SOILS OF KWAZULU-NATAL AND MPUMALANGA: RECOGNITION OF NATURAL SOIL BODIES

by

DAVID PETER TURNER

Thesis submitted in partial fulfilment of the requirements of the degree of Doctor of Philosophy: Soil Science

Department of Plant Production and Soil Science

Faculty of Natural, Agricultural and Information Sciences

University of Pretoria

Promoter: Professor MC Laker

Pretoria

April 2000

CONTENTS

SOILS OF KWAZULU-NATAL AND MPUMALANGA: RECOGNITION OF NATURAL SOIL BODIES

by

DAVID PETER TURNER

Promoter: Professor MC Laker
Department: Plant Production and Soil Science
Degree: Ph.D. (Soil Science)

ABSTRACT

"Natural soil bodies can be identified with limited ranges of variation in soil properties and in the extent of their locations"

This hypothesis statement is central to the document. The information which follows sets out the extent to which this statement is true. It strives to do this in two main respects. The first is to document the soil forms that are regularly encountered in association with each of the major geology formations in KwaZulu-Natal and Mpumalanga. The second is to record the range of variation sampled from the length and breadth of these provinces. Each in its own right represents a statement of the natural soil bodies encountered from numerous observations and samples collected by soil scientists over the last thirty years. This document draws together these soil bodies, and it is hoped, provides new insights into the soils of KwaZulu-Natal and Mpumalanga and their properties.

The history of the soil series class, and their inclusion within the soil classification systems of the United States of America, South Africa and elsewhere are reviewed. The accent over the years placed on the soil series and its role within the scope of soil classification systems of their day reflects the changing emphasis and concepts of the soil series. Important in this regard are the recognition of soils as natural entities, initially with much emphasis placed on their morphological properties. Later the concepts as natural soil bodies, and of the soil series classes within classification systems held prominence. Increasingly emphasis is being placed on soil property values, and the distribution of these values over the landscape. Statistical manipulation of soil information within the framework of the electronic information systems places another emphasis on soil information. Each of these concepts and tools has brought understanding to our

knowledge of soils and of their distribution.

The study has collected the soil profile information from 4 000 sites over the provinces of KwaZulu-Natal and Mpumalanga. Each profile has been linked to a geographic co-ordinate, an underlying geological formation, and entered into computerised databases. After linking and verifying the information it was available for study and analysis. Soil textural information was extracted from the database for each soil form and for each geological formation. The hypothesis that natural soil bodies could be identified rests on the premise that geology formations could effectively be used as tools for separating soil bodies. Extensive use is made of the soil textural triangle and visual interpretation where actual soil profile data is plotted. The results of these separations are quoted in the text, in tables and in figures reported in chapters devoted to each of the major geological formations of KwaZulu-Natal and Mpumalanga. The text place emphasis on numerical soil values such that the central value can be comprehended and possible ranges in variation progressively visualised and determined. This information is reported for the soil textural properties, although the process could be repeated for other soil attribute values as well. For certain of the well sampled and studied soils the range of variation and central value can be clearly illustrated and comprehended. Other soils have been sampled only infrequently such that estimates of soil textural properties only can be gained. For many of the soils illustrated in this document the extent of available data lies between these two extremes.

In placing emphasis on numerical soil texture values the central role played by the soil form as an expression of natural soil bodies should not be overlooked. To this end the soil forms commonly encountered overlying a given geology formation are documented. These soil forms are condensed into Broad Soil Patterns based on the observations and views of soil survey specialists involved in the Natural Resources Survey of South Africa. They have been summarised from the extensive soil inventory database of this survey. Generalised climate information of the Broad Soil Patterns is included to give this perspective to the natural soil bodies.

A summary of the soils and their textural properties in KwaZulu-Natal and Mpumalanga is also presented as an independent chapter. Here the soil forms, and hence the natural soil bodies, associated with each geology formation are reported. Generalised sketches illustrating the range in soil textural properties from red apedal soils, through plinthic soils and duplex soils to red and black clay soils are presented. The information reported in each of these summary sketches is recorded in detail in the chapter dealing with that particular geology formation.

In conclusion it has been possible to show that natural soil bodies can be recognised on the basis of soil form classification and within a given geology formation. Much visual and analytical evidence is available to support this statement. In some soils the range in textural properties is limited with profile values clustering closely around a central value. Their definition into soil series classes with clear and limited boundaries could be considered. In other instances the range of soil textural properties, while exhibiting clearly defined boundaries, is much larger than we have chosen to expect within our formerly defined soil series classes. Some modification to our concepts of natural soil series, or some acceptance of arbitrary defined boundary limits should be considered. In still further instances, more than one natural body with respect to texture is

illustrated. Additional criteria and sampling are often required to clearly define these soils into proposed soil series classes. Improvement in the understanding of the ranges in property values of soil series remains an important tool in developing our knowledge of soil. The electronic analysis of soil information is progressing together with the development of soil series and soil classification information. The construction of electronic information systems should be seen as an important complement to the information gained through the concepts of the soil series and soil classification. The information presented here strives to reinforce this complementary nature of natural soil bodies with the developing electronic information systems. Finally, some thoughts on the process of defining natural soil bodies, of collecting, administering and disseminating this information are considered.

ACKNOWLEDGEMENTS

Professor MC Laker, Department of Plant Production and Soil Science for his encouragement and advice during the course of the project.

Dr AJ van der Merwe, Director, ARC-Institute for Soil, Climate and Water for permission to perform the project and to present this thesis.

Dr CN MacVicar, former Deputy Director, and Dr MCF du Plessis and Dr DM Scotney former Directors of the Soil and Irrigation Research Institute for their interest and support with field work during which time many of the samples were collected.

Fellow Pedologists of ARC-Institute for Soil, Climate and Water especially Mr AL Smith-Baillie, Mr TE Dohse, Mr JL Schoeman, Mr M Samadi and Dr F Ellis who have provided support and encouragement on many occasions including that during the field work and sample collection phases.

Staff of the Analytical Services, ARC-Institute for Soil, Climate and Water who were responsible for many of the soil analyses used in the project.

Mrs ME Rust, Mrs M van der Walt, Mrs M Vermeulen, and Mr M Pienaar of the Geoinformatics Division, ARC-Institute for Soil, Climate and Water for support in preparing databases and with computer programming.

Mrs S van der Merwe, Mrs M Roberts and Mrs C Lombard for assistance with data capture and Mrs C Lombard for assistance with the preparation of certain graphs.

Mr CW van Huyssteen and Mr R Kuschke who initially assisted with procedures in using the Quattro-Pro computer package.

Colleagues of the ARC-Institute for Soil, Climate and Water who have assisted in various ways over the duration of the project.

Ms E Prinsloo and Mrs R van Dyk of the Library, ARC-Institute for Soil, Climate and Water for their assistance.

Mr Deon Maree and the Department of Environment Affairs and Tourism for the provision of an electronic copy of the map "Vegetation of South Africa, Lesotho and Swaziland".

my wife Annemarie, and children Jane and Kate who have given immeasurable support throughout the duration of the project.