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For Rational Utilization of Land and Water Resources

SWAZILAND

CHARACTERIZATION AND CORRELATION
OF THE SOILS OF SWAZILAND

The Kingdom of Swaziland
Food and Agriculture Organization of the United Nations
United Nations Development Programme

Mbabane, 1994

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The conclusions given in this report are considered appropriate at the time of its preparation. They may be modified in the light of further knowledge gained at subsequent stages of the project.

The definitions employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the

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Remmelzwaal, A. and Masuku, B.S. 1994. *Characterization and Correlation of the Soils of Swaziland*. FAO/UNDP/Govt. of Swaziland. Land Use Planning for Rational Utilization of Land and Water Resources Project SWA 89/001. Field Document 15. 74 pp, 1 Table, 1 Map, 6 Appendices.

ABSTRACT

The present system of characterization of the soils of Swaziland is assessed and critically analyzed. A short overview of the main grouping of soils and their dominant occurrence in Swaziland is given. In order to enable proper soil characterization, new description, classification and storage procedures have been introduced, based on the FAO/ISRIC (1990) Guidelines for Soil Description, the FAO/Unesco/ISRIC (1988) Revised Legend of the Soil Map of the World, and the FAO/ISRIC (1989) Soil Database.

The existing Murdoch soil classification system is discussed with respect to its usefulness to characterize the soils of Swaziland. A full assessment and correlation of the present series with the FAO/Unesco/ISRIC (1988) and Soil Taxonomy (Soil Survey Staff, 1990) systems is presented. Recommendations are given on the revision and redefinition of the series of the Murdoch system.

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1. GENERAL SOIL CHARACTERIZATION

1.1 Introduction

Soil characterization may be described as the recognition, description and mapping of soils occurring in a given territory. The definition may go further to also include the storage of gathered information in such a way that it is available for future use. Coordination of field, laboratory and office methods and analyses is required in order to achieve a proper soil characterization system.

Some of the objectives of soil characterization can be summarized as follows:

- To provide data which make it possible to determine the sustainable potential of land and soil resources.
- To have a scientific base for the transfer of knowledge between areas with comparable environments.
- To enable proper soil classification and correlation.
- To provide data that can be used for educational purposes, research and development activities.
- To provide data that will help users of soils in predicting the behaviour of a soil under an intended management system.

In a properly organised soil characterization system there are standards which must be satisfied in order to make the exercise useful at present and in the future. Some of these standards are:

- There should be a clear central concept with accurate definitions in such way that also the non-specialist user will have an understanding of the data.
- Boundaries between soil units or types should be defined precisely and overlaps be avoided.
- Each soil unit or soil type should be supported by representative and comprehensive soil profile descriptions with full analytical data.
- Soil inventories should be set up to determine the spatial distribution of the defined soil units.
- Analytical data must be quantitative rather than qualitative to facilitate proper soil classification.
- All information, including unprocessed data, should be kept or stored in such manner that it is remains available.

1.2 History of soil characterization in Swaziland

The first form of soil characterization in Swaziland was started in the 1950's as part of a joint undertaking with other African states in an effort to define a unified soil classification system for Africa. The result was the introduction of broad system of soil units (the SPI legend) which provided a useful framework that could be refined, modified and adapted to local conditions (D'Hoore, 1964).

In 1955 detailed soil survey work in Swaziland was started by Murdoch in the Lower Usutu basin. This was followed by the first attempt to define the agricultural potential for several important crops based on the recognition of soil series and landscape categories.

In 1968 the national soil reconnaissance programme started by Murdoch was completed. The soils and land capability maps at scale 1:125 000 and the report on Soils and Land Capability in Swaziland were the main products (Murdoch, 1970).

In order to introduce a reference framework for Swaziland soils, Murdoch classified his series according to the SPI legend (D'Hoore, 1964). The following overview gives a list of the main units of the SPI legend as selected and used by Murdoch, together with a short characterization and the primary correlation with the present FAO soil units (FAO-Unesco-ISRIC, 1988).

1. RAW MINERAL SOILS. Very shallow soils including bare rocks and rock debris broken down by mainly physical processes. This soils group is very common throughout the country. Correlation with FAO: Leptosols, Regosols.
2. WEAKLY DEVELOPED SOILS. The most commonly occurring group in the country, consisting of very shallow soils on hard rock and juvenile soils on recent river and other deposits, lacking horizon development. Correlation with FAO: Leptosols, Regosols, Fluvisols.
3. VERTISOLS. Occurring mainly in the Lowveld on basalt and dolerite. Of lithomorphic origin or related to topographic depressions. Characterised by poor drainage, poor permeability, high clay content and strong development of cracks in the dry season. Correlation with FAO: Vertisols and vertic subgroups of other soil units.
4. PSEUDOPODZOLIC/DUPLEX SOILS. These are soils with contrasting soil horizons, having light textured topsoil clearly or abruptly overlying heavy textured subsurface horizons. Hydromorphic properties are common. Correlation with FAO: Planosols, Solonetz, but also other units such as Luvisols.
5. BROWN AND REDDISH BROWN SOILS. These are well developed soils with the topsoil darkened by organic matter and mostly with clay enrichment in the subsoil. Correlation with FAO: Luvisols, Lixisols, Phaeozems, Cambisols.
6. FERSIALITIC SOILS. Soils with an advanced stage of weathering and soil formation, but not as far as the next two groups of Ferrisols and Ferralitic Soils. Clay minerals are dominated by kaolinite, but the CEC is not very low (CEC clay around 20me/100g), as is the base saturation (around 50%). Correlation with FAO: Lixisols, Nitisols, Acrisols.
7. FERRISOLS. These soils have developed further than the Fersialitic Soils but are distinguished from the more mature Ferralitic Soils by stronger structure (CEC clay around 20me/100g), higher base status (but less than 50%), and greater fertility. Kaolinite usually dominates the clay fraction and the reserve of weatherable minerals seldom

reaches 10% of the fine sand fraction. Found mainly in the Upper Middleveld and Highveld. Correlation with FAO: Acrisols.

8. FERRALITIC SOILS. Soils with the most advanced stage of weathering and soil development, occurring in Highveld and Upper Middleveld. Often very deep with diffuse transitions between subsurface horizons. There are little or no weatherable mineral reserves. The CEC clay is low and the base saturation less than 40%. Correlation with FAO: Ferralsols, Acrisols.

9. HALORMOPHIC SOILS. These soils are characterized by the presence of soluble salts in the profile. Found only in the Lowveld, as a result of irrigation malpractices. Correlation with FAO: Solonchaks.

10. HYDROMORPHIC SOILS. The soil development is influenced by permanent or seasonal waterlogging, resulting in hydromorphic properties. Found throughout the country in bottomlands where waterlogging takes place. Correlation with FAO: Gleysols, Fluvisols.

1.3 Main groups of soils in Swaziland

If one looks at the overall situation of Swaziland with regard to soils distribution, there is a clear split between the higher part of the country and the lower part. The higher part comprises the Highveld and Upper Middleveld, the lower part consists of the Lower Middleveld and the Lowveld. The Lebombo Range is in an intermediate position and could be divided into two parts, the higher plateau remnants and the lower eroded slopes. For the definition and description of the physiographic zones reference is made to Remmelzwaal (1993).

The 10 soil units listed in the above section can be grouped into four main categories, as follows:

- Soils typical of the Highveld and Upper Middleveld.
These soils are characterized by intense weathering and leaching with very deep soil formation (Ferrisols and Ferralitic Soils). They have a low CEC clay and a low base saturation of the exchange complex. FAO classification: Ferralsols, Acrisols.
- Soils typical of the Lower Middleveld and Lowveld.
These soils are characterized by moderate weathering and soil formation (Pseudopodzolic Soils, Brown Soils, Vertisols, Halomorphic Soils). They have a moderately high to high CEC clay and generally high base saturation. FAO classification: Vertisols, Planosols, Solonetz, Solonchaks, Lixisols, Luvisols and Phaeozems.
- Soils in transitional position.
These soils are characterized by an advanced stage of weathering and soil formation which has not progressed as far the strongly leached soils of the first group, the main reason being that climatic conditions were less extreme (Fersialitic Soils). These soils occur mainly in the transitional Middleveld and Lebombo zones, but also as remnants in the Lowveld. CEC clay and base saturation are intermediate between the first two groups. FAO classification: Nitisols and Lixisols as typical soils, but also Acrisols do occur.
- Soils not related to physiographic zoning (azonal soils).

These soils occur in all regions of the country and include shallow and hydromorphic soils (Raw Mineral Soils, Weakly Developed Soils, Hydromorphic Soils). FAO classification: Leptosols, Regosols, Gleysols and Fluvisols.

The major soils boundary in Swaziland as occurring between the Upper and Lower Middleveld coincides with the major boundary between the main Tertiary and Quaternary erosion cycles. The higher part of the country has been influenced by Tertiary cycles of geological erosion, but remained relatively unaffected by the major Quaternary cycle, which has progressed approximately as far as the boundary between Upper and Lower Middleveld. The general status of geological erosion explains why the extensive occurrence of old and deeply weathered soils is mainly confined to Highveld and Upper Middleveld. In the Lower Middleveld and Lowveld most of the older soils have disappeared.

The important common boundary of soils and erosion cycles coincides also with the current major climatic boundary in the country. The upper part has relatively high rainfall and moderate temperatures, whereas the lower part has low rainfall and high temperatures (see Van Waveren and Nhlengetfwa, 1992).

1.4 Present situation

Following the soil investigations by Murdoch, a number of other soil scientists have carried out soil description and mapping in Swaziland. Most of them have followed the framework developed by Murdoch with only minor changes proposed.

Although the Murdoch approach to soil classification might have served several useful and practical purposes, it is lacking a number of the standards that a soil characterization system must satisfy. For this reason it is important that a comprehensive revision of the system of soil characterization be undertaken in the country.

In trying to address the problems encountered with the Murdoch system, a programme has been initiated to update the characterization and inventory of the soils of the country.

As a first step a comprehensive soil profile description system based on the FAO/ISRIC (1990) Guidelines for Soil Description has been introduced.

As a second step a soil database has been set up for the proper storage of soil profile data.

As a third step the primary system of soil classification has been changed to the Revised Legend of the Soil Map of the World (FAO/Unesco/ISRIC, 1988).

As a fourth step the soil laboratory has been upgraded, including the provision of additional equipment and proper laboratory methods.

2. SOIL DATABASE

2.1 Introduction of Soil Database System

One of the requirements of a soil characterization system is that data which has been generated is stored in such way that it can be made available when needed.

With recent advances in computer technology, soil databases have been developed. These systems provide means for storage, manipulation and retrieval of data. They also provide the possibility of linking the soil profile data to other sets of information, e.g. spatial data (maps) in geographic analysis systems.

Taking advantage of these developments the establishment of a computerized soil profile database was initiated. The FAO-ISRIC (1989) Soil Database program (SDB) was used as the basis for the development of the soil profile database. This program is designed to store and manipulate soil profile descriptions and laboratory data and includes input, edit, print, and selection facilities. It uses an flexible coding system which makes it possible to adapt the database to local conditions.

A coding system and a soil profile data sheet were developed by adjusting the FAO Guidelines for Soil Description (FAO/ISRIC, 1990) to cover the specific Swaziland conditions. Using the coding system and the data sheet a number of soil profiles were described and stored in the database in order to test the coding system. A number of additional modifications were made before the final version of the coding system was produced. The soil profile data sheet is presented in Appendix 1. The coding system is given in Appendix 2.

2.2 Representative soil profiles

Over 300 profiles have been described and stored in the soil database. Some selected profiles are presented in this report. These profiles represent soils which are important in Swaziland, either in terms of agricultural production or because of their wide distribution over the country. The list of selected profiles is presented in table 1. Comprehensive descriptions of the selected profiles are found in Appendix 3.

Due to lack of support from the Soil Laboratory in the Research Division, analytical data are not complete and therefore not included in this report. The soils have been classified on the basis of the analytical data available, which has been compared with data from other sources.

However, the analytical results of the analysis of most profiles is sufficient to provide a short overview of the main subsoil characteristics relevant to classification.

Profile 17/004 Geric Ferralsol has 50 to 60 percent clay, a very low cation exchange capacity (CEC) of the clay fraction (3-4 cmol(+)/kg clay), a low saturation of exchangeable bases (1-2 cmol) and a percentage base saturation (PBS) of less than 50.

Profiles 28/003 and 02/002 Rhodic Ferralsols both have about 60 percent clay, a CEC clay of 6-10 and a PBS of around 50. Profile 21/002 Rhodic Nitisol has 50 to 70 percent clay, a CEC clay of 16-20 and a PBS of 50-70.

Profile 25/002 Haplic Lixisol has 50 to 60 percent clay, a CEC clay of 16-20 and a PBS of 80-100. Profile 13/057 Luvic Phaeozem has about 50 percent clay, a CEC clay of 40-50 and a PBS of 60-80.

Profile 26/001 Calcic Vertisol has 60 to 80 percent clay, a CEC clay of 70 and a PBS of 100. Profile 13/052 Eutric Planosol has 30 to 40 percent clay, a CEC clay of about 30 and a PBS of 80-100. Profile 13/016 Calci-Stagnic Solonetz has about 40 percent clay, a CEC clay of about 40 and a PBS of 100.

