SOIL CLASSIFICATION - A TAXONOMIC SYSTEM FOR SOUTH AFRICA

The aims of the second edition of the soil classification system, and its possibilities and limitations, are the same as those set out in the preface to the first edition (vide infra).

The conveners of the first edition of the classification system predicted that it "...will continue to develop in step with expanding knowledge of the soils of this country...". The stimulus for embarking upon a second edition came when scientists of the Saasveld Forestry Research Centre showed that the first edition did not reflect the properties of many podzolic soils. The preparation of a second edition having been decided upon, the entire classification system was reviewed with the aim of making whatever changes were needed to reflect our current state of knowledge. Because of the wider interest shown in soils since 1977, a larger number of scientists representing a wider range of organizations than was the case with the first edition were needed on the soil classification working group, the membership of which is given elsewhere in this book. Useful contributions, acknowledged elsewhere, were also made by people who were not members of the working group.

The first edition, consisting of easily understood and visualizable soil forms, with their subdivisions, has proved successful in many important respects: conveying an appreciation of the kinds of soil found in South Africa, contributing to a better understanding of the land capability limitations and advantages of our soils, promoting an understanding of the similarities and differences between soils, focusing attention on properties important to land users and enabling soils to be easily identified and named in a consistent manner. For these reasons, the basic structure and underlying principles of the first edition have, with one exception, largely been retained in the second. The changes, which are summarised in the pages that follow, reflect an improved understanding of our soils and of the differences which need to be reflected by soil classes. The exception involves a change in principle: to include in the classification only those classes which, on the whole, satisfactorily accommodate similar, naturally occurring, more or less uniform soil bodies (= polypedons), and to exclude arbitrarily chosen classes (mainly texture) which continually cause uniform soil bodies to be split artificially by class boundaries. The soil series of the first edition, particularly those defined on the basis of texture, made up the majority of these arbitrary classes. For this reason, and because the information needed to define series classes to accommodate similar, more or less uniform soil bodies is not generally available, the series category has been omitted from the second edition. Consequently, the family, a higher category than the series, has become the lowest category in this, the second edition of the soil classification system.

› Changes to the First Edition of the Soil Classification System
› Structure of the Classification System

CHANGES TO THE FIRST EDITION OF THE SOIL CLASSIFICATION SYSTEM

Classical and simplified soil series | The second edition | The changes

As in the first edition, our aim is to accommodate and reflect, as faithfully as possible, the properties of and relationships between the different kinds of soil which have been found in South Africa. Secondly, wherever possible, differentiating criteria have been chosen that will promote easy soil identification. Thirdly, the way has been cleared for defining, in the course of time, soil series of a more comprehensive kind than those of the first edition.

Classical and simplified soil series

The South African soil mantle consists of a very large number of soil bodies. Examples are a black, smectitic clay on a dolerite outcrop near Bethal or a yellow, kaolinitic clay on Beaufort sediments near Cedara. Many of these soil bodies are very uniform in that each of the many parameters which can be used to describe soil (horizonation, clay content of the B horizon, coarse fragment content of the B horizon, etc.) covers a very limited range. Other soil bodies are rather less uniform with respect to one or more parameters. These soil bodies have been called polypedons (Soil Survey Staff, 1975) and apparent individuals (MacVicar, 1969).

For reasons of soil genesis, some of these bodies are very similar to other soil bodies. For example, many of the yellow, kaolinitic clays on Beaufort sediments in the Natal Midlands are very similar to one another. When any soil difference between similar bodies is judged to have little effect on soil behaviour and to have little pedological significance, the soil bodies concerned may be placed together in the same class (i.e. the same classical soil series) in the lowest formal category (i.e. the series category) of a natural system of soil classification.

Sufficient was known of the soils of South Africa in the early 1970s to develop classes (e.g. forms) and establish differentiae (e.g. dystrophic, mesotrophic, eutrophic) which would satisfactorily accommodate and reflect the properties of uniform soil bodies at levels in the classification higher than the series. Although some improvements by way of new forms and new or modified differentiating criteria have been made in the higher levels, this part of the first edition is little changed in the second.

