SOIL SURVEY AND THE PROBLEMS OF SOIL CLASSIFICATION IN THE KINGDOM OF BUGANDA

S.A. Radwanski

Soil Survey of Uganda.

Summary.

The soil and land-use survey of the Kingdom of Buganda in the Uganda Protectorate has just been completed and the final report and maps are being prepared.

Two main approaches to the problem of soil classification have been made.

A scheme of agricultural classification has been worked out. In this scheme soils are classified into "land classes" according to the progressive number of limitations as regards their agricultural usage.

A number of soil catenas have been recognized in Buganda and these are the basic units for a pedological classification. Each catena consists of several soil series which can be arranged into three morpho-genetic groups as shown in Figure 2. The soils within the groups of any one catena show considerable similarities to their counterparts in other catenas and this fact may be used as the first step in attempting to place them into higher categories of soil classification.

The deeply weathered soils of Group 2 present the most difficult problem in their classification. These soils are truly polygenetic, i.e. their parent materials have been subjected to more than one cycle of weathering and erosion. Although they often lack clearly defined morphological features they occur in distinct topo-climatic units which are not difficult to map in the field. As they are associated with various ancient erosion levels and are also likely to have developed under bio-climatic regimes which are not

operative....

operative today, a purely morphological classification of these soils seems insufficient to define them and a genetic approach based on the study of landscape forms and any other evidence of the past climates (particularly in the Pleistocene period) is necessary in order to obtain a full understanding of the pedogenesis.

Introduction.

The purpose of this paper is to present a brief review of the soil survey work carried out in the Kingdom of Buganda and the account that follows is based on the assumption that we cannot as yet have a uniform overall scheme of soil classification which would embrace all the aspects of this problem. There may be several schemes, equally good and depending on the objective that we want to classify. Certain known common features and certain aspects of soil relationship can be considered and an attempt made to express them in a series of maps or tables, each depicting some (but not all) aspects of classification. This essentially analytical approach would have an enormous advantage of clarity in our own minds and in the minds of those who would use the soil data presented in this way.

The Kingdom of Buganda has an area of about 17,000 square miles (excluding open water) which is well over 1/5 of the Uganda Protectorate (Figure 1). A rapid reconnaissance survey of this area has just been completed with soils, land-use and vegetation* mapped on the scale of 1:250,000. The survey of Buganda is a part of the systematic soil survey of the whole Protectorate, which will be completed at the end of this year.

Two approaches to soil classification in Buganda have been made: one essentially practical and dealing with agricultural utilization and the other

purely.....

* Vegetation survey was carried out by I. Langdale-Brown.

purely pedological, in which the distinguishing criteria are not influenced by practical considerations as regards land-use.

Land Classes.

During the soil survey many field observations were made on the performance of agricultural crops on various soils and their response to the present management. All these data will be incorporated in an agricultural scheme of soil classification which is now being worked out (Radwanski, 1959). This scheme is a modification of a system developed in the United States (Klingebiel, 1958) but adapted to Buganda conditions. The underlying principle is that soils are grouped into land classes according to a progressively greater number of limitations regarding their agricultural usage. Thus Class I consists of the best all round soils which can be used for the growing of many different crops and can be subjected to the widest range of techniques of management including mechanical tillage. The subsequent land classes acquire more and more limitations as one goes down the scale, at the bottom of which there are soils entirely unsuitable for farming. Soils not at present cultivated, due to special conditions such as impedence of drainage or insufficient water supply, are placed in separate classes according to their potential productivity which they are likely to acquire when brought into cultivation. In such cases an assessment of their future productivity is made on the basis of their profile morphology, from which their response to such improvements as drainage or irrigation may be predicted.

The proposed grouping of soils into land classes is based on the qualitative assessment as inferred from field observations and is therefore provisional. The present classification will certainly be modified as more experimental knowledge is gained from individual land classes. Various levels of management and economic considerations such as price fluctuations and marketing facilities will also have an important influence on the land classification of this type.

Soil Catenas.

Having dealt briefly with some practical aspects of soil classification which will be expressed in a separate scheme, we can now turn our attention to what may be termed a pedological classification without an agricultural bias.