Table 1 List of representative soil profiles

PROFILE NO.	CLASSIFICATION	PHYSIOGRAPHIC ZONE AND UNIT	LOCATION
17/004	Geric Ferralsol	Upper Middleveld, MU611	Malkerns
28/003	Rhodic Ferralsol	Highveld, HV93	Nhlangano
02/002	Rhodic Ferralsol	Upper Middleveld, MU63	Ntonjeni
21/002	Rhodic Nitisol	Lebombo Range, LR1	Tikuba
05/019	Dystric Regosol	Highveld, HV4	Motshane
05/001	Dystric Gleysol	Highveld, HV4	Motshane
25/002	Haplic Lixisol	Western Lowveld, LW22	Maloma
13/057	Luvic Phaeozem	Lower Middleveld, ML33	Kabhudla
26/001	Calcic Vertisol	Eastern Lowveld, LE22	Big Bend
13/052	Eutric Planosol	Lower Middleveld, ML33	Kabhudla
13/016	Calci-Stagnic Solonetz	Lower Middleveld, ML33	Kabhudla

3. SOIL CORRELATION

3.1 Discussion Murdoch sets and series

The information from the Murdoch (1970) map and report on the soils of Swaziland is used as an input to the physiographic description and inventory of Swaziland (Remmelzwaal, 1993). As such it is also an important basic element in the land evaluation procedure. In order to make proper and justified use of the information, the Murdoch system is critically reviewed and evaluated on its definition, reliability and practical use.

The Murdoch system has two levels of generalization, namely sets and series. The soil classification system for Africa of D'Hoore (1964) is the higher level framework into which the sets and series fit. The set level, based on the New Zealand concept, does not correspond with a defined level of a universal soil classification system such as the FAO system (FAO-Unesco-ISRIC, 1988) or Soil Taxonomy (Soil Survey Staff, 1974, 1990). The series level corresponds with the series concept developed in the United States. A list of Murdoch soil series and selected data is given in Appendix 4 and 5.

A large amount of soils information is provided in the soil and land capability report of Murdoch (1970), which is partly based on earlier reports, such as Murdoch and Andriess (1964). However, as already observed earlier (Nixon, 1986; Mashwama, 1992; Alexander Gibb, 1992), the local system of soil classification is not easy to correlate with the FAO and Soil Taxonomy systems. Remarks on the Murdoch system fall into four categories related to (a) definition of sets; (b) soil properties; (c) subdivision into series; and (d) mapping:

Related to the definition of sets

1. A number of sets is missing a clear central concept and definition, resulting in an overall lack of balance in the system. Although the description of most sets gives a fair idea of the concept, others remain vague or are distinguished on the basis of criteria irrelevant at set level.
2. Boundaries between sets are not precisely defined and often based on differences between general soil morphological features.
3. In some of the sets certain series are permitted which do not fall within the set concept, resulting in overlap. Examples are the Homestead, Mooihoek, Rasheni, Spekboom and Zikane series.

Related to soil properties

4. The system as presented by Murdoch is based on generalized set and series descriptions. Representative and comprehensive soil profile descriptions with full analytical data are not

provided. In fact, very few soil profile descriptions are available in the country.

5. Soil properties used to characterize sets and series are generally not standardized or defined. E.g. textural descriptions relate to either general texture such as light, medium or heavy texture or to textural classes of which no definitions are given. The same applies to soil depth, drainage, structure, consistence, colour, etc.

6. Standard analytical data are presented as averages at two standard depths (topsoil at about 0-20cm and subsoil at about 60-80cm). Such sampling not always reflects important changes in soil properties within the soil control section. Also, the number of topsoil analyses of each series is always larger than the subsoil, which further decreases the pedogenetic relevance of the data.

Related to subdivision into series

7. The subdivision of sets into series lacks systematic approach. Although the series may represent actually occurring soil types, the system of subdivision could have been more logical and concise. Some series differ only in minor details, others in major aspects. Very often phase criteria are applied, such as gravelly or covering layers, which should be used for subdivision at a lower level.

8. The subdivision into series is often not balanced, especially when the central set concept is reflected by one predominant series, supported by analytical data. Most other series of such sets lack data and seem to represent minor varieties. This is obvious in e.g. the NH, QH, SH, SL, TH, TL, W and ZL sets.

Related to mapping

9. Only sets have been mapped for the national soil map of Swaziland, not series. Yet the areal coverage of the series has been defined with an accuracy of one thousand acres (400ha). When the specific location of the series is not indicated in the text, it is difficult or impossible to identify the applicable series from the map.

10. The set and series letter symbols may lead to confusion. One letter symbol stands in principle for one set. However, several of these single letter symbols have the capital H added for Highveld and L for Lowveld. Such double letter sets, e.g. SH and SL, normally do not relate to each other. Also the series have double letter symbols, which are in some cases the same as the set symbol.

Notwithstanding the obvious shortcomings and practical problems of the Murdoch soils data, it is used as an important set of basic information. Soil mapping units and set/series descriptions have been checked in various parts of the country. The general soils pattern is applicable, but major deviations do occur. With regard to classification, it appeared that often more than one set or series would fit a particular soil profile. In quite a few places the mapped soil units were found to correspond with other sets.

The soils element in the definition of the Physiographic Map of Swaziland (Rommelzwaal, 1993) strictly follows the Murdoch map. For land evaluation, however, data are manipulated in areas where more information has become available. In such cases some sets or series were replaced by others.

The main technical and interpretative aspects of the Murdoch sets and series are discussed in Appendix 6.

3.2 Soil correlation

Appendix 6 contains the correlation of all Murdoch series with the FAO classification system (FAO-Unesco, 1974; FAO-Unesco-ISRIC, 1988) and with Soil Taxonomy (Soil Survey Staff, 1975, 1990). Multiple correlations do apply in most cases, but the list shows only the most probable ones.

Essential elements in the Soil Taxonomy classification are the soil temperature regime and the soil moisture regime. The thermal and moisture zones of the Agro-climatic characterization of Swaziland (Van Waveren and Nhlengetfwa, 1992) were used to define the soil temperature and moisture regimes.

The soil temperature regime is calculated by adding 2.5 °C to the mean annual air temperature. The Swaziland thermal zones are correlated with the soil temperature regimes as follows:

zones MW1/MW2/MW2w	- hyperthermic
zones MC1/MC2/C	- thermic

The Swaziland moisture zones are correlated with the soil moisture regimes as follows:

zone H	- udic
zone SH2	- ustic, bordering udic
zone SH1/MSA2	- ustic, typical
zone MSA1	- ustic, bordering aridic
zone DSA	- aridic, bordering ustic

Map 1 shows the combinations of the soil temperature and soil moisture regimes. It should be noted that these regimes relate to average landscape and soil situations. Soils in poorly drained areas may be subject to water saturation with reducing conditions, and qualify for an aquic soil moisture regime.

3.3 Recommendations on the use of the Murdoch system

Since the Murdoch system is widely applied in Swaziland, it is at the present moment not advisable to abruptly discontinue its use. However, in order to establish sound correlation and enable data

transfer, a thorough revision of the system is necessary. The system would be only useful if better definitions are introduced. The available key to the Murdoch sets and series (Sutcliffe, 1975) is largely based on general morphological properties and characteristics, which are only partly quantified. The present practice of application by soil scientists reveals that the system and key are used in a subjective manner, with a preference for certain sets and series, whereas others are overlooked.

It is necessary to have an overall structure, or framework, based on defined diagnostic horizons and properties. The most suitable system is the FAO classification system (FAO-Unesco-ISRIC, 1988), which is presently being revised and will also serve as the World Reference Base for Soil Resources in conjunction with the International Soil Science Society (ISSS-ISRIC-FAO, 1994). The USDA Soil Taxonomy classification system (Soil Survey Staff, 1975, 1990) is highly recommended as the secondary reference system. Both systems are based on the same principles

Map 1 Soil temperature and soil moisture regimes of Swaziland

LEGEND

- 1** **Hyperthermic - Aridic bordering ustic**
- 2** **Hyperthermic - Ustic bordering aridic**
- 3** **Hyperthermic - Ustic, typical**

- 4 Hyperthermic - Ustic bordering udic**
- 5 Thermic - Ustic, typical**
- 6 Thermic - Ustic bordering udic**
- 7 Thermic - Udic**

and are relatively easy to correlate. The advantage of the FAO system in the Swaziland context is that less detailed analytical data are required.

Revision of the Murdoch system should start with appraisal of the usefulness of the sets. Many sets are not well defined or not balanced with regard to series subdivision. Several series are not within the set concept. It will not always be easy to redefine the sets in a satisfactory manner, and it is questionable whether continuation of the use of sets is practical. The nomenclature of letter symbols with additional references to Highveld and Lowveld is rather confusing. It is probably more advantageous to give priority to the series definition. The following eight sets serve little use and are better incorporated with other sets, as follows:

DL set - to R, L sets
E set - to JL, I, H sets
NL set - to R set
P set - to O, H, ZL, JH sets
QL set - to H, ZL sets
X set - to B set
Y set - to V, K, ZL, H sets
ZH set - to M set.

3.4 Main soil groupings

In order to obtain a general overview, the Murdoch sets can be accommodated in the following pragmatic groupings:

Planosolic soils (having an abrupt textural boundary)

H set (except for Homestead series)

ZL set (except for Zikane series)

Petronella series

Vertisols

K set

V set

Rasheni series

TL set (probably minor part only)

Soils with vertic properties (vertic subgroups)

TL set (probably major part)

CL set

Rhebok series

Shebani series

Wisselrode series

Alluvial soils

B set (inc. X set) (Fluvisols)

I set (Fluvisols, Gleysols)

W set (Cambisols, Luvisols)

L set (part of; Luvisols)

Organic soils (Histosols)

DH set

Soils high in organic carbon (humic properties, mollic/umbric horizons)

CH set (humic properties, medium PBS, medium CEC clay; Phaeozems)

SH set (medium/high PBS, medium/high CEC clay; Phaeozems)

NH set (humic prop., low PBS, medium/high CEC clay; Acrisols/Alisols)

A set (part of; low PBS, medium CEC clay; Cambisols)

Acid soils (moderately deep to very deep)

TH set (very acid, high CEC clay; Regosols/Cambisols)

A set (part of; medium CEC clay; Cambisols/Acrisols)

QH set (medium/low CEC clay; Acrisols/Ferralsols)

M set (low CEC clay; Ferralsols)

Mooihoek series (high CEC clay; Alisols)

Non-acid soils (moderately deep to very deep)

R set (high CEC clay; Cambisols/Luvisols)

L set (medium/high CEC clay; Lixisols/Luvisols/Nitisols)

F set (medium/high CEC clay; Lixisols/Luvisols)

JL set (medium/high CEC clay; Arenosols/Cambisols)

Shallow soils (very shallow to moderately deep)

JH set (medium/high CEC clay, low/medium PBS; Regosols/Lixisols)

SL set (high CEC clay, high PBS; Leptosols/Regosols/Phaeozems)

O set (medium CEC clay, low/medium PBS; Leptosols/Regosols/Cambisols)

G set (medium CEC clay, low/medium PBS; Leptosols/Regosols)

U set (Leptosols)

This list is simplified and should serve as a first approach. Within these broad groupings a practical system can be worked out. Several sets contain series which qualify for another grouping or are transitional. Diagnostic horizons occur across sets and series, e.g. topsoils enriched in organic carbon (mollic or umbric horizons) are found in part of the R, L, SL and O sets.

3.5 Series revision

The series need properly be defined in terms of specific combinations of diagnostic soil horizons and properties. The definitions should include standard descriptions of drainage classes, texture, depth, colours, etc., following the FAO Guidelines for Soil Description (FAO-ISRIC, 1990).

Representative soil profiles with analytical data should form the basis of the series characterization. Phase criteria, such as covering layers (shallow mantles of new material), stoniness, geology, etc. should not be used at series level. A series should also have a sufficient coverage. The present series need to be reassessed for their usefulness.

Appendix 4 provides a list of all series according to coverage (in acres) as given by Murdoch. The series are subdivided into three categories as follows: (a) useful series, to be defined in more detail,

(b) series to be thoroughly redefined, which may include a shift or change of the present meaning, and (c) series to be deleted in the present meaning and definition.

Appendix 5 gives selected analytical data of the Murdoch series, arranged per set. It also gives relevant information on soil properties, such as soil depth and drainage, as well as an indication of the main occurrence over the physiographic zones. The list is for easy reference, and is relevant in particular to the soil correlation as described in Appendix 6. It should be noted that the data are averages and should be interpreted accordingly.

3.6 Redefinition of series

An example is given of how the series of a set can be redefined and reorganized.

R set - General characteristics:

High CEC clay > 24 me/100g clay (all >50, except for Rathbone);
High PBS > 50 (average > 70);
Clay texture of the subsoil (B horizon);
Soil depth moderately deep (> 50cm) or deeper;
Moderately well or well drained;
Colour reddish yellow (5-7.5YR, chroma >4);
Diagnostic horizons: ochric or mollic; cambic or argic.

The Rhebok and Rasheni series may have vertic properties, or even classify as Vertisols. Soils with vertic properties could be distinguished, but are also defined elsewhere (CL and TL sets).

With ochric and cambic horizon:

mod.deep	Rondspring I	Chromic Cambisols
deep-very deep	Rathbone I	Chromic Cambisols
mod.deep-deep; ferric	Rhebok I	Ferric Cambisols

With ochric and argic horizon:

mod.deep	Rondspring II	Chromic Luvisols
deep-very deep	Rathbone II	Chromic Luvisols
mod.deep-deep	Rhebok II	Ferric Luvisols

It is possible that ferric properties only occur in combination with vertic properties. In that case the above Rhebok series are superfluous. There may be need to also accommodate soils with a calcic horizon.

Since R set soils also occur with a mollic horizon, it is useful to accommodate these in a similar way:

With mollic and cambic horizon:

mod.deep	Rondspring III	Haplic Phaeozems
deep-very deep	Rathbone III	Haplic Phaeozems

With mollic and argic horizon:

mod.deep	Rondspring IV	Luvic Phaeozems
deep-very deep	Rathbone IV	Luvic Phaeozems

The revision and redefinition of series will only have practical meaning if the exercise is undertaken within the context of a regular soil survey programme.