At the time of preparing the first edition, the amount of information needed to define soil series, in the classical sense, was available for relatively few of South Africa's soils. With this in mind, the first edition was developed to serve two purposes. First, it had to reflect the nature of the soils that occur in South Africa as they were then known and understood; that part of the classification system above the series level mainly served this purpose. Secondly, it needed to enable non-soil scientists to describe soils in such a way as to be meaningful and also to provide sufficient information to permit land capability interpretations to be made. It was decided to include simplified soil series classes, based largely on clay content and grade of sand, in the first edition to ensure that soil surveyors would collect at least a minimum of information about the important property, texture. These classes were made mutually exclusive to avoid confusion in allocating soil profiles to series classes. To this minimum information, the soil surveyor would add any further data (e.g. thickness of horizons, soluble salt content, silt content, climate data) needed to make the interpretations required by the project.

Taking into account the size of the task of defining soil series in the classical sense for the entire country, it was believed by some that such a task might never be tackled and that, with minor adjustments, the 1977 edition and its simplified soil series would suffice in the long term. However, considerations set out in the following pages suggest that the large task of defining series in the classical sense will probably be worthwhile.

The second edition

Soil science is one of the natural sciences which deals with material phenomena, and the material with which it is concerned is the soil mantle. This frail layer supports all terrestrial life and in it differences are found, often within short distances, that affect the way it can be utilized. Furthermore, to all intents and purposes, the soil mantle cannot be replaced and must be used forever. The need to understand it is, therefore, as great as the need to understand the material phenomena of other natural sciences.

In striving to increase our knowledge we study soil profiles. The greater part of the information gained this way need not remain in the form of unconnected profile descriptions and their analytical data. We may choose soil profiles to enable us to characterise uniform soil bodies and define series in the classical sense. By extending our knowledge from soil profiles to "uniform" soil bodies, to soil series and then showing the location of series on maps, we develop our knowledge of the soil mantle and present it in a form useful to others.

This process takes place in two stages. Firstly, soil profiles are studied, soil bodies identified and soil series defined and, eventually, mapped. In the second stage, our knowledge of each soil series, particularly those that are important to man, is deepened, a process which takes place intermittently over many years on the initiative of many scientists. One scientist may, for example, study the nature of biological activity in a soil under defined conditions, another its ability to prevent applied phosphorus from being taken up by plants and yet another its ability to store water and make it available to crops under defined conditions of cultivation, cropping and weather.

The bricks from which a classification system must be built that will accommodate and reflect such continually improving knowledge, must therefore be the markedly uniform soil bodies or polypedons that make up the soil mantle. However, the information about polypedons needed to define series for the majority of South Africa's soils is presently not available. In order to avoid confusion and so as to encourage scientists to generate the necessary information and define soil series, the second edition is restricted to that part of the system above the series level of the first edition. The arbitrarily chosen texture classes of the first edition are omitted.

The lowest category in the second edition is the family. Each form and family has a code (e.g. Hu1200). For example, family 1200 of Hutton form accommodates all dystrophic soils of that form which have a marked increase in clay from the A to the B horizon. Names of forms in the first edition are used in the second. In the second edition, however, form names are not used as family names. Series names in the first edition are not used for families in the second.

The second edition aims to accommodate and reflect our current state of knowledge down to family level and to provide a structure which will accept, in a rational way, the addition of soil series which will reflect further advances in our knowledge of the South African soil mantle. Secondly, this edition is again a vehicle for communicating an understanding of soil. The soil families contain, either directly or by operation of covariance, much of the information needed to make land capability interpretations. However, in many instances interpretations require additional information about the soil (texture, thickness of horizons, etc.) and about other features, for example climate (e.g. rainfall for a particular period of the year expressed as a frequency distribution). Texture, omitted in the second edition, will usually be needed. The normal texture class descriptions are recommended for this purpose: fine sandy loam, clay loam, etc. Unless otherwise specified, the term Hu1200 medium sandy loam will mean Hu1200 family of Hutton form with a medium sandy loam ***topsoil texture***.

Looking ahead of this edition to the task of defining soil series, every effort will be made in the interests of easy and correct soil identification to ensure that series definitions are mutually exclusive. However, this will not always be possible. For example, polypedons X1, X2 and X3 found in one district may be the same as polypedons Y1, Y2 and Y3 in another district in every respect but one, namely clay content: the clay contents of X and Y are 14-25% and 18-35% respectively. In order to reflect the actual properties of these soils and to promote the making of good interpretations, it might be deemed necessary to define two series to accommodate these two sets of polypedons. The person making a quick identification from a single profile could well be confronted with a figure of 22% clay. In the absence of further information about the clay content range, he would use the locality (e.g. the district) in order to identify the soil. When necessary then, location will form part of the definition of a soil series. Often, but not always, climate will therefore also indirectly become, in varying degree, connected with soil series.