The basic mapping unit in Buganda is a catena as originally conceived by Milne (1935). A majority of Buganda soils form catenary sequences though there are some other mapping units consisting of one or more soil series which do not form a catena but are nevertheless associated with one another, e.g. some alluvial soils, lake soils, old river terrace deposits etc. Every catena consists of a number of associates generally separated at the soil series level. In more detailed surveys these individual soil series may be mapped separately.

A typical catena may be divided into three morphogenetic soil groups each represented by one or more soil series, as shown in a simplified cross-section diagram (Figure 2). There are, of course, more complicated catenas or catenary complexes with different arrangement and distribution of their component soil series but the one shown in the diagram is typical of large areas of East Africa.

The three soil groups indicated in the diagram are described as follows:-

1. ......

1. Immature, shallow soils occurring on summits and relatively steep upper slopes of hills. These are characterized by the presence of partially weathered fragments of their respective parent rocks at shallow depths, often in or just below the top-soil. Their profiles are not well developed and consist of A1 or incipient A1 overlying the C horizon. According to the old principle of zonality such soils would be typical of the azonal group, in which the influence of climate as one of the factors responsible for weathering and pedogenesis has been checked by the resistance of the parent rock.

2. Mature, deeply weathered and often considerably altered soils occurring on relatively gentle middle slopes or pediments which have been carved out of the mid-Tertiary peneplain mainly by parallel slope retreat. Except where accelerated erosion has taken place, there are no traces of weathered rock in these soils. The subsoils are strikingly uniform in appearance to a depth often exceeding 10 feet and are underlain by a variety of rock strata ranging from metamorphosed sediments to basic igneus rocks. Climate (rainfall and temperature) and the associated biological processes have exerted the most profound influence on the formation of these soils and in this respect they may be regarded as related to the zonal group. Their common features are red (2.5 YR) or brown (5 YR) colour and the presence of varying amounts of free sesquioxides. They are also associated with large termite mounds with termite channels occasionally penetrating the subsoil to the depth of 5 - 6 feet. There is no doubt that termites are largely responsible for the

maintenance......

maintenance of the present thickness of these soils, thus slowing down the pace of natural erosion. However, their contribution to soil building has not yet been appraised quantitatively. A typical profile consists of the A1 horizon characterized by humic staining and crumb structure, overlying a structural B horizon* which in turn merges into a thoroughly weathered and uniform C horizon not easily distinguishable from B. Well developed stone lines consisting of quartz stones and boulders are often found at a variable depth. With advanced lateritic alteration mottled and semi-indurated horizons or ironstone concretions are formed within these profiles.

3. Unlike the previous two groups, alluvial soils, occurring on valley slopes and bottoms, have developed under impeded drainage conditions from a wide range of transported parent materials. They may be referred to as intrazonal soils and their profiles consist of the A1 horizons overlying gleyed C horizons. On raised and relatively better drained sites a colour B horizon is usually formed directly above the C horizon as a result of improved drainage conditions.

If several different catenas are analysed in this way it will become apparent that in certain important aspects of profile morphology and soil genesis the catenary associates of each of the three groups described above will have more in common with their counterparts in other catenas than between the groups within one catena. For example, the middle slope or pediment members of one catena will be more closely related in respect of their

genesis ......

* The structural B horizon is more compact than either A or C and contains sub-angular blocks of varying size and stability.

genesis and the main profile features to the middle slope or pediment members of another catena, than to their other associates in the same catena. Similar, but not so striking, relationship exists between the two other soil groups described above. There are, of course, differences as well due to different parent materials, different climatic regimes and topography but the fact that these soils are similar in many respects can be used as the first step in establishing higher categories of soil classification.

Classification Problems.

The soil series of Group 1 and Group 3 present a comparatively easy problem of classification. Group 1 soils may be placed in higher categories, using the type of parent rock as the main distinguishing criterion at, say, the soil Family level. Several families of these soils may therefore be established, e.g. soils developed over acid igneus rocks, metamorphic sediments, massive laterite etc. In Group 3 the soils may be placed in higher categories, using such criteria as relative efficiency of internal drainage and its effect on the profile development, the accumulation and the kind of organic matter, texture of the subsoil, presence or absence of soluble salts etc.