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APPENDIX 2 SOIL CODING SYSTEM

General code: ? = not known

STATUS

1 reference pit
2 routine pit
3 Incomplete pit
4 soil angering
5 other

TOPOGRAPHY

F flat
A almost flat
G gently undulating
U undulating
R rolling
H hilly
S steeply dissected
M mountainous

ZONE

HV highveld
MV middleveld
MU upper middleveld
ML lower middleveld
LV lowveld
LE eastern lowveld
LW western lowveld
LR Lubombo range

LANDFORM

MO mountain
HI hill
PT plateau
PL plain
VA valley

LAND ELEMENT

IF interfluve
VA valley
VF valley floor
CH channel
LE levee
TE terrace
FP floodplain
AF alluvial fan
SL slope
RI ridge
DE depression

POSITION

CR crest
US upper slope
MS middle slope
LS lower slope
BO bottom
HI higher part
IN intermediate part

LO lower part

SLOPE GRADIENT

1 < 0.2%
2 0.2- 0.5%
3 0.5- 1%
4 1 - 2%
5 2 - 5%
6 5 - 10%
7 10 - 15%
8 15 - 30%
9 30 - 60%

SLOPE FORM

S straight
C concave
V convex
T terraced
X complex

MICRO TOPOGRAPHY

LE level
GI gilgai
M termite mounds
AT animal tracks
AB animal burrows
HU hummocks
TS terracettes

LAND USE

AA annual cropping
AA4 - Rainfed
AA6 - Irrigated
AA6S - sprinkler
AA6F - furrow
AP perennial
cropping
AP1 - rainfed
AP2 - irrigated
AP2S - sprinkler
AP2F - furrow
AT tree cropping
AT1 - rainfed
AT2 - irrigated
AT2D - drip
AT2F - furrow

+ I improved trad.
C commercial
R research
F fallow

HE extensive grazing
HI intensive grazing
HI2 - dairying
HI3 - ranching
FN natural forestry
FP plantations
E extraction
PN2 parks/nature

reserves
SR residential
SI industrial
SX excavations

CROPS

AV avocado
BA banana
BE beans
CI citrus
CT cotton
CP cowpea
GR groundnut
GU guava
GA granadilla
LI litchi
MA maize
MI millet
MG mango
PA papaya
PN pecan nuts
PI pineapple
PO potato
RI rice
SO sorghum
SB soybean
SC sugar cane
SF sunflower
SP sweet potato
TE tea
TB tobacco
TN tung nuts
VE vegetables
WH wheat

HUMAN INFLUENCE

N no influence
VU disturbed
vegetation
TE terracing
GS grass strips
AD artificial drain
CL clearing
BR burning
BP borrow pits
RC road cuts

VEGETATION

N no vegetation
G grassland
FB forbland
SA savanna
SAO - open
SAD - dense
SS shrub savanna
SSO - open
SSD - dense
SH shrubland
WO woodland
FO forest

GRASS COVER

0 no cover
1 < 15%
2 15-40%
3 40-80%
4 > 80%

PARENT MATERIAL

AU aeolian
LA lacustrine
FL fluvial
CO colluvial
FD fan deposits
SD slope deposits
AL alluvial
WE in situ
SA saprolite
OR organic

ROCK TYPE

AC acid rock
GR granite
GN gneiss
GG granite/gneiss
QZ quartzite
SC schist
IN intermediate rock
AN andesite
DI diorite
BA basic rock
UB ultrabasic rock
GA gabbro
DO dolerite
BT basalt
VO volcanic rocks
TU tuff
IG ignimbrite
PY pyroclastic rock
SE sedimentary rock
LI limestone
SA sandstone
QS - quartzitic
SH shale
CO conglomerate

EFFECTIVE DEPTH

1 < 30cm
2 30 - 50cm
3 50 -100cm
4 100-150cm
5 > 150cm

ROCKOUTCROPS**cover**

N none
V very few <2 %
F few 2-5 %
C common 5-15%
M many 15-40%

A abundant 40-80%
D dominant >80%

distance

1 >50m
2 20-50m
3 5-20m
4 2- 5m
5 < 2m

COARSE FRAGMENTS

cover

N none
V very few <2 %
F few 2-5 %
C common 5-15%
M many 15-40%
A abundant 40-80%
D dominant >80%

size

F fine gr. <0.6cm
M med. gr. 0.6-2cm
C coarse gr. 2- 6cm
S stones 6-20cm
B boulders 20-60cm
L large bldrs >60cm

EROSION

degree

N none
S slight
M moderate
S severe
E extreme

type

N no evidence
WS sheet erosion
WR rill erosion
WG gully erosion
WT tunnel erosion
WD water deposition
AM wind erosion/dep

area affected

1 0 -5%
2 5-10%
3 10-25%
4 25-50%
5 >50%

SURFACE SEALING

thickness

N none
F thin <2 mm
M medium 2-5 mm
C thick 5-20mm
V very thick >20mm

consistence

S slightly hard
H hard
V very hard
E extremely hard

CRACKS**width**

N none
F fine <1 cm
M medium 1-2 cm
W wide 2-5 cm
V very wide 5-10cm
E extr.wide >10cm

distance

1 < 0.2m
2 0.2 - 0.5m
3 0.5 - 2m
4 2 - 5m
5 > 5m

SURFACE SALT**cover**

0 none
1 low <15%
2 moderate 15-40%
3 high 40-80%
4 dominant >80%

DRAINAGE**class**

E excessive
S somewhat excess
W well
M moderately well
I Imperfect
P poor
V very poor

saturation

N never
R rarely
S short periods
L long periods

external drainage

P ponded
N neutral
S slow run-off
M moderate run-off
R rapid run-off

FLOODS**frequency**

N none
A annually
F every 2-4 years
T every 5-10 years

R rare

duration

1 < 1 day
2 1-15 days
3 15-30 days
4 30-90 days

GROUNDWATER

depth classes

N not observed
1 < 30cm
2 25-50 cm
3 50-100cm
4 100-150cm
5 >150cm

MOISTURE CONDITIONS

D dry
S slightly moist
M moist
W wet

BOUNDARY

distinctness

A abrupt <2cm
C clear 2-5cm
G gradual 5-15cm
D diffuse >15cm

topography

S smooth
W wavy
I irregular
B broken

COLOUR

modifier

D dry
M moist
MD mottled dry
MM mottled moist

MOTTLES

abundance

N none
V very few <2 %
F few 2-5 %
C common 5-15%
M many 15-40%
A abundant >40%

size

V very fine <2mm
F fine 2-6 mm
M medium 6-20mm
C coarse >20mm

contrast

F faint
D distinct
P prominent

boundary

S sharp <0.5mm
C clear 0.5-2mm
D diffuse >2mm

colour

WH white
RE red
RS reddish
YR yellowish red
BR brown
BS brownish
DB dark brown
RB reddish brown
YB yellowish brown
YE yellow
RY reddish yellow
GE green(ish)
GR grey
GS greyish
BU blue
BB bluish black
BL black

TEXTURE

basic codes:

S sand
CS coarse sand
MS medium sand
FS fine sand
VFS very fine sand
SI silt
C clay
L loam

ROCK FRAGMENTS**abundance**

N none
V very few < 2%
F few 2- 5%
C common 5-15%
M many 15-40%
A abundant 40-80%
D dominant >80%

size

F fine gravel
<0.6cm
M medium gravel
0.6-2cm
C coarse gravel
2-6cm
S stones 6-20cm
B boulders 20-60cm
L large boulders

>60cm

shape

F flat
R rounded
S subrounded
A angular

weathering

F fresh
W weathered
S strongly weathered

nature

see rocktype
additional codes:
QU quartz
MI mica
FE feldspar

STRUCTURE

grade

MA massive
SG single grain
VW very weak
WE weak
MO moderate
ST strong
VS very strong

size

VF very fine
FI fine
ME medium
CO coarse
VC very coarse

type

SG single grain
MA massive
GR granular
PR prismatic
CO columnar
SB subangular blocky
SN nutty subangular
blocky
AB angular blocky
AW - wedge shaped
AP - parallelepiped
AS angular +
subangular
SA subangular +
angular
PL platy
RS rock structure
SS stratified

relationship

> parting into
/ merging

+ both

CONSISTENCE

dry

LO loose
SO soft
SHA slightly hard
HA hard
VHA very hard
EHA extremely hard

moist

LO loose
VFR very friable
FR friable
FI firm
VFI very firm
EFI extremely firm

stickiness

NST non sticky
SST slightly sticky
ST sticky
VST very sticky

plasticity

NPL non plastic
SPL slightly plastic
PL plastic
VPL very plastic

VOIDS

type

I interstitial
B vesicles
V vughs
C channels

abundance

N none
V very few
F few
C common
M many

size

V very fine <0.5mm
F fine 0.5- 2mm
M medium 2 - 5mm
C coarse 5 -20mm E very coarse >20mm

porosity

1 very low <2%
2 low 2- 5%
3 medium 5-15%
4 high 15-40%
5 very high >40%

CUTANIC FEATURES

abundance

N none
V very few < 2%
F few 2 - 5%
C common 5 -15%
M many 15-40%
A abundant 40-80%
D dominant >80%

contrast

F faint
D distinct
P prominent

nature

SF shiny pedfaces
CS clay-sesquioxides
CH clay-humus
C clay
PF pressure faces
SN slickensides
SP - partly intersecting
SI - intersecting

location

P pedfaces
PV vertical pedfaces
PH horizontal pedfaces
CF coarse fragments
LA lamellea
VO voids
NS no specific location

CEMENTATION

continuity

N none
B broken
D discontinuous
C continuous

structure

M massive
P platy
V vesicular
S pisolitic
N nodular

degree

C compacted
W weakly cemented
M moderately cemented
S strongly cemented

nature

K carbonates
S sesquioxides
F iron
M manganese
Q quartz
M mechanical
processes

P ploughing
T traffic

MINERAL NODULES

abundance

N none
V very few < 2%
F few 2- 5%
C common 5-15%
M many 15-40%
A abundant 40-80%
D dominant >80%

kind

C concretion
N nodule
S soft segregation
R residual rock fragment

size

V very fine < 2mm
F fine 2- 6mm
M medium 6-20mm
C coarse > 20mm

shape

R rounded
F flat
A angular
I irregular
E elongate

hardness

H hard
S soft
B both hard + soft

nature

K carbonates
F iron
S sesquioxides
M manganese
Z salt
C clay
Q silica

colour

see MOTTLES

ROOTS

abundance

N no roots
V very few
F few
C common
M many

size

V very fine <0.5mm

F fine 0.5-2mm
M medium 2-5mm
C coarse >5mm

BIOLOGICAL FEATURES

abundance

N none
F few
C common
M many

kind

BU burrows
 unspecified
BO - open
BI - infilled
CU channels
 unspecified
CE - earthworm
CT - termites
P pedotubules
IN insect nests
C charcoal
A artifacts

CARBONATES

N non calcareous
SL slightly
 calcareous
MO moderately
 calcareous
ST strongly
 calcareous
EX extremely
 calcareous

APPENDIX 4

MURDOCH SERIES ACCORDING TO ACREAGE AND DEFINITION

UN	Ungabolima	817000
UC	Upcountry	395000
OT	Otandweni	220000
SO	Somerling	213000
OR	Orrin	173000
ZD	Zwide	123000
QO	Qolweni	117000
HA	Habelo	112000
TX	Tatani	105000
MA	Malkerns	80000
ND	Nduma	74000
CA	Canterbury	73000
HL	Hlunya	68000
RO	Rondspring	67000
SA	Sangweni	65000
<i>UB</i>	<i>Umbeluzi</i>	65000
KZ	Kwezi	60000
JW	Juweel	55000
LE	Lesibovu	49000
OL	Oldreef	48000
RT	Rathbone	45000
ID	Idukathole	45000
MT	Mtilane	43000
OU	Outspan	41000
PO	Pofane	40000
IN	Ingoje	39000
OK	Ongeluk	36000
ZL	Zwakela	35000
BU	Bushbaby	34000
OM	Omhlandlu	32000
GC	Gocuka	32000
EK	Enkulunyo	31000
SK	Sikhutwane	30000
ST	Stegi	29000
QB	Qwabise	29000
JB	Jolobela	28000
NZ	Ngazi	28000
MO	Mooihoek	26000
LO	Lomahasheni	26000
JV	Jovane	25000
ZN	Zikane	25000
CU	Cuba	24000
PT	Petronella	23000
HO	Homestead	22000
JK	Jekhi	20000
<i>OS</i>	<i>Osaguleni</i>	19000
SV	Sivulo	19000
MD	Mdutshane	19000
WN	Winn	17000
ZO	Zombode	17000
TM	Tambankulu	16000
AL	Alicedale	16000
VA	Valumgwaco	15000
RK	Rhebok	15000

CO	Coseni	15000
EM	Empahli	15000
<i>PB</i>	<i>Peebles</i>	14000
SH	Shebani	14000
LZ	Lutzi	14000
GN	Gongola	14000
<i>HE</i>	<i>Hersov</i>	14000
FU	Funebizo	13000
AM	Amuke	13000
FE	Felwako	13000
<i>MB</i>	<i>Mbeli</i>	12000
<i>TO</i>	<i>Torgyle</i>	12000
AT	Atondozi	11000
VM	Vimy	11000
GE	Gege	11000
<i>LD</i>	<i>Ludomba</i>	10000
<i>MV</i>	<i>Madevu</i>	10000
BE	Betusile	10000
CM	Cimurphy	9000
<i>JH</i>	<i>Johannesloop</i>	9000
<i>SP</i>	<i>Spekboom</i>	9000
GB	Gubane	8000
DK	Darketown	8000
RS	Rasheni	7000
<i>MZ</i>	<i>Mzawo</i>	7000
<i>ZA</i>	<i>Zayifu</i>	7000
XU	Xulwane	7000
<i>FR</i>	<i>Frazer</i>	6000
BO	Bona	6000
<i>KN</i>	<i>King</i>	6000
<i>NH</i>	<i>Nhloya</i>	6000
DE	Delcor	5000
<i>GZ</i>	<i>Gudzeni</i>	5000
<i>ZE</i>	<i>Zebra</i>	4000
<i>KT</i>	<i>Kwamtusse</i>	4000
<i>TS</i>	<i>Tshaneni</i>	4000
<i>VU</i>	<i>Vuso</i>	4000
DZ	Dziva	4000
<i>EB</i>	<i>Ebede</i>	4000
<i>IM</i>	<i>Imbojane</i>	3000
<i>WA</i>	<i>Waspageni</i>	3000
<i>RE</i>	<i>Reidbult</i>	2000
<i>WS</i>	<i>Wisselrode</i>	2000
<i>TH</i>	<i>Thorburn</i>	2000
<i>GR</i>	<i>Groening</i>	2000
<i>WH</i>	<i>Whiterock</i>	2000
<i>DT</i>	<i>Daputi</i>	2000
<i>YA</i>	<i>Yakeni</i>	1000
<i>QU</i>	<i>Qualm</i>	1000
<i>IV</i>	<i>Ivy</i>	1000
<i>YO</i>	<i>Youngsvlei</i>	1000
<i>NS</i>	<i>Nsoko</i>	1000
<i>MU</i>	<i>Munali</i>	1000

The status of the present series definition is as follows:

bold series (29) useful, but definition needs refinement;
normalseries (43) to be maintained, but redefinition necessary;
italicseries (35) to be deleted in present definition.