Because mesoclimate differences, or climate differences within the landscape, are often crucial in making satisfactory land capability evaluations and because the definition of South Africa's climate at that level of detail is not possible at this time, the direct use of climate criteria in soil series definitions is not contemplated.

The development of a country-wide inventory of soil series, and the maintaining of such an inventory will require a long-term commitment by an organization which has functions intimately concerned with South African soil science.

The changes

The introduction of additional diagnostic horizons and materials has increased the number of forms from 41 to 73. Some criteria previously used below the form level have been modified or omitted, and others retained. Similar genetic regimes, wherever they may be found in the world, give rise to similar soils, and the characteristics which best distinguish between soils are very often, therefore, either the same or very nearly the same from country to country. In formulating definitions and choosing differentiating criteria, we have often, not surprisingly, found in Soil Taxonomy (Soil Survey Staff, 1975) both assistance and confirmation.

A soil family category has been established and soil series omitted. Soil texture is not used as a differentiating criterion, but will be used regularly in conjunction with forms and families, for example Hutton fine sandy loam. Accommodation has been made for our improved knowledge of South African podzols. "Podzol B" has replaced the term "ferrihumic B" and the concept of the placic pan is introduced. Implicit in many soil forms (e.g. Sterkspruit) is a significant clay increase from topsoil to subsoil. To indicate such increase in other forms, the concept of the luvic B horizon is introduced. The concept of the G horizon has been widened to include the gleycutanic B of Kroonstad form in the first edition. The E horizon is reserved for "grey" subsoil horizons that have undergone weathering and loss of colloidal matter in contrast with regic sand which has not undergone such weathering. The criterion, signs of wetness, is used to distinguish certain B horizons that are hydromorphic. In some soils, the A horizon in the dry state has the "grey" colours of the subsoil E horizon; these are distinguished at family level from those that do not have this colour. Many pedocutanic and red structured B horizons have medium or coarse angular structure; these are distinguished from those with either subangular or fine angular structure. Calcareous horizons that previously qualified as red or yellow-brown apedal B horizons or as a neocutanic B, are now accommodated in the neocarbonate B. The soft carbonate horizon, hardpan carbonate horizon, dorbank, man-made soil deposit, unconsolidated material without signs of wetness, unconsolidated material with signs of wetness and unspecified material with signs of wetness (which replaces the gleycutanic B horizon in Pinedene form) are introduced as diagnostic horizons and materials. The underlying diagnostic material in Mispah form is restricted to hard rock (or silcrete), with dorbank, hardpan carbonate horizon and hard plinthite being components of new soil forms.

The concept of the humic A horizon now covers both thick and thin, low base status A horizons with more than 1.8% organic carbon. The base status boundary between humic and melanic A horizons lies on a sliding scale with organic carbon content. The required thickness of the diagnostic O horizon has been reduced from 300 mm to 200 mm and degree of humification of the organic O horizon is used to distinguish between families. Lithocutanic B horizons and diagnostic saprolite, which are largely weakly weathered hard rock, have implications for land use and are a reflection of a youthful landscape; accommodation has been made for these hard diagnostic horizons in the relevant soil forms. Plasticity index is introduced to distinguish between vertic and non-vertic A horizons. Soil CEC (NH4OAc, pH7) is used as an aid to distinguish between apedal and neocutanic on the one hand, and red structured and pedocutanic on the other. Certain E horizons are "yellow" in the moist state; this phenomenon is used to distinguish between families in certain forms. The presence or absence of lamellae is a differentiating criterion within Fernwood form. Stratified alluvium with a predominantly red colour is encountered in some arid regions; provision is made for this in Dundee form.

Youthful, cross-bedded aeolian sands, usually in the form of dunes, with colour that is predominantly red or yellow, no longer qualify as red or yellow-brown apedal B horizons; provision is made for these regic sands in the Namib form. Carbonate horizons that are unconsolidated are distinguished from hardpan carbonate horizons at form level.