The soils of Group 2, however, present the most difficult and probably the most controversial problem in their classification. They have been given various names by many authors and are known as tropical red earths or red loams (Vageler, 1933), lateritic soils (Van Der Merwe, 1941), latosols (Kellog: Davol, 1943), climatophytic earths (Brammer, 1956), to quote a few examples of terminology. More recently in a system of soil classification proposed by Sys of the Belgian Congo (1957)

these ......

these soils have received special attention and have been appropriately classified according to the degree of lateritic alteration as shown by analytical data and reflected in the profile morphology. In his recent visit to Buganda Van Wambeke*, one of the co-workers of Sys, was able to correlate some of these soils with the corresponding groups in the Belgian system.

Some significant distinguishing features which might serve as criteria for placing the soils of Group 2 into higher Categories are as follows:-

1. The type of parent material and particularly the type of clay fraction and the degree of alteration as shown by the presence of varying amounts of free sesquioxides.

2. The presence or absence of semi-indurated horizons resulting from the deposition of iron at depth.

3. Organic matter type and status as controlled by the present vegetation.

4. pH, exchange capacity and base saturation reflecting the degree of leaching in the profile.

5. Profile truncation resulting from accelerated erosion.

Such an enumeration of morphological and analytical data would provide a useful basis for grouping these soils at higher levels of abstraction but does not elucidate their origin.

In Buganda there are comparatively few profile characteristics which could be used as criteria in separating these soils in the field and it is primarily the environmental factors such as topography and climate as expressed in vegetation that enable the surveyor to place

them.....

* Dr. A. Van Wambeke : verbal communication.

them in well defined topo-climatic mapping units. That such soils are truly polygenetic, i.e. affected by more than one cycle of weathering and erosion, is an established fact (Greene, 1945, Charter, 1950). Opinions differ as to the mode of formation of these soils and a number of authors have presented some evidence in support of their own theories (Anderson, 1957, Ollier, 1958). This only serves to emphasize the need for more systematic studies and closer correlation between African territories.

The soils of Group 2 occur at various ancient erosion levels not only in Buganda but also throughout the Uganda Protectorate and in other parts of Africa (Spurr, 1954, Radwanski, 1956). This close association with old landscape features brings the problem of origin of these soils into the sphere of geomorphology. On the other hand, climatic fluctuations in the Pleistocene indicate that these soils may have been formed under different environmental conditions which have ceased to be operative today (Heinzelin, 1952). Therefore, as a further step in classifying such soils it will be desirable to use genetic criteria, in preference to purely analytical and morphological characteristics, in an attempt to separate the ancient soil forming factors from those which operate today. In this way a complementary genetic system of classification enabling one to get a better understanding of these soils could be built up gradually.

Acknowledgements.

This paper is published by permission of the Director of Agriculture, Uganda. The writer is grateful to Dr. E.M. Chenery and Mr. D. Stephens for their helpful criticism of the text.

References.

1. Anderson, B. 1957. "A survey of soils in the Kongwa and Nachingwea Districts of Tanganyika." University of Reading.

2. Brammer, H. 1956 "C.F. Charter's interim scheme for the classification of tropical soils." Submitted to Sixth Int. Cong. of Soil Sci. Paris.

3. Charter, C.F. 1950. "Report on the environmental conditions prevailing in Block A, Southern Province, Tanganyika Territory." Cyclostyled and submitted to the Overseas Food Corporation, London.

4. Greene, H. 1945. "Classification and use of tropical soils." Proc. Soil Sci. Soc. Amer. 10.

5. Heinzelin, J. de, 1952. "Sols, paleosols et desertifications anciennes dans le secteur nord-oriental du Bassin du Congo." I.N.E.A.C. Bruxelles.

6. Kellog, C.E. and Davol, F.D. 1949. "An exploratory study of the Soil Groups of the Belgian Congo." I.N.E.A.C. Serie Scient. No. 46.