APPENDIX 5 SELECTED ANALYTICAL DATA OF MURDOCH SOIL SERIES

SERIES	AREA	ZONE	DRAIN	DEPTH	TEXTURE	pH		ORG.C		CEC		PBS		CEC CLAY	
						TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT	TOP	BOT
AL	16000	HV	MU	I 4	SCL SCL	5.2	5.2	2.7	0.6	8.6	6.3	27	21	35	24
AM	13000	HV	MU	M 5											
AT	11000	HV	MU	I 3											
BU	34000	LV	XX	S 5	LS LS	6.7	0.9	8.4		76	92				
BE	10000	LV	XX	S 5	SL SIL	6.5	6.7	1.2	0.3	10.5	8.6	105	108	80	90
BO	6000	LV	XX	S 5											
CO	15000	HV	MV	M 5	C C	6.2	5.7	2.6	1.3	11.8	11.2	21	18	64	58
CM	9000	HV	MV	M 5	LS LS	5.6	5.8	2.6	1.3	16.0	12.3	123	103	55	58
CA	73000	LV	LR	I 3	C CL	6.7	7.4	1.8	1.2	22.4	23.8	53	61	91	100
CU	24000	LV	LR	I 3											
DK	8000	HV		S 2											
DZ	4000	HV		P 4											
DE	5000	LE	LR	I 4	SC C	6.7	6.7	2.0	0.8	16.3	9.8	41	23	70	75
dt	2000	LV		I 4											
EK	31000	LV	MV	S 4	S S	5.7	5.6	0.5	0.1	3.9	2.8	98	70	46	57
EM	15000	MV	XX	I 4	S S	5.9	6.0	0.7	0.2	3.4	2.5	57	42	59	48
eb	4000	LV	XX	S 3											
FE	13000	LR	LW	M 3	SCL CL	6.4	4.9	1.3	0.6	11.0	9.8	48	25	84	67
5.9	1.9	0.6	8.7	10.7	54	37	53	58							
fr	6000	LV	MV	I 2											
GC	32000	LW	MV	I 3	LS SCL	5.8	6.3	0.8	0.4	7.8	8.6	52	30	61	57
GN	14000	XX		I 1											
GE	11000	HV		I 2											
GB	8000	ML		S 3	S S	5.3	5.9	0.5	0.2	5.7	5.5	95	110	28	49
gz	5000	MU		M 3											
gr	2000	LR		I 3											
HA	112000	LW	ML	I 3	LS SCL	6.0	6.7	0.9	0.3	6.3	12.0	53	34	67	88
HL	68000	LW	ML	I 3	LS SC	6.0	6.0	0.9	0.3	7.6	13.7	84	37	58	60
HO	22000	LW	ML	I 4											
he	14000	LE	LW	I 3											
ID	45000	MV	HV	P 4	LS SCL	5.3	5.6	1.4	0.5	6.5	6.9	65	22	38	54
IN	39000	MV	HV	P 4	LS SC	5.5	6.0	1.8	0.7	6.7	6.0	34	16	45	68
im	3000	LV		V 4											
iv	1000	LE		P 4											
JW	55000	HV	MU	M 2	SCL C	5.5	5.3	1.7	0.8	5.5	10.9	20	23	69	57
JB	28000	HV	MU	M 2	SCL	5.3	0.0	1.6	0.0	9.6	0.0	37	0	25	0
jw	9000	HV	M2	M 2											
JV	25000	LW	MU	W 5	LS LS	6.2	5.8	0.8	0.2	5.5	6.6	79	51	69	50
JK	20000	LW	MU	W 5											

KZ 60000 LE XX I 3 C C 7.5 8.3 1.9 1.0 35.8 48.0 75 98 97 100
 kn 6000 MV XX I 3
 kt 4000 LV XX I 3

LE 49000 LW ML W 5 CL C 6.0 6.2 1.4 0.5 9.7 8.4 28 18 58 60
 LO 26000 LR W 4 CL C 6.1 5.9 2.9 1.0 9.7 12.9 28 28 58 53
 lz 14000 ML LV W 3
 ld 10000 LW ML W 5 LS SCL 6.4 6.2 1.1 0.5 8.0 11.5 73 34 63 58

MA 80000 MU HV W 5 SCL C 5.5 5.5 2.0 0.6 7.6 5.4 24 12 50 53
 MT 43000 MU HV W 3 SCL C 4.9 5.2 1.6 0.5 6.8 4.9 28 11 29 36
 MO 26000 MU HV W 5 LS SCL 5.5 5.2 1.9 0.7 10.2 9.5 51 28 37 34
 MD 19000 MU HV W 5 SCL SC 5.4 5.4 1.8 0.5 7.5 4.8 29 13 38 45
 mb 12000 MU HV W 5
 mv 10000 MU HV W 3
 mz 7000 MU ML W 5
 mu 1000 MU M 2

ND 74000 HV MU M 5 SCL SC 5.0 5.2 2.7 0.6 8.7 9.0 30 24 22 18
 NZ 28000 HV MU M 4

SERIES AREA ZONE DRAIN DEPTH TEXTURE pH ORG.C CEC PBS CEC CLAY
 1 2 TOP BOT TOP BOT TOP BOT TOP BOT TOP BOT TOP BOT

nh 6000 LW M 3
 ns 1000 LW M 3

OT 220000 LW ML S 2 LS 6.0 0.7 5.8 64 56
 OR 173000 MV HV S 3 LS LS 5.8 5.7 1.3 0.5 6.0 5.4 43 27 54 58
 OL 48000 HV S 2 LS 5.7 2.2 4.7 47 43
 OU 41000 LR S 2
 OK 36000 HV MV S 2 LS 5.5 1.8 9.0 69 52
 OM 32000 LV S 3
 os 19000 LW S 3

PO 40000 MV HV I 2 LS SCL 5.7 5.3 1.0 0.4 5.6 7.3 51 29 48 61
 PT 23000 LW I 3 LS SCL 6.0 6.7 1.2 0.5 7.2 6.9 80 20 65 80
 pb 14000 ML I 2

QO 117000 HV MU S 4 SCL SCL 5.7 5.5 2.2 0.6 6.4 5.0 26 17 39 46
 QB 29000 HV MU S 4

qu 1000 LW P 2

RO 67000 LE LW M 3 SC CL 6.3 6.5 1.6 0.9 20.8 21.6 56 54 66 73
 RT 45000 LE LW M 5 CL C 6.4 6.5 1.9 1.2 13.6 12.6 35 27 70 75
 RK 15000 LE M 4 C C 6.2 6.5 1.6 0.7 20.0 28.0 36 60 64 70
 RS 7000 LE I 5 C C 7.0 8.5 1.9 0.5 30.4 39.2 56 91 98 100
 re 2000 LV M 4

SA 65000 HV MV M 4 SCL SCL 5.8 5.9 2.1 0.6 8.4 7.8 29 22 60 63
 SV 19000 HV MV M 3

SO 213000 LE LW S 1 SCL 6.4 2.0 21.4 71 73
 SK 30000 LV ML S 1
 ST 29000 LR W 2
 SH 14000 LE LW M 1

sp 9000 MV HV W 1
 TX 105000 HV MU S 3 LS LS 4.8 4.7 1.9 0.2 6.9 6.3 46 35 18 19
 to 12000 HV MU S 3
 TM 16000 LE I 3 CL C 6.1 6.8 2.0 0.4 31.9 40.5 86 68 63 79
 ts 4000 LE P 3
 th 2000 LE ML I 3 SCL SCL 6.0 6.2 1.2 0.4 11.0 9.5 46 29 59 63
 UN 817000 HV XX E 1
 UC 395000 HV XX S 1
 ub 65000 XX W 1
 VA 15000 LE XX P 5 C C 7.7 8.5 2.2 0.8 44.5 53.2 101 130 100 100
 VM 11000 LE LW P 2 C C 7.8 7.9 1.4 0.5 43.5 44.2 87 78 100 100
 vu 4000 MU XX P 5
 WN 17000 LV XX W 5 LS SCL 6.6 6.6 1.0 0.3 7.1 7.3 39 33 84 85
 wa 3000 LV XX W 3
 ws 2000 LV I 5 SCL SCL 8.2 8.6 1.0 0.4 37.6 25.3 125 72 99 100
 wh 2000 LV M 3
 XU 7000 XX V 1
 yo 1000 LV I 2 C C 7.9 8.3 1.3 1.0 44.2 50.6 74 87 100 100
 ya 1000 LV P 2 C C 5.4 6.8 1.4 0.5 22.8 15.3 46 23 49 77
 ZO 17000 HV MU W 3
 za 7000 HV MU W 3
 ZD 123000 LW P 2 LS SC 6.2 7.7 1.1 1.7 13.2 14.0 73 36 60 98
 ZL 35000 LW LE I 1
 ZN 25000 LW LE P 2 SC SC 6.8 7.8 1.4 0.5 13.0 15.0 35 35 70 100
 ze 4000 LW LE I 2

Abbreviations

Zones: HV Highveld; MV Middleveld; MU Upper Middleveld; ML Lower Middleveld; LV Lowveld; LW Western Lowveld; LE Eastern Lowveld; LR Lebombo Range; XX All Zones.

Drainage: E Excessively; S Somewhat Excessively; W Well; M Moderately Well; I Imperfectly; P Poorly; V Very Poorly.

Depth: 1 Very Shallow (0-30cm); 2 Shallow (30-50cm); 3 Moderately Deep (50-100cm); 4 Deep (100-150cm); 5 Very Deep (>150cm).

APPENDIX 6

SOIL CORRELATION

The main technical and interpretative aspects of the Murdoch sets and series are discussed as follows:

SET : set letter code

Main characteristics: main characteristics such as colour, texture, depth of horizons, drainage, etc., as given by Murdoch. A summary of analytical results is given in Appendix 2, which are used in the correlation and classification of the soil series. Standardization of terminology has been applied as much as possible, such as for drainage classes, etc. (FAO-ISRIC, 1990).

Overlap of definition with other sets: other Murdoch sets with a substantial overlap in definition.

Remarks: relate to the definition of the set and the series subdivision.

SERIES : series letter code and name

Series differential criteria: the criteria used by Murdoch to differentiate the series.

Analytical data: yes or no data provided by Murdoch.

Soil correlation: FAO 1988: self explanatory
Soil Taxonomy 1990: self explanatory

The classification is given as detailed as possible, depending on the information provided by Murdoch.

Occurrence: the series are subdivided into four groups according to coverage in Swaziland (in acres), as given by Murdoch:

major	:	more than 50.000	(a total of 18 series)
common	:	16.000 - 50.000	(,, 34 ,,)
minor	:	6.000 - 15.000	(,, 33 ,,)
very minor	:	1.000 - 5.000	(,, 22 ,,)

Status series: if the series is not considered useful, it is indicated for what reason. The series may be obsolete or not mapped. The series may be not relevant because of the kind of differential criteria used. The series may be not practical because of an unclear definition. A series could be relevant as a concept, but not practical for lack of definition. It may be recommended to merge the series with another series.

Series use in physiographic/agro-ecological units: as only sets are mapped by Murdoch, it is essential to know where the various series of that set occur. The Murdoch series description may indicate the location, but it may also not. The three possibilities are (1) no, (2) part, or (3) complete specific geographic distribution of that particular series within the set. If no indication of the distribution is given, that particular series may be chosen to represent the whole set, or at least some of the other series of which also no geographic distribution is indicated. In the case of minor series, they may be represented by major series. If only a partial indication is given, the most appropriate one

or two series are selected per physiographic unit.

SET A

Main characteristics: may have dark humic top, deep, yellow, acid, medium texture, imperfectly drained.

Overlap of definition with other sets: with QH set.

Remarks: There is no practical boundary between the Alicedale and Amuke series because no lower limit is given for the iron pan in Alicedale. The Atondozi series is characterized by the occurrence of an iron pan between 70 and 100cm depth and by an increase of clay. However, it is not indicated which series applies when there is an iron pan at that depth but no clay increase.

SERIES AL ALICEDALE

Series differential criteria: Soft iron pan below 100cm, no clay increase with depth.

Analytical data: yes

Soil correlation: FAO 1988: Ferri-Humic/Ferri-Dystric Cambisols
Soil Taxonomy 1992: Typic Haplumbrepts/Udic Ustochrepts

Occurrence: common

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Alicedale series within A set. Alicedale series represents A set.

SERIES AM AMUKE

Series differential criteria: no iron pan, no clay increase.

Analytical data: no

Soil correlation: FAO 1988: Humic/Dystric Cambisols
Soil Taxonomy 1990: Typic Haplumbrepts/Udic Ustochrepts

Occurrence: minor

Status series: not practical, may be merged with Alicedale.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Amuke series within A set. Represented by Alicedale series.