STRUCTURE OF THE CLASSIFICATION SYSTEM

Master Horizons | Diagnostic Horizons and Materials | Soil Forms | Soil Families

In essence the system is a very simple one which employs two main categories or levels of classes - an upper or general level containing soil forms, and a lower, more specific one containing soil families. Each of the soil forms in the classification is a class at the upper level, defined by a unique vertical sequence of diagnostic horizons and materials. All forms are subdivided into two or more families which have in common the properties of the form (that is, the prescribed horizon sequence) but are differentiated within the form on the basis of other defined properties. The range of variation permitted within a class at the family level is thus narrower than that at the form level and the family is a more specific concept than the form.

Using soil profiles or pedons as sampling sites, the polypedon, i.e. a group of contiguous similar pedons (Soil Taxonomy: Soil Survey Staff, 1975), is classified with reference to this system, being allocated first to a form (aided by the key to the soil forms) and then to a family on the basis of the relevant soil properties which define the classes. Identification (and communication) is accomplished by means either of the name or of the symbol of the soil class. The system is a two-name (form and family) one, but because no two families in the classification system have the same name, reference can be made to a family without using its form name. However, as the number of families is fairly large, communication may be made easier by using the form name, or its abbreviation, with the family name.

The procedure to be followed in the identification of a soil by means of this system involves:

(i) demarcating the master horizons present in the profile,

(ii) identifying diagnostic horizons or materials,

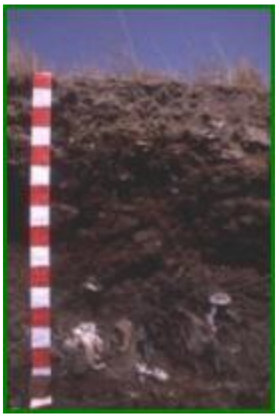
(iii) establishing the soil form using the Key,

(iv) identifying family differentiae,

(v) establishing the soil family, and

(vi) determining the texture class of the A horizon and adding it to the name or code of the soil family.

The definitions and criteria needed to apply this procedure of identification are discussed in the pages which follow and lead up to a presentation of the classification itself.



Master horizons

Development of genetic horizons, as distinct from depositional or inherited stratifications, has been accepted traditionally as the quintessence of soil formation. Processes which form soil have a net tendency to differentiate the materials on which they act (rocks and loose sediments of various kinds) into horizons. The importance of these horizons to the classifier is that they are reproduced over and over under the same genetic conditions. Soils, therefore, are unique in that they consist of horizons. This is the starting point.

If one regards this attribute of soils as the norm, then the absence or minimal development of genetic horizons in materials which, for practical purposes, are regarded as soil becomes significant and is A usually traceable to youthfulness or processes which work against horizonation. Although they represent the exception rather than the rule, provision is nevertheless made for the inclusion of certain undifferentiated materials in the system (young alluvia, deposits of raw sand, man-made soil deposits, hard rock).

The organization and re-organization of material as a result of soil formation follows a pattern which can be generalized by recognizing a small number of master horizons.

Standard letter symbols are used to denote the master horizons as follows:

O -- An organic horizon formed at the surface by the accumulation of organic material under saturated or non-saturated conditions. The organic material varies from loose leaves and organic debris, largely undecomposed, to partially decomposed or matted organic debris.

A -- A mineral horizon formed at the surface or beneath an O horizon and consisting predominantly of mineral particles intimately mixed with a greater or lesser amount of humified organic matter.

E -- A mineral horizon underlying the O or A horizon (if present), having a lower content of colloidal matter (clay, sesquioxides, organic matter) than the immediately overlying and/or underlying horizon, usually reflected by a pale colour and a relative accumulation of quartz and/or other resistant minerals of sand or silt sizes.

B -- A mineral horizon between the A or E and C or R horizons which is characterized by a concentration of silicate clay (by illuviation or alteration), sesquioxides (by illuviation or residual accumulation), organic matter (by illuviation), lime (by illuviation or residual accumulation), by the disappearance of depositional stratification, by the partial or complete destruction (by weathering) of rock structure, or by the development of crumb, granular, blocky or prismatic structure, alone or in combination.

