THE SOIL SERIES IN RELATION TO AGRICULTURAL RESEARCH AND LAND USE PLANNING

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The Soil Series

It is frequently possible to encounter, in a very limited area, almost the whole range of every soil property: from soil reaction values of pH 3.5 to pH 9.0, from structureless to very strongly structured, from sands to clays, from impermeable to excessively permeable materials etc. It has been one of the main objectives of the pedologist to classify this seemingly incomprehensible mass of data into some system so as to enable him to organise his thinking about soils.

The system of classification which has been developed is largely founded on the fact that soil properties do not follow a random pattern, but an orderly one, the key to which are the genetic processes which have contributed to the formation of soil properties. The same set of genetic processes at different sites produce the same soil properties. This has enabled soil individuals, which not only occupy certain sites in a particular landscape, but which may also be reproduced elsewhere, to be identified, defined (classified) and studied. These genetic processes have simplified the difficulties of classification by rendering certain properties mutually exclusive: a soil material cannot, for instance, be strongly gleyed and have a uniform reddish brown colour.

The most important contribution of soil genesis to classification has been in enabling soil horizons (A, B and C) to be recognised, in enabling each of these to be grouped into types of horizons (e.g. ferrallitic B, solonetzic B podsolic B) and in enabling each of these types of horizon to be subdivided according to the degree of expression of the properties in the horizon (e.g. sodic solonetzic B and non-sodic solonetzic B, fine textured ferrallitic B and medium textured ferrallitic B).

Soil individuals can thus be grouped into taxonomic units or taxa. The individuals in each taxon have the maximum number of properties in common and therefore are the most useful units of classification. The members of each unit have the same arrangement and number of horizons (e.g. A-B-C, A-C or A-B-R etc.) the horizons are of the same type (ferrallitic B, humic A etc.) and the properties of each horizon have the same degree of expression.

In most parts of the world today the term soil series, or its equivalent by other names, is applied to this lowest category of soil classification. A recent definition (Soil Survey Staff, 1960) reflects modern thinking on the concept: "The soil series is a collection of individuals essentially uniform in differentiating characteristics and arrangement of genetic horizons." In passing, a departure from an earlier definition (Soil Survey Staff, 1951) may be noted, namely the qualification "developed from a particular type of parent material" has now been omitted. This is due to the degree of speculation involved in estimating soil parent materials.

The series is the pedological analogue of the botanical species and, like the species, it is defined solely in terms of its properties. It is not defined in terms of climate, topographical situation, depth, texture of the plough layer (including stoniness) and other criteria not of the soil body.

In order to obtain greater accuracy of prediction about soil behaviour, phases of series are frequently defined; these are in terms of variations in characteristics which are significant to the use and management of the soil. However, the range in variation must not exceed the limits prescribed in the definition of the series. Primary phases are defined on cilmatic differences (temperature and the distribution and amount of rainfall). Secondary phases cover variations in properties such as texture of the plough layer, depth to a strongly contrasting substratum, erosion etc. The use and production potential of *Themeda triandra* varies significantly from a warm semi-arid climate to a moist and more temperate climate. Likewise, the two primary phases of the Cartref series occurring in the Natal Sugarbelt and the Western Cape differ significantly in use and production potential.

Series identification and definition (classification)

Series classification must be based on the unbiased examination and study of soil individuals as they occur in the landscape. Soil survey and mapping play an indispensable role in the classification exercise by defining the modal form and range of properties of series and how associated series are related in the landscape. The collection of one or two forms or a collection of widely scattered observations are an insufficient basis for classification.

The nature of soils is such that series merge, one with another, and if classification is not conducted by systematic survey of a relatively large area (in which the full range of properties of the various series is likely to be found), the precise nature and form of each series cannot be accurately defined.

In some areas where the complexity of the soil pattern complicates the issue of series classification, the problem of classification has often been avoided by resorting to rather vague and broad definition of soil series; these omnibus classes — so called soil series — contribute little to our understanding of soils and generally tend to confuse those who must concern themselves with applied pedology. Because a botanist is faced with a wide selection of species in a plant community, the abandonment of the first principles of taxonomy and the reduction of the number of species by means of wider "species" is certainly no solution to his problem.

