Climate and Water. The FOD database was used to establish relationships between soil attributes and various spatial data layers (e.g. soil colour, terrain units, slope and geology). These relationships were used to establish scripting rules for integrating the various layers. The end products were soil associations, soil depth and clay content. In addition to this certain soil fertility information layers were created from the SPIS database. Unlike soil association, depth and clay content these layers were derived directly from interpolation of point data. The results of the point interpolation were then adjusted to the class boundaries on the soil association layer.

## 5. RESULTS AND DISCUSSION

Soil associations, soil depth and clay content layers were created from vertical data integration techniques, while various soil fertility layers were created from horizontal point interpolation. A visual comparison between the soil associations, soil depth, clay content layers and land types showed that in general these products correlate well on a broad scale level with land types. The spatial detail on more detailed scales, however, was significantly enhanced.

The products were intended to be used in a Multilayer Decision Support System (MDSS) and differ from the spatial detail of land types such that attributes were now separate spatial data layers. This spatial un-mixing (of attributes) made it conceptually easier to use the data in a MDSS than land type data where probability analysis tables were created and are used together with legend information to evaluate the products before they are used in a MDSS.

To create these products a combination of direct mapping and modelling was necessary. The methodology relied on the assumptions that (1) soil patterns are not random in the landscape and (2) terrain features can be accurately mapped. Direct mapping of certain soil features from multi-spectral satellite imagery was possible and reduced the dependency to model all soil attributes [4]. Probability/accuracy statements are essential to quantify the certainty/uncertainty of the end products.

It is envisaged that these techniques will also be applicable for broad level products in countries that do not have land type (or equivalent) maps. On a detailed scale it should be possible to produce sampling frames reducing the number of sampling sites needed conventionally. It should also assist in the automated creation of certain soil related boundaries. However, at a detailed level a significant amount of detailed image interpretation and field sampling is necessary but the overall time and cost should be less than with traditional survey techniques.

## 6. REFERENCES

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