C -- A mineral horizon consisting of soil material (including weathered rock) which either lies beneath the lowest B horizon or which does not show properties of other master horizons.

R -- Consolidated bedrock and strictly, therefore, not an horizon.

These master horizons are more or less universally recognized.

The following additional master horizon has, however, been defined for classifying soils in South Africa:

G -- A mineral horizon under an A or E horizon showing strong features of reduction under anaerobic conditions viz. grey, low chroma matrix colours, often with blue or green tints.

Transition horizons are indicated by combining the letter symbols of the master horizons above and below the transition horizon, for example AE, EA, AB, BA, EB, BE, BC, CB, AC, CA. The first letter (e.g. the A in AB) indicates the master horizon which corresponds most closely with the transition horizon. An horizon which consists of two separate master horizon components (for example, an horizon consisting of E horizon tongues and an illuvial B horizon) is indicated using the master horizon letters separated by a virgule (/) as follows: B/E.

A master horizon may be subdivided vertically and numbered, for example B1, B2, B3. B1 refers to the uppermost part of the master B horizon and is not a transition horizon between the A and B master horizons, as was the case in the 1977 first edition of the classification system.

Few soils contain all of these horizons, but all soils contain some of them, and in a majority of cases they are quite easily identifiable in vertical exposure such as is provided by the face of a soil pit.

Diagnostic horizons and materials

Recognition of master horizons is the first step in examining, describing and identifying soils in the field. However, it will be appreciated that the master horizons only really contain or convey information relating to position in the profile (a B horizon, for example, occurs below an A or E and above a C or R) and the general nature of the processes which have taken place (for example, accumulation of organic matter, development of soil structure, weathering). B horizons, for example, are found which have such widely contrasting properties as to be entirely different from one another in all respects except those which determine that they are B horizons. These more specific properties of the master horizons are equally or more important than the master horizons themselves when it comes to identifying (and utilizing) soils. Subscripts have been used as a device for specifying some of the more outstanding properties of master horizons: Bca, for example, signifies a B horizon having an accumulation of calcium carbonate. However, this device has limitations.

The modern trend is towards defining, more completely, specific kinds of master horizons. Unfortunately there is as yet no general agreement on a standard set of such diagnostic horizons nor on the criteria that should be used for their definition. This classification system defines in fairly rigorous terms a number of diagnostic horizons and materials (Fig. 1) that are tailored to fit the soils of South Africa. These definitions are presented in Chapter 3. For two reasons a short discussion of the underlying concept of the horizon follows its definition. Firstly, definitions of horizons have been formulated with the object of including certain things and excluding others. They are phrased in terms of soil properties and are as concise as possible. Each gives expression to a concept but, because the definitions eventually can become complicated (they describe a complex system), the underlying concepts tend to become obscured and the meaning behind the definition somewhat unintelligible. It is not very satisfying to apply a definition more or less slavishly without some appreciation of what is intended by it. Secondly, although correct identification will be achieved by literal application of the definitions in the vast majority of soils, there will always be anomalous cases which are not accommodated comfortably in all respects. It is probably impossible to formulate definitions that will take care of all eventualities. In such instances the user is at a disadvantage if he cannot fall back on personal judgement and common sense, backed by an understanding of the concepts and intentions behind the definitions of diagnostic horizons and materials.