Soil mapping

Strictly, the soil series is a taxon; it is not a mapping unit, and its use as such has led to much unnecessary confusion in applied pedology. On intermediate and large scale soil maps, areas consisting of a single soil series — or a single phase — are frequently demarcated. This has tended to lead non-pedologists to the belief that every soil profile in a demarcated area falls within the definition of that series. The assumption is erroneous and potentially dangerous. What is meant by this single map unit is that at least 75 per cent of that area falls within the definition of the named series; less than 25 per cent of the unit would comprise examples of other series and other unclassified pedons. These are purely practical considerations in which limitations of time and scale are the most important. To put an end to the confusion between series as a taxon and series as a map unit, the term *consociation* is proposed for the map unit; for instance, Shortlands consociation and deep Shortlands consociation for the deep phase when it is mapped apart.

The connotation of the term consociation is analagous to the plant ecological consociation in which the plant community is dominated by a single species. In certain complex areas, where the desired accuracy of demarcation of the soil consociation cannot be attained, the term *association* should be used (e.g. Clansthal-Lytton association).

The soil association is defined (Soil Survey Staff, 1951), as "a group of defined and named taxonomic soil units, regularly geographically associated in a defined proportional pattern." Further, "the levels of grouping and the levels of homogeneity used in defining soil associations vary widely with the purpose of the map."

Given a large scale base map, two competent pedologists working independently in the same area would place the boundaries of series consociations more or less in the same places. This is not so in the case of small scale mapping. The association is too broadly defined to ensure that two small scale maps of the same area compiled independently by two pedologists would be more or less the same.

The properties of a series reflect the very local factors of environment which have contributed to its formation. It is suggested that, on a broader scale, there is a unit of land populated by soils whose properties reflect a group of environmental factors peculiar to that unit. Moreover, it is suggested that this unit is capable of fairly precise definition enabling it to be mapped similarly by pedologists working independently. If such a soils unit can be mapped, it will go far, not only towards showing soil distribution, but also towards showing a distribution of environmental factors.

Just as there is a vertical succession of horizons which exhibit varying degrees of interdependency in a soil series (the basis of a consociation), so also is there a lateral succession in the landscape of soil series, which exhibit varying degrees of inter-dependency due to drainage, drift etc. It would be reasonable, therefore, to use this lateral succession of series in the landscape as the basis for a smaller scale mapping unit than the series consociation.

The term *soil community* is proposed for a certain kind of association which is defined in terms of the number and kind of soil series which occupy unit landscape — that section of the landscape which, when repeated, defines the landform. If in one area series M, N and O occupy positions from crests to bottomlands and soils M, P and Q occupy these positions in another, two communities would be defined and mapped. In plant ecology, the community is not defined in terms of the occurrence of aberrant species. Similarly, not every series in the landscape is essential to the definition of a community. Further, the infrequent and irregular absence of a member of a community is insufficient reason for the creation of a new community. Although the factors of the environment — climate, topography, parent materials etc. — cause the soil composition of one community to differ from that of another, communities are defined solely in terms of series.

Use of the soil series

A knowledge of soil behaviour is of particular interest to the agricultural industry and to the field of civil engineering.

Research of any kind, whether it be connected with erosion rates under certain management practices, fertilizer trials, soil physics and chemistry etc. must be carried out on defined series if the results are to find application elsewhere. Results of research are more surely and more quickly applied if the series upon which it is conducted can be correlated with series elsewhere. The series, if clearly defined, is the ideal vehicle for the accumulation of research results and land use experience. It is the ideal means whereby extension services can bring the results of research to the users of the land.