SERIES AT ATONDOZI

Series differential criteria: light textured topsoil, clay increase with depth, soft iron pan below 70cm depth. Moderately deep soil, hence not fully within A set concept.

Analytical data: no

Soil correlation: FAO 1988: Ferric Acrisols
Soil Taxonomy 1992: Humic Hapludults/Kanhaplic Haplustults
Aquic/Ustic Haplohumults

Occurrence: minor

Status series: useful, but not practically defined within A set concept.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Atondozi series within A set.
Represented by Alicedale series.

SET B

Main characteristics: stratified alluvium, deep, brownish, light textured,
well to somewhat excessively drained.

Overlap of definition with other sets:

Remarks: Series differentiation based on minor textural differences, without
sharp boundaries.

SERIES BU BUSHBABY

Differential criteria: loamy sand, with lighter and heavier layers.

Analytical data: yes

Soil correlation: FAO 1988: Eutric Fluvisols
Soil Taxonomy 1990: Typic Ustipsamments/Ustifluvents

Occurrence: common

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Bushbaby series within B set.
Bushbaby represents B set.

SERIES BE BETUSILE

Series differential criteria: sandy loam

Analytical data: yes

Soil correlation: FAO 1988: Eutric Fluvisols
Soil Taxonomy 1990: Typic Ustifluvents

Occurrence: minor

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Betusile series within B set.
Represented by Bushbaby series.

SERIES BO BONA

Series differential criteria: sand

Analytical data: no

Soil correlation: FAO 1988: Eutric Fluvisols
Soil Taxonomy 1990: Typic Ustipsamments

Occurrence: minor

Status series: not practical, may be merged with Bushbaby series.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Bona series within B set. Represented by Bushbaby series.

SET CH

Main characteristics: deep humic, very deep, clay, moderately well drained.

Overlap of definition with other sets: with NH and SH set.

Remarks: From the soil description and location one would expect lower CEC and pH (Humic Ferralsols rather than Phaeozems) than is indicated by the analytical data. Series distinction not very relevant.

SERIES CO COSENI

Differential criteria: dark brown throughout.

Analytical data: yes

Soil correlation: FAO 1988: Haplic Phaeozems
Soil Taxonomy 1990: Cumulic/Typic Hapludolls
Cumulic/Udic/Typic Haplustolls

Occurrence: common

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Coseni series within CH set. Coseni series represents CH set.

SERIES CM CIMURPHY

Differential criteria: almost black top 30-80cm, over red subsoil.

Analytical data: yes

Soil correlation: FAO 1988: Haplic Phaeozems
Soil Taxonomy 1990: Cumulic/Typic Hapludolls
Cumulic/Udic/Typic Haplustolls

Occurrence: minor

Status series: not practical, may be merged with Coseni series.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Cimurphy series within CH set.
Represented by Coseni series.

SET CL

Main characteristics: dark reddish brown, vertic, imperfectly drained.

Overlap of definition with other sets: with K set.

Remarks: Although described as Vertisols, CL set has only moderately developed vertic properties which do not qualify for Vertisols (see K set), but for Vertic soil units or subgroups. It is likely that part of the series has an argic horizon, but this is not indicated by the analytical data.

SERIES CA CANTERBURY

Differential criteria: calcareous throughout.

Analytical data: yes

Soil correlation: FAO 1988: Calci-Vertic Cambisols
Soil Taxonomy 1990: Vertic Ustochrepts/Ustollic Calciorthids

Occurrence: major

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Canterbury series within CL set.
Canterbury series represents CL set.

SERIES CU CUBA

Differential criteria: non or weakly calcareous.

Analytical data: no

Soil correlation: FAO 1988: Vertic Cambisols
Soil Taxonomy 1990: Vertic Ustochrepts/Ustertic Camborthids

Occurrence: common

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Cuba series within CL set.
Represented by Canterbury series.

SET DH

Main characteristics: highly organic, very acid.

Overlap of definition with other sets:

Remarks: Scattered in minor and often not mappable units.

SERIES DK DARKETOWN

Differential criteria: mountain peat, shallow, sandy, well drained.

Analytical data: yes

Soil correlation: FAO 1988: Terric Histosols, lithic phase
Soil Taxonomy 1990: Lithic Medisaprists

Occurrence: minor

Status series: useful but mapping not practical.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Darketown series within DH set.
Darketown series represents DH set.

SERIES DZ DZIVA

Differential criteria: fen peat, sandy clay, poorly drained.

Analytical data: no

Soil correlation: FAO 1988: Terric Histosols
Soil Taxonomy 1990: Fluvaquentic Medisaprists

Occurrence: very minor

Status series: not practical, may be merged with Darketown.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Dziva series within DH set.
Represented by Darketown series.

SET DL

Main characteristics: very deep, yellowish, imperfectly drained, may have dark humic top.

Overlap of definition with other sets: with R and L set.

Remarks: Minor occurrence and vague definition does not warrant separation as set and subdivision in series. Although defined as commonly derived from ignimbrite, it does not show the colour of soils on ignimbrite. Use of DL set is better discontinued. May be merged with R or L set.

SERIES DE DELCOR

Series differential criteria: clayloam

Analytical data: yes

Soil correlation: FAO 1988: Haplic Phaeozems
Soil Taxonomy 1990: Typic/Aridic Haplustolls

Occurrence: very minor

Status series: not relevant

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Delcor series within DL set. Delcor series represents DL set.

SERIES DT DAPUTI

Series differential criteria: sandy loam

Analytical data: no

Soil correlation: FAO 1988: Haplic Phaeozems
Soil Taxonomy 1990: Typic/Aridic Haplustolls

Occurrence: very minor

Status series: obsolete and not practical, may be merged with Delcor series.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Daputi series within DL set. Represented by Delcor series.

SET E

Main characteristics: greyish sand over clay or iron pan at 90cm or deeper.

Overlap of definition with other sets: with J, H, I and G set.

Remarks: The E set is defined in an incoherent way, e.g. it varies from excessively drained upland soils (Enkulunyo series) to imperfectly drained bottomland soils (Empahli series). The clay or iron pan is the main soil characteristic, but the lower depth is not defined. The appropriate classification of the part of E set where the pan occurs within a control section of 125cm would be as H set. The remainder of Enkulunyo and Ebede series is better placed in JL set, and most of Empahli series in I set.

SERIES EK ENKULUNYO

Series differential criteria: excessively drained.

Analytical data: yes

Soil correlation: FAO 1988: Eutric Arenosols

Soil Taxonomy 1990: Typic Ustipsamments

Occurrence: common

Status series: useful, but better placed with JL set.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Enkulunyo series within E set.

SERIES EM EMPAHLI

Series differential criteria: imperfectly drained sands.

Analytical data: yes

Soil correlation: FAO 1988: Gleyic Arenosols
Soil Taxonomy 1990: Typic Psammaquents/Aquic Ustipsamments

Occurrence: minor

Status series: useful, but better placed with I set.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Empahli series within E set.

SERIES EB EBEDE

Series differential criteria: gravelly sand.

Analytical data: no

Soil correlation: FAO 1988: Eutric Arenosols
Soil Taxonomy 1990: Typic Ustipsamments

Occurrence: very minor

Status series: not relevant, may be merged with Enkulunyo series.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Ebede series within E set.
Represented by Enkulunyo series.

SET F

Main characteristics: orange sandy clay with lighter top, iron concretions and soft iron pan at depth.

Overlap of definition with other sets: with G and O set.

Remarks: Minor set without clear concept. Content of iron concretions not quantified, depth of occurrence quite variable, even outside series control section (Funebizo series). Frazer series rather shallow, would also fit O set.

SERIES FE FELWAKO

Series differential criteria: iron concretions at moderate depth.

Analytical data: yes

Soil correlation: FAO 1988: Ferric Luvisols/Lixisols
Soil Taxonomy 1990: Aquic/Kanhaplic/Ultic HaplustalFs

Occurrence: minor

Status series: useful

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Felwaco series within F set.

SERIES FU FUNEBIZO

Series differential criteria: iron concretions deeper than 120cm, does not really fit F set concept.

Analytical data: yes

Soil correlation: FAO 1988: Chromic Luvisols
Soil Taxonomy 1990: Ultic HapustalFs

Occurrence: minor

Status series: not relevant and not practical, may be merged with Felwaco series or with another set.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Funebizo series within F set.

SERIES FR FRAZER

Series differential criteria: iron concretions at moderate or shallow depth.

Analytical data: no

Soil correlation: FAO 1988: Ferric Luvisols/Lixisols
Soil Taxonomy 1990: Aquic/Kanhaplic/Ultic HaplustalFs

Occurrence: very minor

Status series: not relevant and not practical, may be merged with Felwako series or with G or O set.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Frazer series within F set.
Represented by Felwako series.

SET G

Main characteristics: hard iron concretions and/or cemented iron pan at very shallow to moderate depth, light or medium texture, imperfectly drained.

Overlap of definition with other sets: with F set.

Remarks: Series differentiation based on poorly defined soil depth. The effective soil depth for plant growth is therefore difficult to determine. Of several series it is not clear whether they have a pan or only concretions, and in which quantity. It is assumed that only the first two series have a major iron pan and the others at least 35 percent gravels.

SERIES GC GOCUKA

Series differential criteria: hard iron pan.

Analytical data: yes

Soil correlation: FAO 1988: Ferric Luvisols/Lixisols, petroferric phase
Soil Taxonomy 1990: Aquic/Kanhaplic/Ultic Haplustalfs

Occurrence: common

Status series: useful, but not practically defined.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Gocuka series within G set. Gocuka series represents Gongola, Gudzeni and Groening series.

SERIES GN GONGOLA

Series differential criteria: hard iron pan at very shallow depth.

Analytical data: no

Soil correlation: FAO 1988: Lithic Leptosols
Soil Taxonomy 1990: Lithic Ustorthents

Occurrence: minor

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Gongola series within G set. Represented by Gocuka series.

SERIES GE GEGE

Series differential criteria: more humic and more acid than other G set series (no data). No depth criteria of iron pan.

Analytical data: no

Soil correlation: FAO 1988: Umbric Leptosols/Regosols
Soil Taxonomy 1990: Aquic/Entic/Typic Haplumbrepts

Occurrence: minor

Status series: not relevant

Series use in physiographic/agro-ecological units:

complete specific geographic distribution of Gege series within G set.

SERIES GB GUBANE

Series differential criteria: gravelly sand on loose concretions or broken pan. No depth criteria.

Analytical data: yes

Soil correlation: FAO 1988: Dystric Leptosols/Regosols
Soil Taxonomy 1990: Typic Ustorthents

Occurrence: minor

Status series: not relevant

Series use in physiographic/agro-ecological units:
complete specific geographic distribution of Gubane series within G set.

SERIES GZ GUDZENI

Series differential criteria: orange to red

Analytical data: no

Soil correlation: FAO 1988: Dystric/Eutric Regosols, part skeletal phase
Soil Taxonomy 1990: Typic Ustorthents

Occurrence: very minor

Status series: not relevant and not practical, may be merged with other G set series.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Gudzeni series within G set.
Represented by Gocuka series.

SERIES GR GROENING

Series differential criteria: orange to red

Analytical data: no

Soil correlation: FAO 1988: Ferric Luvisols/Lixisols
Soil Taxonomy 1990: Aquic/Kanhaplic/Ultic Haplustalfs

Occurrence: very minor

Status series: obsolete

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Groening series within G set.
Represented by Gocuka series.

SET H

Main characteristics: greyish light textured top over mottled sandy clay subsoil, poorly (or imperfectly) drained.

Overlap of definition with other sets: with E and ZL sets.

Remarks: No comprehensive set definition of nature of boundary of contrasting layers. H Set includes Planosols with abrupt boundaries, but also soils with more gradual transitions. The Homestead series is defined with gradual boundaries and should not be a series of the H set. In practice it appears that gradual boundaries also occur in the dominant Habelo and Hlunya series, which are defined with an abrupt boundary. The drainage of the soils of H set is in general imperfect rather than poor.

SERIES HA HABELO

Series differential criteria: vague

Analytical data: yes

Soil correlation: FAO 1988: Eutric Planosols/Stagnic Luvisols
Soil Taxonomy 1990: Arenic/Aeric/Typic Albaqualfs
Aquic Paleustalfs/Haplustalfs

Occurrence: major

Status series: useful, but not defined in a practical way.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Habelo series within H set. Habelo series represents H set.

SERIES HL HLUNYA

Series differential criteria: vague

Analytical data: yes

Soil correlation: FAO 1988: Eutric Planosols/Stagnic Luvisols
Soil Taxonomy 1990: Arenic/Aeric/Typic Albaqualfs
Aquic Paleustalfs/Haplustalfs

Occurrence: major

Status series: not relevant and not defined in a practical way, may be merged with Habelo series.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Hlunya series within H set. Represented by Habelo series.

SERIES HO HOMESTEAD

Series differential criteria: gradual boundary between contrasting textural layers. Does not fit the H set concept.

Analytical data: no

Soil correlation: FAO 1988: Stagnic/Haplic Luvisols
Soil Taxonomy 1990: Aquic Haplustalfs

Occurrence: common

Status series: not relevant

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Homestead series within H set.
Represented by Habelo series.

SERIES HE HERSOV

Series differential criteria: vague

Analytical data: no

Soil correlation: FAO 1988: Eutric Planosols/Stagnic Luvisols
Soil Taxonomy 1990: Arenic/Aeric/Typic Albaqualfs
Aquic Paleustalfs/Haplustalfs

Occurrence: minor

Status series: not relevant, may be merged with Habelo series.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Hersov series within H set.
Represented by Habelo series.

SET I

Main characteristics: hydromorphic, mostly stratified alluvium, may have dark humic topsoil, poorly to very poorly drained.

Overlap of definition with other sets: with E set.