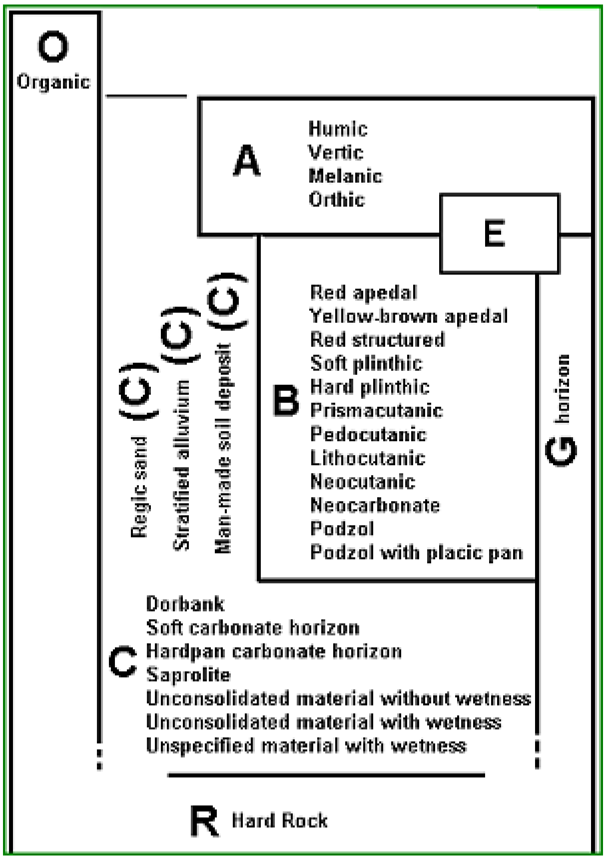


Fig 1 Diagnostic horizons and materials

In addition to meeting specified requirements in terms of properties, soil horizons should also occur wholly or in part within 1500 mm of the surface in order to be diagnostic for the purposes of classification. A depth limit is necessary and that chosen, although arbitrary, is convenient in that it coincides with the depth to which soils are normally investigated during systematic surveys (using a hand auger), and acceptable in so far as the importance of soil for a majority of agricultural purposes diminishes rapidly beyond this depth. This limit is a guideline in that an element of common sense is needed in its application. Clearly, material at a depth of 20 m is of little importance to most land users and is excluded by this guideline. However, a soil form comprising say three horizons may occur in a landscape in such a way that in some places the third horizon occurs partly or wholly within 1500 mm depth, and in other places it is below, often not by far, the 1500 mm mark. In these instances, and even when the third horizon just misses the 1500 mm mark throughout the landscape, it would be wrong to ignore it on such an arbitrary basis. Excluding it in these cases would frequently mean ignoring properties and processes, such as hydromorphy, important to land use as well as to an appreciation of genesis.

Soil forms

Recognition of horizons as definable entities amounts to dissection of the soil profile into a number of discrete, component parts. This analytical step is essential in the classification procedure but it should not be misinterpreted. Soils are not random combinations of horizons - they are unique integrated wholes. The horizons of a soil do not form independently of one another but are produced by the operation of a set of processes which affect the entire soil, albeit to different degrees in different parts of the depth profile. Diagnostic horizons and materials have been abstracted and defined by studying whole soils as they occur in the field.

Because one is classifying whole soils and not horizons, it is necessary to reconstitute the soil after identifying master and diagnostic horizons and materials. This is accomplished by means of the soil form which is a specification of the kind and sequence of diagnostic horizons and materials present and, in some cases, also of the general nature of the underlying material.

Seventy-three different horizon sequences, and thus soil forms, have been encountered in South Africa to date. These are arranged systematically for easy reference and as an aid to profile identification in the Key to the soil forms. Each form is referred to by means of a geographic name (for example Swartland, Estcourt) which serves as a tag or label and has no further intrinsic significance.

The soil forms are illustrated by means of colour plates of selected profiles that have been included with the Form-family schedules in a later section. These profiles are representative examples of soils which belong in each particular form, chosen to show as clearly as possible the horizon sequence that defines the form. They do not illustrate the range of variation that occurs or that is possible within the form. This must be deduced from the horizon definitions and from the family specifications.

Soil families

Soil forms are conceptual generalizations based on selected soil properties (those used to define diagnostic horizons) with fairly wide permissible variations. To make the classification useful for a variety of objectives, it is necessary to classify further in order to narrow down such wide variations as still exist. For narrower definition, use is made of two kinds of properties: firstly, narrower ranges of properties used to define the diagnostic horizons and materials of the form, and secondly, properties that are not used to define diagnostic horizons and materials. Subdivision of forms into families is the means whereby this further refinement is achieved and expressed. Each family has a geographic name and a code. The latter consists of the form abbreviation followed by digits which specify the particular family within the form, for example Hu1200

It should be noted that certain soil properties, notably soil depth and salinity, are not used in this classification. This does not mean that they are unimportant. On the contrary, a property such as soil depth is often critically important in practice. However, it is difficult to set limits that will be consistently relevant for all soils and all purposes. Practical distinctions which have a variable significance but which are needed to interpret the classification in terms of soil behaviour are introduced (for example during mapping) as phases. As the information required becomes available, it is the intention to introduce a formal category, namely series, below the family, which will carry more information relevant to land use than does the family.