7. Klingebiel, A.A. 1958. "Soil capability groupings" Proc. Soil Sci. Soc. Amer. 22.

8. Merwe, C.R. Van Der 1940. "Soil Groups and Sub-Groups of South Africa." Govt. Printer, Pretoria.

9. Milne, G. 1935. "Composite units for the mapping of complex soil associations." Trans. Third Int. Cong. Soil Sci. 1.

10. Ollier, C.D. 1958. "A two-cycle theory of tropical pedology." Submitted to the (British) J. Soil Sci.

11. Radwanski, S.A. 1956. "Soils developed over ancient drifts in the forest zone of Ghana with particular reference to the upper Tano Basin." Submitted to the Sixth Int. Cong. Soil Sci. Paris.

--- 1959. "Soils, land-use and land classification in the Kingdom of Buganda." (in preparation).

12. Spurr, A.M.M. 1954. "A basis of classification of the soils of areas of composite topography in Central Africa with special reference to the soils of the southern highlands of Tanganyika." Second inter-African Soils Conference, Vol.I.

13. Sys, K. 1957. "Carte des sols du Congo Belge et Ruanda-Urundi." I.N.E.A.C. Yangambi.

14. Vageler, P. 1933. "An introduction to tropical soils." Macmillan & Co. Ltd., London.

FIGURE 1.

LOCATION MAP — UGANDA PROTECTORATE

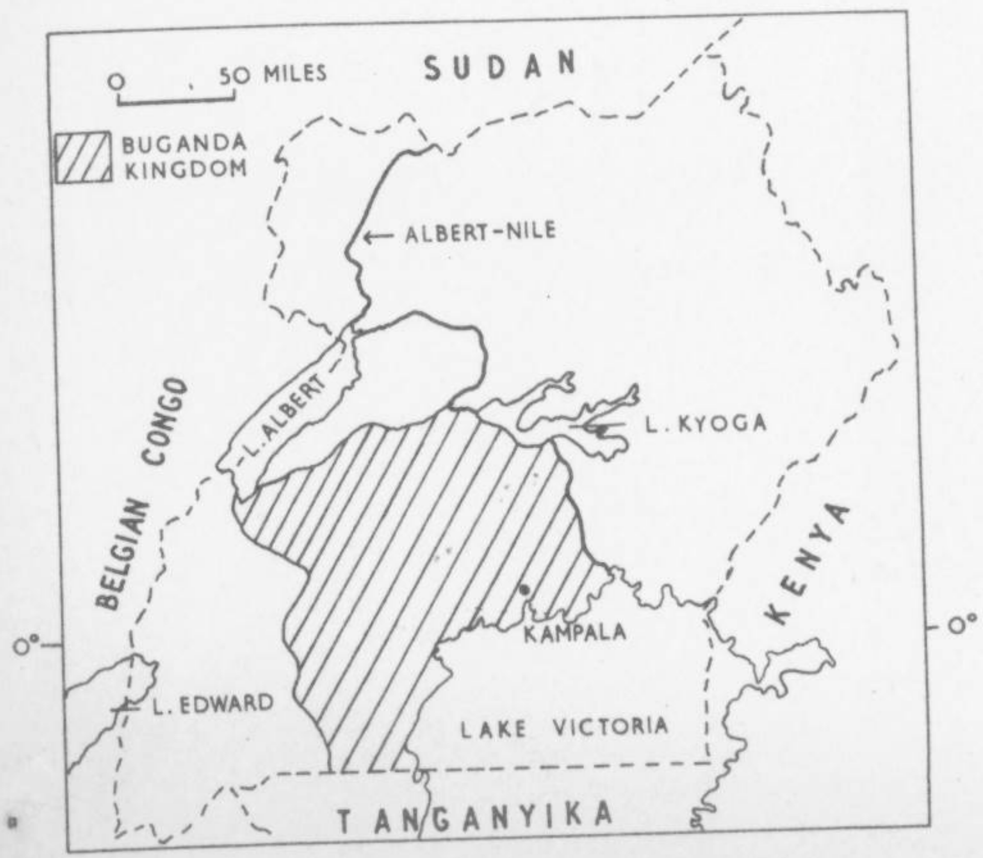

FIGURE 2.

SIMPLIFIED CROSS-SECTION OF A TYPICAL CATENA IN BUGANDA.