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RECENT ADVANCES IN SOIL CLASSIFICATION

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1. INTRODUCTION

Over the last decades, with the rapid development of agriculture, our increased knowledge about soils and a greater diversity of soil uses, the classification of soils has become organized and scientific. In developing soil classification systems, a logic and basic principle has been to create natural classifications i.e. systems whereby all attributes of the soil population are considered and those which have the greatest number of covariant or associated characteristics are selected as the ones to define and separate the various classes (Mill, 1925). In practice however, the approach could only be followed to a certain extent, as we tend to give a different weight to the various differentiating characteristics and properties, resulting in classification systems which are actually mental constructions (van Wambeke, 1966).

During the fifties, sixties and early seventies, the development of soil classification systems, both nationally and at international level, received very much attention. As a result of a greater knowledge about soils and reflecting the "state of the art", the classifications developed during these decades have shifted from a qualitative genetic approach to a much more quantitative expression of properties of the soil itself. The selection of differentiae, however, remained to be inspired by factors of soil formation. Particularly for the highest categories, characteristics which have accessory properties and mark important processes in soil genesis are considered to be the most suitable (Dudal, 1979). The genetic thread principle as a framework for classification also helps the systems to be more useful in making soil surveys, since it facilitates, to a certain extent, the placement of more accurate natural boundaries.

None of the classification systems developed is universally accepted and particularly in the tropical world several of these systems, or national modifications, are presently in use. The systems most widely used in the ASEAN region are the morphogenetic Soil Taxonomy (Soil Survey Staff, 1975) and the FAO-UNESCO legend of the soil map of the world (FAO-UNESCO, 1974), or national systems developed along the lines of the latter system . This confusing situation is actually an obstacle to one of the major objectives of soil classification, namely to serve as a medium of communication between scientists and for extending and extrapolating of research results.

In the absence of an unified and internationally accepted classification system, there is the need to compare the different systems used and to correlate the classes of each system into classes of the others.

Classification systems, however, to be compared and correlated, should have a common denominator. As they are based on different sets of criteria and concepts, there is substantial overlap between the classes of each system and it is not possible to develop a correlation key valid universally. It is nevertheless important to recognize that the systems often have very similar units at the lower categoric levels. Successful correlation can therefore be achieved through referring to the properties of soil series or other low-category classes of the mapping units of large and medium scaled soil maps (van Barneveld, 1983).

2. THE U.S. SOIL TAXONOMY

The U.S. Soil Taxonomy classification system has been developed from 1951 onwards by the Soil Survey Staff of the US Soil Conservation Service. The system went through a series of painstaking approximations and after substantial revision, it has formally been published in 1975 (Soil Survey Staff, 1975).

The system, apart from being completely new in design and nomenclature, contributed to the sorting and grouping of the many soil series, identified in larger-scale soil surveys (like the county surveys) but without a concurrent and simultaneous quantification of the earlier, genetically based great group system (Baldwin, Kellog and Thorp, 1938; Thorp and Smith, 1949).
Although the reasons for undertaking the development of the new system of classification were clear, it should be pointed out that the earlier systems had been very useful and had played a major role in the development of soil science. Even in 1964, groups of american soil scientists continued with efforts to refine and improve the definitions of the 1938 system.

Through inclusion of data and experience from non US-countries, notably Western Europe, Latin America as well as from intensive international contacts, Soil Taxonomy had moreover the potential of becoming a globally accepted system of soil classification. This in spite of its obvious geographical bias towards the soil conditions of mainland USA, Hawaii and Puerto Rico and the fact that for most of the tropical world the system has a large number of gaps and is (still) very tentative. This was in fact already foreseen by the authors, who stated that the classification of oxisols in particular "needs to be tested more widely ..... for it is far from completion and is certain to have many shortcomings".

On the other hand, however, the system leaves no scope for subjective speculation and among its innovations, the use of quantitative criteria and concepts of diagnostic horizons are acclaimed. Several countries adopted the system (e.g. Venezuela, Argentina, India, Malaysia and Thailand), or refined their own systems along similar lines (Australia, Canada, the Netherlands).