The consociation, either as a series or a phase of a series, is the most efficacious mapping unit for the planning of intensive and semi-intensive agricultural enterprises. The criterion which differentiates a particular phase often overshadows all other definitive properties of the series in importance to land use. For instance, the loamy sand phase of a series which is defined as having less than 15 per cent of clay in the A2 horizon may be capable of dryland crop production in a relatively dry area, while the coarser textured sand phase may be too droughty due to a low available moisture capacity. The soil community is useful for purposes of regional planning since, in this instance, it is the production potential of landscapes and not merely consociations which is of interest.

The absence of a precise series classification in South Africa, coupled with an unwillingness on the part of agronomists to familiarise themselves with series classification, have in the past constituted a serious barrier to the progress of agronomic research and extension in this country. The situation still persists although a break-through appears to have been made in some parts of Natal.

The series is given a name, its properties become familiar, it is correlated with certain limitations and a certain production potential — it is the nucleus around which we build our understanding of soils and without which there is either ignorance or confusion.

References

Soil Survey Staff (1951). Soil survey manual. Handbook No. 18. U.S. Dept. Agric., Washington, D.C.

Soil Survey Staff (1960). Soil classification, a comprehensive system. 7th Approximation. U.S. Dept. Agric. Soil Cons. Serv., Washington, D.C.

Mr. Mann: The entire subject of the soil taxonomist — naming all soils — has for some time been a controversial one. For many years the controversy hinged around how this should be done, for various people who used the soil sought to classify it according to their own specific needs. The farmer, the engineer, the scientist, all used different criteria. Not until the soil taxonomist copied the example of the biologist and started the systematic naming of soils based on recognisable characteristics in the soil horizons, was the original controversy overcome. In making this decision, however, other controversies arose. How long, for example, would it take to have all the soils named and mapped? Further, is the science exact enough to enable two trained men working independently to recognise and map the different soils on an area of land with a sufficient degree of concurrency? Finally, will all this effort not be stowed away in libraries, or in the minds of a few academically inclined men?

Our two authors have gone a long way towards answering these questions and they have done so largely by borrowing a further term from the book of their fellow scientists. This time it has been that of the ecologist, for they have suggested the terms consociations, associations and communities as the map units of soil series or even separate phases of a series. They have defined and given examples of what they mean by these terms. The importance of this is that, be it describing the known soil series or mapping large associations or even soil communities, the practical man will be able to use this knowledge to his advantage.

A trained agricultural scientist is readily able to approve of and use a soil series classification, but I would like to address my remarks more specifically to an even larger group of people who study and use the soil, namely our farmers. What will the naming of the soil series and the mapping of various consociations and associations mean to him in his daily farming routine? He is already aware of the major soil groups that occur on the coast, as for example red Recent Sands or Lower Ecca shale soils. If the ideas in this paper are accepted, henceforward these groups of soils will probably be known as geological associations of the Clansthal-Lytton series and the Phoenix-Milkwood series.

All this may interest, bore, or annoy the farmer If it interests him I need say no more; if it bores him it is because we have not yet shown him enough proof of its practical implications; finally, if it annoys him, it is probably because he resists change, or because he considers the criteria of wetness, fertility, slope, depth, surface texture, etc. more important than what the soil is actually derived from, or what it is called.

This is exactly where this paper makes its biggest contribution, for it enables us to associate different soil series, even from different geological soil groups, together in one association with similar agricultural properties. To a farmer, farming on the Middle and Lower Ecca shales, it makes little difference at present whether a field is Phoenix series or Windermere series. However, the boundary demarcating the Phoenix-Windermere association would include most of his fairly heavy vlei soils. This is the land which, if blocked off into individual fields and well drained, could be planted to our heaviest yielding varieties and cut annually in the spring. Because of its higher moisture status it can support a reasonably heavy annual crop even in the driest seasons.

This is just one example of the practical value of mapping and understanding our various soil series. I leave you to think out many more but let us all, farmers and agricultural scientists alike, learn to know our soils better so that we can use to advantage the knowledge that people like Dr. Loxton and Dr. Macvicar can give us.

(Further discussion on the subject of soil series took place following the succeeding papers by Prof. E. R. Orchard, Dr. J. J. van der Eyk and Mr. G. Murdoch.)