Remarks: hydromorphic criteria not defined.

SERIES ID IDUKATHOLE

Series differential criteria: light textured top over medium to heavy textured subsoil.

Analytical data: yes

Soil correlation: FAO 1988: Umbric/Dystric Fluvisols/Gleysols
Soil Taxonomy 1990: Typic Fluvaquents/Fluvaquentic Humaquepts

Occurrence: common

Status series: useful, but not well defined.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Idukathole series within I set.
Idukathole series represents I set.

SERIES IN INGOJE

Series differential criteria: medium to heavy texture.

Analytical data: yes

Soil correlation: FAO 1988: Umbric/Dystric Fluvisols/Gleysols
Soil Taxonomy 1990: Typic Fluvaquents/Fluventic Humaquepts

Occurrence: common

Status series: not very relevant, may be merged with Idukathole series.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Ingoje series within I set.
Represented by Idukathole series.

SERIES IM IMBOJANE

Series differential criteria: clay of waterholes.

Analytical data: yes

Soil correlation: FAO 1988: Fluvisols/Gleysols
Soil Taxonomy 1990: Fluvents/Aquents

Occurrence: very minor

Status series: not relevant

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Imbojane series within I set. Not
represented.

SERIES IV IVY

Series differential criteria: gravelly lacustrine clay.

Analytical data: no

Soil correlation: FAO 1988: Calcic/Eutric Gleysols
Soil Taxonomy 1990: Aeric/Typic Haplaquepts

Occurrence: very minor

Status series: obsolete

Series use in physiographic/agro-ecological units:
complete specific geographic distribution of Ivy series within I set. Not
represented.

SET JH

Main characteristics: thick stoneline at about 30-60cm depth, underlain by

deep red soil or saprolite, moderately well drained.

Overlap of definition with other sets: with O and TH set.

Remarks: series differentiation not well defined.

SERIES JW JUWEEL

Series differential criteria: medium textured topsoil, medium to heavy textured subsoil.

Analytical data: yes

Soil correlation: FAO 1988: Eutric Regosols/Chromic Lixisols, skeletal phase
Soil Taxonomy 1990: Typic Ustorthents/Kanhaplic Haplustalfs

Occurrence: major

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Juweel series within JH set. Juweel series represents JH set.

SERIES JB JOLOBELA

Series differential criteria: subsoil usually weathering rock.

Analytical data: yes

Soil correlation: FAO 1988: Dystric Regosols, skeletal phase
Soil Taxonomy 1990: Typic Ustorthents/Udorthents

Occurrence: common

Status series: not very relevant

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Jolobela series within JH set. Represented by Juweel series.

SERIES JH JOHANNESLOOP

Series differential criteria: vague

Analytical data: yes

Soil correlation: FAO 1988: Eutric/Dystric Regosols, skeletal phase
Soil Taxonomy 1990: Typic Ustorthents

Occurrence: minor

Status series: not relevant, may be merged with Juweel series.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Johannesloop series within JH set.

Represented by Juweel series.

SET JL

Main characteristics: very deep, light texture, horizons merge, well to somewhat excessively drained.

Overlap of definition with other sets: with E set.

Remarks: series differentiation based on texture is overlapping.

SERIES JV JOVANE

Series differential criteria: reddish grey, loamy sand to sandy loam.

Analytical data: yes

Soil correlation: FAO 1988: Haplic Arenosols/Dystric/Eutric Cambisols
Soil Taxonomy 1990: Typic Ustipsamments/Typic Ustochrepts

Occurrence: common

Status series: useful, but better confined to sand/loamy sand only.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Jovane series within JL set. Jovane series represents JL set.

SERIES JK JEKHI

Series differential criteria: greyish to orange, sandy loam.

Analytical data: no

Soil correlation: FAO 1988: Dystric/Eutric Cambisols
Soil Taxonomy 1990: Typic Ustochrepts

Occurrence: common

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Jekhi series within JL set. Represented by Jovane series.

SET K

Main characteristics: moderately deep black or very dark grey cracking clay, on basic rock (lithomorphic), imperfectly drained (described as poorly).

Overlap of definition with other sets: with C and V set.

Remarks: The subdivision of series on the basis of occurrence of carbonates is not well defined and non practical. Also because of minor occurrence King

and Kwamtusse series seem rather superfluous.

SERIES KZ KWEZI

Series differential criteria: calcareous throughout.

Analytical data: yes

Soil correlation: FAO 1988: Calcic Vertisols
Soil Taxonomy 1990: Typic Pellusterts

Occurrence: major

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Kwezi series within K set. Kwezi series represents K set.

SERIES KN KING

Series differential criteria: upper soil non calcareous.

Analytical data: no

Soil correlation: FAO 1988: Calcic Vertisols
Soil Taxonomy 1990: Typic Pellusterts

Occurrence: minor

Status series: not practical

Series use in physiographic/agro-ecological units:
part specific geographic distribution of King series within K set. Represented by Kwezi series.

SERIES KT KWAMTUSSE

Series differential criteria: calcareous throughout, indurated lime pan in subsoil, usually unbroken.

Analytical data: no

Soil correlation: FAO 1988: Petri-Calcic Vertisols
Soil Taxonomy 1990: Typic Pellusterts

Occurrence: very minor

Status series: not very useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Kwamtusse series within K set. Represented by Kwezi series.

SET L

Main characteristics: very deep red sandy clay to clay, strong blocky or nutty structure, gradual horizon boundaries, well drained.

Overlap of definition with other sets: with W, O and R set.

Remarks: the soils of the Lutzi and Ludomba series do not fit the concept of the L set (deep soils with gradual horizon boundaries) and should be accommodated elsewhere.

SERIES LE LESIBOVU

Series differential criteria: red, very deep (deeper than 200cm), gradual horizon boundaries.

Analytical data: yes

Soil correlation: FAO 1988: Rhodi-Chromic Luvisols/Lixisols
Soil Taxonomy 1990: Rhodic/Kandic Paleustalfs

Occurrence: common

Status series: useful

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Lesibovu series within L set.
Lesibovu series represents Lutzi and Ludomba series.

SERIES LO LOMHASHENTI

Series differential criteria: occurs on ignimbrite only.

Analytical data: yes

Soil correlation: FAO 1988: Humic/Rhodic Nitisols
Soil Taxonomy 1990: Typic Paleustolls

Occurrence: common

Status series: useful

Series use in physiographic/agro-ecological units:
complete specific geographic distribution of Lomhasheni series within L set.

SERIES LU LUTZI

Series differential criteria: moderately deep on weathered rock. Does not fit the L set concept.

Analytical data: yes

Soil correlation: FAO 1988: Chromic Luvisols
Soil Taxonomy 1990: Typic Rhodustalfs

Occurrence: minor

Status series: not relevant

Series use in physiographic/agro-ecological units:

no complete specific geographic distribution of Lutzi series within L set. Represented by Lesibovu series.

SERIES LD LUDOMBA

Series differential criteria: distinct horizon boundaries, colluviated greyish brown sandy topsoil covering red subsoil. Does not fit the L set concept.

Analytical data: yes

Soil correlation: FAO 1988: Chromic Luvisols
Soil Taxonomy 1990: Typic Rhodustalfs

Occurrence: minor

Status series: not relevant

Series use in physiographic/agro-ecological units:

part specific geographic distribution of Ludomba series within L set. Represented by Lesibovu series.

SET M

Main characteristics: strongly weathered very deep red to orange sandy clay to clay, generally weak structure and gradual horizon boundaries, relatively acid and low CEC clay, well drained.

Overlap of definition with other sets: with NH, QH, ZL and L set.

Remarks: The subdivision into eight series is not balanced and logical. The Mooihoek series differs from the other M series by having a much higher CEC clay. Also because of the low base saturation it would better fit the NH set. The minor Madevu, Mzawo and Munali series represent lower level phase criteria and are rather irrelevant. The Mtilane series also represents a phase criterion, a stone line, which has an irregular occurrence. The minor Mbeli series is very vaguely defined and should be merged with the Mdutshane series which is also orange. Additional analytical data indicate that soils of the Malkerns series are more acid and have a lower base saturation than the Murdoch data suggest. Also clay contents seem generally much higher. Most M set profiles show a clear clay increase with depth. Areas mapped by Murdoch as M set are not always confirmed as M set. M set soils mapped in e.g. the Pigg's Peak area (perhaps mostly Mdutshane and Mbeli series) largely consist of weathering material, and seem to fit other sets such as NH or QH.

SERIES MA MALKERNS

Series differential criteria: structured argic/kandic horizon in upper part (30-80cm) of subsoil.

Analytical data: yes

Soil correlation: FAO 1988: Geric/Rhodic Ferralsols
Soil Taxonomy 1990: Rhodic Acrustox/Kandiustox

Occurrence: major

Status series: useful

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Malkerns series within M set.

SERIES MT MTILANE

Series differential criteria: thin quartz stoneline in upper meter.

Analytical data: yes

Soil correlation: FAO 1988: Geric/Rhodic Ferralsols
Soil Taxonomy 1990: Rhodic Acrustox/Kandiustox

Occurrence: common

Status series: not practical because of irregular occurrence in complex with Malkerns series, may be merged with Malkerns series and distinguished at lower phase level.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Mtilane series within M set.
Represented by Malkerns series.

SERIES MO MOOIHOEK

Series differential criteria: medium texture, pale red, often on rocks of Pongola system. Does not fit M set for reasons of high CEC clay.

Analytical data: yes

Soil correlation: FAO 1988: Haplic Alisols
Soil Taxonomy 1990: Paleustults

Occurrence: common

Status series: useful, but probably more appropriate in NH set.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Mooihoek series within M set.

SERIES MD MDUTSHANE

Series differential criteria: medium texture, orange

Analytical data: yes

Soil correlation: FAO 1988: Xanthic/Haplic Ferralsols
Soil Taxonomy 1990: Xanthic/Typic Kandiustox

Occurrence: common

Status series: useful, but not precisely defined.

Series use in physiographic/agro-ecological units:

no specific geographic distribution of series within M set. Represented by Malkerns series.

SERIES MB MBELI

Series differential criteria: orange

Analytical data: no

Soil correlation: FAO 1988: Xanthic/Haplic Ferralsols
Soil Taxonomy 1990: Xanthic/Typic Kandiuustox

Occurrence: minor

Status series: not relevant and not well defined, may be merged with Mdutshane series.

Series use in physiographic/agro-ecological units:

no specific geographic distribution of Mbeli series within M set. Represented by Malkerns series.

SERIES MV MADEVU

Series differential criteria: associated with boulders.

Analytical data: no

Soil correlation: FAO 1988: Rhodic Ferralsols
Soil Taxonomy 1990: Rhodic Kandiuustox

Occurrence: minor

Status series: not practical, may be merged with Malkerns series.

Series use in physiographic/agro-ecological units:

no specific geographic distribution of Madevu series within M set. Represented by Malkerns series.

SERIES MZ MZAWO

Series differential criteria: admixture with sandy colluvium in topsoil.

Analytical data: no

Soil correlation: FAO 1988: Rhodic Ferralsols
Soil Taxonomy 1990: Rhodic Kandiuustox

Occurrence: minor

Status series: not practical, may be merged with Malkerns series.

Series use in physiographic/agro-ecological units:

part specific geographic distribution of Mzawo series within M set. Represented by Malkerns series.

SERIES MU MUNALI

Series differential criteria: red to brown loam topsoil over clay at 20-40cm, over deep red loam.

Analytical data: no

Soil correlation: FAO 1988: Rhodic Ferralsols
Soil Taxonomy 1990: Rhodic Kandustox

Occurrence: very minor

Status series: obsolete

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Munali series within M set.
Represented by Malkerns series.

SET NH

Main characteristics: dark humic top, very deep, yellow to reddish yellow subsoil, medium texture, acid, well drained.

Overlap of definition with other sets: with TH set.

Remarks: Series subdivision into 130cm deep and more than 130cm deep does not seem practical.

SERIES ND NDUMA

Series differential criteria: very deep

Analytical data: yes

Soil correlation: FAO 1988: Humic/Haplic Acrisols/Alisols
Soil Taxonomy 1990: Ustic/Typic Palehumults/Paleustults

Occurrence: major

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Nduma series within NH set. Nduma series represents NH set.

SERIES NG NGAZI

Series differential criteria: deep

Analytical data: no

Soil correlation: FAO 1988: Humic/Haplic Acrisols/Alisols
Soil Taxonomy 1990: Ustic/Typic Haplohumults
Kanhaplic/Typic Haplustults

Occurrence: common

Status series: not very relevant, may be merged with Nduma series.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Ngazi series within NH set.
Represented by Nduma series.

SET NL

Main characteristics: brown medium textured soil over red clay, well drained.

Overlap of definition with other sets: with R set.

Remarks: Vague and irrelevant set definition. NL set is an obsolete set mapped with R set. The set should be deleted and classified as a phase of R set.

SERIES NH NHLOYA

Series differential criteria: not specific

Analytical data: no

Soil correlation: FAO 1988: Chromic Luvisols
Soil Taxonomy 1990: Ustalfic Haplargids

Occurrence: minor

Status series: not mapped and not relevant, to be merged with R set.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Nhloya series within NL set.
Represented by R set.

SERIES NS NSOKO

Series differential criteria: thin alluvial top layer.

Analytical data: no

Soil correlation: FAO 1988: Chromic Luvisols
Soil Taxonomy 1990: Ustalfic Haplargids

Occurrence: very minor

Status series: not mapped and obsolete.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Nsoko series within NL set.
Represented by R set.

SET O

Main characteristics: shallow (often less than 40cm), light and medium texture, well to somewhat excessively drained.

Overlap of definition with other sets: with JH, U, L set.

Remarks: O set is defined as Lithosols, but a large variation in soil depth is allowed within the set and series. The effective or rooting depth may be as deep as 90cm (Orrin series), and hard rock much deeper. Such a wide set definition results in overlap with series of other sets. Most series lack precise depth criteria, which makes distinction and correlation difficult. Field checks have confirmed the large variety of O set soils. It also appeared that mollic, cambic and argic horizons frequently occur.

