The influence of the soil formation factors on the mapping of salt-affected soils on a national scale in South Africa

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INTRODUCTION

A wide variety of mapping and measurement techniques are available to map salt-affected soils. These technologies are derived from the disciplines of soil science, hydrology, geology, geomorphology, geophysics and remote sensing. The optimum strategy for mapping salt-affected soil depends on the scale and resources available. The purpose of this study was to determine the baseline salinity, sodicity, and alkalinity conditions for South African soils. The research objectives were as follow: (i) To describe and quantify the primary salinity, primary sodicity and primary alkalinity status on a national scale in terms of the major geological formations, rainfall, evaporation, aridity zones, elevation and slope (ii) To prepare a saline sodic soil map at a scale of 1:1 000 000 for South Africa. (iii) To develop an algorithm to quantify salt-affected soils

METHODOLOGY

TOf the original more than 40 000 soil data points, only 22 404 data points were used due to the stringent cleaning protocol. To compile the 1:1 000 000 scale primary salt-affected soil map of South Africa, the following maps were used: 1:1 000 000 scale topographical map as base map, 1:1 000 000 scale geological map;, electronic inverse distance pH, ESP and EC maps on a 1:1 000 000 scale maps. For each soil observation point the climate parameters rainfall, aridity and evaporation; geological formations; and topographic parameters were calculated.

RESULTS

Primary salt-affected soils do not occur extensively in South Africa. The majority of salt-affected soils occur west of longitude 26° in areas that can be considered mainly, although not entirely, as arid or hyper-arid. Nearly 60% of the soils are non-saline, 23% slightly saline, 5.1% saline, 1.4% moderately saline, 0.4% strongly saline, 3.8% saline-sodic (non-alkaline), 6.3% saline-sodic (alkaline), and only 0.4% can be considered as sodic. Geological material is an important soil formation factor, but for salt-affected soils its effect is probably overshadowed in many areas by rainfall and position in the landscape. There is a tendency that some of the most sodic and alkaline soils develop from geological units rich in granite and gneiss. Sodic soils developed on geological units with a marine depositional environment characterised by mudstone, siltstone, and shale. There is a decrease in salinity and sodicity, from the lowest annual rainfall class to the highest annual rainfall class; an increase in salinity and sodicity from the lowest annual evaporation class to the highest annual evaporation class; and a drastic decrease in salinity and sodicity from the hyper-arid to the humid aridity zones. There is an increase on a national scale in EC, ESP and pHwater from the highest elevation class to the lowest elevation class.

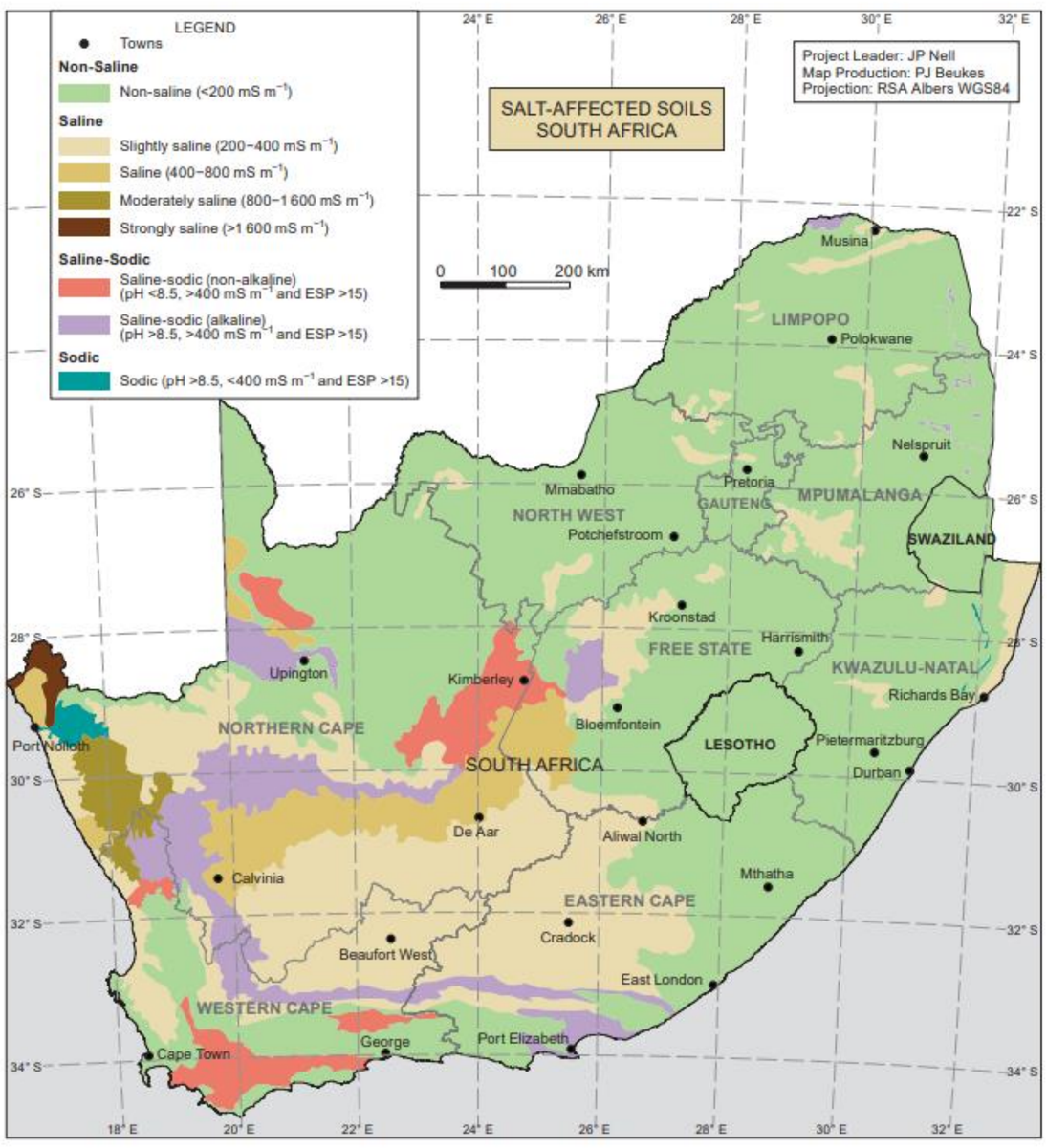

Figure 1: Areas calculated to be affected by primary soil salinity, sodicity and alkalinity. ESP = exchangeable sodium percentage

CONCLUSIONS

Saline and sodic soils in South Africa mostly occur only in relatively small areas due to localised factors, making the mapping on a national scale problematic. The relative area affected by primary salt-affected soils in South African is much more favourable, compared to other countries. The main reason for this condition is probably the fact that South African soils are mostly derived from geological material that is Ca dominant and not Na dominant. Regression relationships for EC, ESP, and pHwater versus rainfall, evaporation, aridity index, elevation and slope show weak linear correlations on a national scale.

All of the five natural soil-forming factors affect and are affected by water. The flux factors of soil formation (vegetation and climate) as well as the site factors (parent materials and topography) can be linked to landscape hydrology, which is further modified by the internal soil hydrological environment. Soil-forming processes such as transformation, translocation, additions and deletions that have a strong influence on the development of salt-affected soils, or the lack thereof, are all influenced by water to a significant degree.

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