SERIES OT OTANDWENI

Series differential criteria: hard rock within 30cm.

Analytical data: yes

Soil correlation: FAO 1988: Lithic/Eutric/Dystric Leptosols
Soil Taxonomy 1990: Lithic Ustorthents

Occurrence: major

Status series: useful

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Otandweni series within O set.

SERIES OR ORRIN

Series differential criteria: moderately deep, weathered rock at 90cm.

Analytical data: yes

Soil correlation: FAO 1988: Regosols/Cambisols/Luvisols
Soil Taxonomy 1990: Typic Ustorthents/Ustochrepts/Haplustalfs

Occurrence: major

Status series: useful

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Orrin series within O set.

SERIES OL OLDREEF

Series differential criteria: yellowish loamy sand, probably shallow depth (30-50cm) only.

Analytical data: yes

Soil correlation: FAO 1988: Dystric Regosols, lithic/skeletal phase
Soil Taxonomy 1990: Typic/Lithic Ustorthents/Udorthents

Occurrence: common

Status series: useful, but not well defined.

Series use in physiographic/agro-ecological units:
complete specific geographic distribution of Oldreef series within O set.

SERIES OU OUTSPAN

Series differential criteria: more humic, reddish brown loamy sand to sandy loam, probably shallow depth (30-50cm) only.

Analytical data: no

Soil correlation: FAO 1988: Haplic Phaeozems, lithic/skeletal phase
Soil Taxonomy 1990: Lithic/Typic Haplustolls

Occurrence: common

Status series: useful, but not well defined.

Series use in physiographic/agro-ecological units:
complete specific geographic distribution of Outspan series within O set.

SERIES OK ONGELUK

Series differential criteria: orange or pale red, on rocks of Pongola system, probably shallow depth (30-50cm) only.

Analytical data: yes

Soil correlation: FAO 1988: Eutric/Dystric Regosols, lithic/skeletal phase
Soil Taxonomy 1990: Typic/Lithic Ustorthents

Occurrence: common

Status series: not relevant, may be merged with Oldreef series.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Ongeluk series within O set.
Represented by Oldreef series.

SERIES OM OMHLANDLU

Series differential criteria: orange or yellow, light or medium texture, shallow to moderately deep, on upper Karoo sandstone.

Analytical data: no

Soil correlation: FAO 1988: Eutric Regosols, part skeletal phase.
Soil Taxonomy 1990: Typic Ustorthents

Occurrence: common

Status series: not relevant, may be merged with Otandweni or Orrin series.

Series use in physiographic/agro-ecological units:

part specific geographic distribution of Omhlandlu series within O set. Represented by Otandweni and Orrin series.

SERIES OS OSAGULENI

Series differential criteria: reddish sandy loam, truncated L set, probably shallow to moderately deep.

Analytical data: no

Soil correlation: FAO 1988: Eutric Regosols, part skeletal phase.
Soil Taxonomy 1990: Typic Ustorthents

Occurrence: common

Status series: not relevant, may be merged with Orrin or Otandweni series.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Osaguleni series within O set. Represented by Otandweni and Orrin series.

SET P

Main characteristics: light textured topsoil over weathered rock or heavier textured subsoil, shallow to moderately deep, imperfectly drained.

Overlap of definition with other sets: with O, H, JH and ZL set.

Remarks: Weakly defined set without distinct characteristics. Pofane series falls within O set concept, Petronella series within H set concept and Peebles series within JH or O set concept. There is no practical use of P set.

SERIES PO POFANE

Series differential criteria: sandy topsoil, not abruptly overlying weathered rock.

Analytical data: yes

Soil correlation: FAO 1988: Eutric Regosols
Soil Taxonomy 1990: Typic Ustorthents

Occurrence: common

Status series: not relevant, may be merged with Orrin and Otandweni series.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Pofane series within P set.

SERIES PT PETRONELLA

Series differential criteria: sandy topsoil, abruptly overlying sandy clayloam or sandy clay.

Analytical data: yes

Soil correlation: FAO 1988: Eutric Planosols
Soil Taxonomy 1990: Aquic/Kandic/Typic Paleustalfts/Haplustalfts

Occurrence: common

Status series: not relevant, may be merged with H set.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Petronella series within P set.

SERIES PB PEBBLES

Series differential criteria: thick quartz stoneline.

Analytical data: yes

Soil correlation: FAO 1988: Eutric Regosols, skeletal phase
Soil Taxonomy 1990: Typic Ustorhents

Occurrence: minor

Status series: not relevant, may be merged with JH or O set.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Peebles series within P set.
Represented by Pofane series.

SET QH

Main characteristics: deep to very deep, medium texture, grey topsoil, gravelly red to yellow subsoil, merging horizons, on rotten rock, somewhat excessively drained.

Overlap of definition with other sets: with A and M set.

Remarks: series differentiation based on colour only.

SERIES QO QOLWENI

Series differential criteria: red subsoil.

Analytical data: yes

Soil correlation: FAO 1988: Rhodic Ferralsols/Haplic Acrisols
Soil Taxonomy 1990: Rhodic Haplustox/Hapludox
Rhodic Kandistults/Kandiudults
Paleustults/Paleudults/Rhodustults/Rhodudults

Occurrence: major

Status series: useful but not precisely defined

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Qolweni series within QH set. Qolweni

series represents QH set.

SERIES QB QWABISE

Series differential criteria: orange to yellow subsoil.

Analytical data: no

Soil correlation: FAO 1988: Xanthic/Haplic Ferralsols/Haplic Acrisols
Soil Taxonomy 1990: Typic Haplustox/Hapludox
Typic Kandistults/Kandiudults
Paleustults/Paleudults/Haplustults/Hapludults

Occurrence: common

Status series: not very relevant

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Qwabise series within QH set.
Represented by Qolweni series.

SET QL

Main characteristics: sandy topsoil, abruptly overlying sodic clayey subsoil.

Overlap of definition with other sets: with H, P and ZL set.

Remarks: definition and separation of QL set is not based on analytical data. Very minor occurrence compared to other sets, especially ZL, which may have similar characteristics. Probably better accommodated as series within ZL set.

SERIES QU QUALM

Series differential criteria: only one series.

Analytical data: no

Soil correlation: FAO 1988: Abrupti-Stagnic Solonetz
Soil Taxonomy 1990: Albic/Typic Natraqualfs/Aquic Natrustalfs

Occurrence: very minor

Status series: useful, but not mapped and obsolete. Actual occurrence probably underestimated (mapped as H and ZL set).

Series use in physiographic/agro-ecological units:
not relevant.

SET R

Main characteristics: dark reddish, clayey (generally no clay increase with depth, except for Rathbone), moderately deep to very deep, well structured,

relatively high base saturation and CEC clay, well to imperfectly drained.

Overlap of definition with other sets: with O, K, T and C set.

Remarks: Series differentiation not logical and practical. Rasheni and Rhebok series fall within concept of K and TL set respectively, apart from perhaps slightly more reddish colour (not defined). Reidbult series is obscure and not well defined. Rondspring series is rather shallow, would also fit O set. There is a gap between Rondspring (moderately deep) and Rathbone (very deep) series.

Field checks indicate that mollic and argic horizons quite frequently occur.

SERIES RO RONDSRING

Series differential criteria: moderately deep

Analytical data: yes

Soil correlation: FAO 1988: Chromic Cambisols
Soil Taxonomy 1990: Typic Ustochrepts/Ustollic Camborthids

Occurrence: major

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Rondspring series within R set.

SERIES RT RATHBONE

Series differential criteria: very deep

Analytical data: yes

Soil correlation: FAO 1988: Chromic Cambisols/Luvisols
Soil Taxonomy 1990: Typic Ustochrepts/Ustollic Camborthids
Ultic/Typic Paleustalfs/Ustollic Haplargids

Occurrence: common

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Rathbone series within R set.

SERIES RK RHEBOK

Series differential criteria: iron concretions or soft iron pan at moderate depth.

Analytical data: yes

Soil correlation: FAO 1988: Vertic Cambisols
Soil Taxonomy 1990: Vertic Ustochrepts

Occurrence: minor

Status series: not very practical, may be merged with T set (only slightly different colour).

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Rhebok series within R set.

SERIES RS RASHENI

Series differential criteria: strongly vertic, imperfectly drained. Does not fit the R set concept.

Analytical data: yes

Soil correlation: FAO 1988: Calcic Vertisols
Soil Taxonomy 1990: Typic Chromusterts

Occurrence: minor

Status series: not relevant, may be merged with K set.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Rasheni series within R set.

SERIES RE REIDBULT

Series differential criteria: very vague

Analytical data: no

Soil correlation: FAO 1988: Chromic Cambisols
Soil Taxonomy 1990: Typic Ustochrepts

Occurrence: very minor

Status series: obsolete and not practical, may be merged with Rondspring or Rathbone series.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Reidbult series within R set.
Represented by Rondspring series.

SET SH

Main characteristics: dark humic top, moderately deep to deep, medium texture, well structured, on basic rock, well to moderately well drained.

Overlap of definition with other sets: with CH and SL set.

Remarks: Highveld soil also occurring in Lower Middleveld and Lowveld. Lowveld samples may have raised average base saturation figures, which seem relatively high for Highveld soils.

SERIES SA SANGWENI

Series differential criteria: moderately deep to deep

Analytical data: yes

Soil correlation: FAO 1988: Haplic/Luvic Phaeozems
Soil Taxonomy 1990: Udic/Typic Haplustolls/Argiustolls

Occurrence: major

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Sangweni series within SH set.
Sangweni series represents SH set.

SERIES SV SIVULO

Series differential criteria: moderately deep

Analytical data: no

Soil correlation: FAO 1988: Haplic/Luvic Phaeozems
Soil Taxonomy 1990: Udic/Typic Haplustolls/Argiustolls

Occurrence: common

Status series: not very relevant, may be merged with Sangweni series.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Sivulo series within SH set.
Represented by Sangweni series.

SET SL

Main characteristics: very shallow to shallow, medium to heavy texture, dark coloured, on basic rock, well to moderately well drained.

Overlap of definition with other sets: with SH, CL and R set.

Remarks: The subdivision into series seems unbalanced with Somerling series by far dominant and all other series rather vaguely defined as intergrades (without analytical data). The used criteria (colour and carbonate contents) are overlapping. The Spekboom series, rather poorly defined and described to predominantly occur in Middleveld and Highveld, should be accommodated elsewhere and deleted as S Lowveld series.

SERIES SO SOMERLING

Series differential criteria: dark brown

Analytical data: yes

Soil correlation: FAO 1988: Mollic/Eutric Leptosols
Eutric Regosols/Haplic Phaeozems, skeletal phase
Soil Taxonomy 1990: Lithic/Typic Ustorthents
Lithic/Aridic/Entic/Typic Haplustolls

Occurrence: major

Status series: useful

Series use in physiographic/agro-ecological units:

part specific geographic distribution of Somerling series within SL set.
Somerling series also represents other series of SL set.

SERIES SK SIKHUTWANE

Series differential criteria: dark red

Analytical data: no

Soil correlation: FAO 1988: Eutric Leptosols/Regosols, skeletal phase
Soil Taxonomy 1990: Typic Ustorthents

Occurrence: common

Status series: not very practical, may be merged with Somerling series.

Series use in physiographic/agro-ecological units:

no specific geographic distribution of Sikhutwane series within SL set.
Represented by Somerling series.

SERIES ST STEGI

Series differential criteria: dark brown, shallow, on ignimbrite.

Analytical data: no

Soil correlation: FAO 1988: Haplic Phaeozems, skeletal phase
Soil Taxonomy 1990: Entic/Typic Haplustolls

Occurrence: common

Status series: useful, but not well defined.

Series use in physiographic/agro-ecological units:

complete specific geographic distribution of Stegi series within SL set.

SERIES SH SHEBANI

Series differential criteria: vertic properties, calcareous topsoil,
petrocalcic horizon.

Analytical data: no

Soil correlation: FAO 1988: Verti-Petri-Calcic Kastanozem
Soil Taxonomy 1990: Lithic Petrocalcic/Torrertic Calciustoll

Occurrence: minor

Status series: useful

Series use in physiographic/agro-ecological units:

no specific geographic distribution of Shebani series within SL set.

Represented by Somerling series.

SERIES SP SPEKBOOM

Series differential criteria: vertic properties, loam to clayloam, top 30cm non calcareous, mainly in Middleveld and Highveld (!).

Analytical data: no

Soil correlation: FAO 1988: Vertic Cambisols/Haplic Phaeozems, skeletal phase

Soil Taxonomy 1990: Vertic Ustochrepts/Torrertic/Vertic Haplustolls

Occurrence: minor

Status series: not relevant and not logical to also occur in Highveld, may be merged with other series of SL, SH or CL set.

Series use in physiographic/agro-ecological units:

part specific geographic distribution of Spekboom series within SL set. Represented by Somerling series.

SET TH

Main characteristics: greyish moderately deep (30-80cm), very acid, loamy sand to sandy loam on deeply weathered whitish soft rock.

Overlap of definition with other sets: with NH set.

Remarks: The series subdivision based on minor colour differences is not very relevant. The subordinate Torgyle series, without analytical data, is better deleted.

SERIES TX TATANI

Series differential criteria: reddish grey over whitish subsoil.

Analytical data: yes

Soil correlation: FAO 1988: Dystric Regosols/Cambisols

Soil Taxonomy 1990: Typic Ustorhents/Udorthents

Typic Ustochrepts/Dystochrepts

Occurrence: major

Status series: useful

Series use in physiographic/agro-ecological units:

no specific geographic distribution of Tatani series within TH set. Tatani series represents TH set.

SERIES TO TORGYLE

Series differential criteria: yellowish grey over whitish to orange subsoil.

Analytical data: no

Soil correlation: FAO 1988: Dystric Regosols/Cambisols
Soil Taxonomy 1990: Typic Ustorthents/Udorthents
Typic Ustochrepts/Dystochrepts

Occurrence: minor

Status series: not relevant, may be merged with Tateni series.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Torgyle series within TH set.
Represented by Tateni series.

SET TL

Main characteristics: dark grey or dark brown, medium to heavy texture, imperfectly to poorly drained.

Overlap of definition with other sets: with K and CL set.

Remarks: Very general definition of set, hence overlapping with other sets. The very minor Tshaneni and Thorburn series are poorly defined and irrelevant.

SERIES TM TAMBANKULU

Series differential criteria: vertic properties, iron concretions and soft iron pan at moderate depth, over weathering basalt.

Analytical data: yes

Soil correlation: FAO 1988: Eutric Vertisols/Ferri-Vertic Luvisols
Soil Taxonomy 1990: Typic Chromusterts/Vertic Haplustalfs

Occurrence: common

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Tambankulu series within TL set.
Tambankulu series represents TL set.

SERIES TS TSHANENI

Series differential criteria: lenses of grey clay within or below iron layer.

Analytical data: no

Soil correlation: FAO 1988: Eutric Vertisols/Ferri-Vertic Luvisols
Soil Taxonomy 1990: Typic Chromusterts/Vertic Haplustalfs

Occurrence: very minor

Status series: not relevant, may be merged with Tambankulu series.

Series use in physiographic/agro-ecological units:

no specific geographic distribution of Tshaneni series within TL set.
Represented by Tambankulu series.

SERIES TH THORBURN

Series differential criteria: clay loam, moderately to very deep, orange mottling, no iron pan.

Analytical data: no

Soil correlation: FAO 1988: Vertic Luvisols
Soil Taxonomy 1990: Vertic Haplustalfs

Occurrence: very minor

Status series: not relevant and obsolete.

Series use in physiographic/agro-ecological units:

no specific geographic distribution of Thorburn series within TL set.
Represented by Tambankulu series.

SET U

Main characteristics: rock outcrops, unconsolidated debris of talus slopes, alluvial pebbles, etc. Steep and very steep slopes, somewhat excessively or excessively drained. Includes small pockets of associated very shallow and shallow soil.

Overlap of definition with other sets: with O set.

Remarks: The areas mapped as U set contain quite a substantial proportion of shallow soils (on both hard and weathered rock). Proportions of rock outcrops and debris are often only moderate. U set is more defined as a mapping unit than as a soil type. Shallow and very shallow soils are only vaguely covered by the U set definition, and a clear boundary with the O set is missing.

SERIES UN UNGABOLIMA

Series differential criteria: non or slightly weathered hard rock predominant at the surface.

Analytical data: no

Soil correlation: FAO 1988: Lithic Leptosols
Soil Taxonomy 1990: Lithic Ustorthents/Udorthents

Occurrence: major

Status series: useful

Series use in physiographic/agro-ecological units:

no specific geographic distribution of Ungabolima series within U set.
Ungabolima series represents U set.

SERIES UC UPCOUNTRY

Series differential criteria: unconsolidated debris

Analytical data: no

Soil correlation: FAO 1988: Dystric Leptosols, part lithic phase
Soil Taxonomy 1990: Typic/Lithic Ustorthents/Udorthents

Occurrence: major

Status series: not very useful due to lack of quantitative definition.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Upcountry series within U set.
Represented by Ungabolima series.

SERIES UB UMBELUZI

Series differential criteria: rocky valley floors and associated gravelly and stony drift material of colluvial-alluvial origin.

Analytical data: no

Soil correlation: FAO 1988: Lithic/Eutric Leptosols
Soil Taxonomy 1990: Lithic/Typic Ustorthents

Occurrence: major

Status series: not very relevant and not distinctly different from other U series.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Umbeluzi series within U set.
Represented by Ungabolima series.

SET V

Main characteristics: dark, clayey, strongly vertic, topomorphic, calcareous but generally no calcic horizon, poorly drained.

Overlap of definition with other sets: with K set.

Remarks: Series differentiation not practical.

SERIES VA VALUMGWACO

Series differential criteria: low sodium level.

Analytical data: yes

Soil correlation: FAO 1988: Eutric Vertisols
Soil Taxonomy 1990: Typic Pellusterts

Occurrence: minor

Status series: useful

Series use in physiographic/agro-ecological units:

part specific geographic distribution of Valumgwaco series within V set. Valumgwaco series represents V set.

SERIES VM VIMY

Series differential criteria: moderate sodium levels (ESP around 20).

Analytical data: yes

Soil correlation: FAO 1988: Eutric Vertisols
Soil Taxonomy 1990: Typic Pellusterts

Occurrence: minor

Status series: not very practical, may be merged with Valumgwaco series.

Series use in physiographic/agro-ecological units:

part specific geographic distribution of Vimy series within V set. Represented by Valumgwaco series.

SERIES VU VUSO

Series differential criteria: topsoil non calcareous.

Analytical data: no

Soil correlation: FAO 1988: Eutric Vertisols
Soil Taxonomy 1990: Typic Pellusterts

Occurrence: very minor

Status series: not very relevant, may be merged with Valumgwano series.

Series use in physiographic/agro-ecological units:

part specific geographic distribution of Vuso series within V set. Represented by Valumgwaco series.

SET W

Main characteristics: alluvium of river terraces, very deep, brown to red sandy loam to sandy clayloam, predominantly well drained.

Overlap of definition with other sets: with L set.

Remarks: Winn series is the central concept of the set; the three other series are of minor occurrence and weakly defined. Waspageni series is distinguished by subsoil gravel at variable depth, which is a phase criterion. Wisselrode series is imperfectly drained and has vertic characteristics, without a heavy texture. Whiterock series is another intergrade, with lime in the subsoil.

SERIES WN WINN

Series differential criteria: orange, non gravelly and non calcareous, well drained.

Analytical data: yes

Soil correlation: FAO 1988: Chromic Luvisols/Cambisols
Soil Taxonomy 1990: Typic Paleustalfs/Ustalfic Haplargids
Typic Ustochrepts/Ustochreptic Camborthids

Occurrence: common

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Winn series within W set. Winn series represents W set.

SERIES WA WASPAGENTI

Series differential criteria: orange, gravel layers within 100cm from the surface, non calcareous, well drained.

Analytical data: no

Soil correlation: FAO 1988: Chromic Luvisols/Cambisols
Soil Taxonomy 1990: Typic Haplustalfs/Ustalfic Haplargids
Typic Ustochrepts/Ustochreptic Camborthids

Occurrence: very minor

Status series: not practical at this level, may be merged with Winn series.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Waspagenti series within W set. Represented by Winn series.

SERIES WS WISSELRODE

Series differential criteria: slightly vertic properties and heavier subsoil, brown, calcareous, imperfectly drained.

Analytical data: no

Soil correlation: FAO 1988: Vertic/Haplic Luvisols
Soil Taxonomy 1990: Vertic/Typic Haplustalfs

Occurrence: very minor

Status series: obsolete and not practical as intergrade, may be merged with Vimy or Winn series.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Wisselrode series within W set. Represented by Winn series.

SERIES WH WHITEROCK

Series differential criteria: lime at 100cm depth, moderately well drained.

Analytical data: no

Soil correlation: FAO 1988: Chromi-Calcic Luvisols/Cambisols
Soil Taxonomy 1990: Typic Haplustalfs/Ustalfic Haplargids
Typic Ustochrepts/Ustochreptic Camborthids

Occurrence: very minor

Status series: useful, but quite obsolete.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of series within W set. Represented by Winn series.

SET X

Main characteristics: coarse textured stratified alluvium of floodplains and channels, no profile differentiation.

Overlap of definition with other sets: with B and U set.

Remarks: In essence not different from B set, and probably better merged.

SERIES XU XULWANE

Series differential criteria: polychrome gravels

Analytical data: no

Soil correlation: FAO 1988: Eutric Fluvisols, rudic phase
Soil Taxonomy 1990: Typic Ustifluvents

Occurrence: minor

Status series: not very relevant, may be merged with B set.

Series use in physiographic/agro-ecological units:
only one series, but because of minor occurrence not applied.

SET Y

Main characteristics: saline or saline-alkaline, dark, deep to very deep, calcareous, poorly drained.

Overlap of definition with other sets: with K, V, H and ZL sets.

Remarks: Salinity is due to irrigation. Recorded electric conductivity as a measure for salinity does not qualify for salic properties and classification as Solonchak. Very minor area which can be reclaimed. Recognition at set level seems doubtful, rather a phase of another set.

Distinction of two series seems exaggerated, especially considering the acid (!) top of the Yakeni series.

SERIES YO YOUNGSVLEI

Series differential criteria: dark brown, salt patches in top soil.

Analytical data: yes

Soil correlation: FAO 1988: Calcic/Eutric Vertisols
Soil Taxonomy 1990: Typic Pellusterts

Occurrence: very minor

Status series: not mapped, not relevant, may be obsolete.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Youngsvlei series within Y set.
Youngsvlei series not used because of very minor occurrence.

SERIES YA YAKENI

Series differential criteria: dark grey, acid in top.

Analytical data: yes

Soil correlation: FAO 1988: Calcic/Eutric Vertisols
Soil Taxonomy 1990: Typic Pellusterts

Occurrence: very minor

Status series: not mapped, not relevant, may be obsolete.

Series use in physiographic/agro-ecological units:
part specific geographic distribution of Yakeni series within Y set. Yakeni series not used because of very minor occurrence.

SET ZH

Main characteristics: red to orange sandy clayloam to sandy clay, truncated M set profiles, weathering rock at 90cm depth, well drained.

Overlap of definition with other sets: with M set.

Remarks: ZH set should have been placed as a series of M set. Weathering rock is defined to occur at 90cm, but it is not clear whether also shallower profiles, e.g. of 60cm depth, classify as ZH or fall into another set. The boundary with M set is also not defined, it could be at 100cm but also deeper. The distinction between Zombode and Zayifu series is only based on the colour difference red to orange.

SERIES ZO ZOMBODE

Series differential criteria: red

Analytical data: no

Soil correlation: FAO 1988: Rhodic Ferralsols
Soil Taxonomy 1990: Rhodic Kanhaplustults/Kandiustox

Occurrence: common

Status series: useful, but not practical as a series of a separate ZH set, may be merged with M set.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Zombode series within ZH set. Represented by Malkerns series.

SERIES ZA ZAYIFU

Series differential criteria: orange

Analytical data: no

Soil correlation: FAO 1988: Haplic Ferralsols
Soil Taxonomy 1990: Typic Kanhaplustults/Haplustox

Occurrence: minor

Status series: not very relevant as a series of a separate ZH set, may be merged with M set.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Zayifu series within ZH set. Represented by Malkerns series.

SET ZL

Main characteristics: grey sandy loam, abruptly overlying dark grey prismatic sandy clay with vertic properties, over olive calcareous subsoil, poorly drained.

Overlap of definition with other sets: with H set.

Remarks: The main set characteristic, the abrupt textural boundary, does not apply to the Zikane series (see analyses). Soils of the Zikane series, defined as a saline-alkaline intergrade, are neither saline nor alkaline (see analyses). These soils are better placed elsewhere in the system, but need to be properly defined in the first place. From the description it is assumed that the Zwakela series lacks the olive calcic horizon and has imperfect drainage. The Zebra series is based on a phase criterion, having a top layer of undefined thickness of alluvial wash of B set material. Although the average sodium and magnesium levels are not quite sufficient for a natric horizon, part of the set is undoubtedly characterized by natric horizons.

SERIES ZD ZWIDE

Series differential criteria: albic horizon 0-30cm, calcic horizon 110-

150cm.

Analytical data: yes

Soil correlation: FAO 1988: Verti-Eutric Planosols/Calci-Stagnic Solonetz
Soil Taxonomy 1990: Vertic Albaqualfs/Albic Glossic Natraqualfs

Occurrence: major

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Zwide series within ZL set. Zwide series represents ZL set.

SERIES ZL ZWAKELA

Series differential criteria: albic horizon at surface and less than 20cm thick, rock at 60-80cm, not highly calcareous.

Analytical data: no

Soil correlation: FAO 1988: Verti-Eutric Planosols/Stagnic Solonetz
Soil Taxonomy 1990: Vertic Albaqualfs/Albic Glossic Natraqualfs

Occurrence: common

Status series: useful

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Zwakela series within ZL set. Represented by Zwide series.

SERIES ZN ZIKANE

Series differential criteria: no textural contrast, in gully wash material. Does not fit ZL set concept.

Analytical data: yes

Soil correlation: FAO 1988: Calcic Gleysols/Gleyic Solonetz
Soil Taxonomy 1990: Vertic Ochraqualfs/Typic Natraqualfs

Occurrence: common

Status series: not relevant and not practical, may be merged with another set.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Zwide series within ZL set. Represented by Zwide series.

SERIES ZE ZEBRA

Series differential criteria: pale brown sandy loam alluvial toplayer over prismatic sandy clay as Zwide series.

Analytical data: no

Soil correlation: FAO 1988: Verti-Eutric Planosols/Calci-Stagnic Solonetz
Soil Taxonomy 1990: Vertic Albaqualfs/Albic Natraqualfs

Occurrence: very minor

Status series: not practical, may be merged with Zwide or other series.

Series use in physiographic/agro-ecological units:
no specific geographic distribution of Zebra series within ZL set.
Represented by Zwide series.

SET

Main characteristics:

Overlap of definition with other sets:

Remarks:

SERIES

Series differential criteria:

Analytical data: yes no

Soil correlation: FAO 1988:
Soil Taxonomy 1990:

Occurrence: major common very minor

Status series: useful not mapped not relevant obsolete not practical, may be merged with

Series use in physiographic/agro-ecological units:
no part complete specific geographic distribution of series within set.
series represents set. Represented by series.