3. THE FAO-UNESCO LEGEND

For Africa, the 1:5.000.000 soil map of d'Hoore (1960) served for quite some time as an example for regional communication. The map proved to be a good synthesis and brought the french and belgian approaches of classification of tropical soils together. Stimulated by this experience as well as by other regional soil mapping efforts, FAO and UNESCO, following a recommendation of the ISSS, initiated in 1961 the Soil Map of the World programme. Based on compilation of available soil survey material from all over the world and through numerous regional soil correlation tours, reported in 43 World Soil Resources Reports, the programme was carried out till the early seventies, when the first sheets of the 1:5.000.000 map were printed.

The legend is simple and comprises only two categories (bicategorical scheme). The basic element of the soil unit of which 106 are recognized and which are grouped into 26 groups on the basis of generally accepted principles of soil formation. In addition, there are also a number of soil phases, which may be applied to any soil unit.

In its final form, the system makes use of the principles of diagnostic surface and subsurface horizons, adopted in a simplified form from Soil Taxonomy. It also incorporates features and nomenclature from various pedogenetic classifications, including the French and Russian systems.

The scheme presents a systematic inventory of the world's soil resources on a comparative basis. As a legend of a map and as an organized compilation of definitions of mapping units, the units are not always defined at the same level of generalization (Dudal, 1968). The scheme is thus essentially a compromise, attaining a balance between the use of natural soil bodies, genetic concepts and morphometric criteria. The scheme is also not a formal soil classification system and it not meant to replace any of the national systems. Instead, it wants to serve as a common denominator.

Nevertheless, attracted by its simplicity, a number of countries adopted the scheme as a starting point for the development of their own classification systems (Indonesia, Mexico, Kenya, Uruguay).

But to be useful as a classification system for larger-scale mapping, lower categories of the scheme need to be developed and defined. An example of the development of a third-level terminology and definitions is the legend of the exploratory 1:1.000.000 soil map of Kenya. With lower level categories ,the FAO-UNESCO scheme would be an attractive reference scheme for the grouping of soils in countries without a well established soil classification system (Sombroek, 1978).

4. SOIL CLASSIFICATION AS A CONTINUOUS PROCESS

Many soil scientists expected that after the publication of the U.S. Soil Taxonomy, as a detailed quantitative system and the FAO-UNESCO scheme, as an overview type of system directly related to small scale mapping, there would be no immediate need for major new efforts. The two systems would serve sufficiently well the needs of international soil classification.

However, the presentation of the two systems resulted in an increased interest in all aspects of soil classification and in an awareness, throughout the world, of the importance of more quantitative approaches to soil classification. Soil classification being essentially a continuous process, the makers of the systems encouraged soil scientists to collect new data, to accomodate new information and to propose amendments, new definitions and other changes.

5. IMPROVING SOIL TAXONOMY

Soon after the system was formally published it appeared there were a number of drawbacks. While serving the needs in the USA quite satisfactorily, its application elsewhere, and in the tropics in particular, appeared to be not without problems. It is mentioned already that for many tropical soils the system was still tentative and that further testing would be essential.
Other difficulties appeared to be the complexity of the system, its vocabulary, semantics and presentations with lengthy and complex definitions, which were considered to be obstacles to its use, particularly in the non-English speaking world (Cline, 1980), though this should be a minor threshold only.
More relevant, however, is the fact that the use of the system also requires well equiped soil laboratories, a strict standardization of analytical laboratory methods and procedures not always suitable for tropical soils and many quantitative data on parameters for which information is rarely available.

There are also objections to the system itself, such as the use of soil moisture and soil temperature regimes, particularly at the higher categoric levels and with criteria not too well adapted to the tropics and subtropics.

Then there is the confusing mix-up of soil classification units and soil mapping units, already indicated in the subtitle of the system, as a result of an early decision by the developers of the system that the "soil series" - essentially a mapping unit - should form the basic building stone of the system.

Many suggestions for major and minor changes were received and in 1975 the first appointed international Committee to assess and incorporate such proposals was installed. It was the ICOMLAC Committee, charged with reviewing the classification of Alfisols and Ultisols with low-activity-clays (largely the "Oxic" subgroups). The Committee issued a series of circular letters and organized a first international workshop on the subject in Brazil in 1977 (Camargo and Beinroth, 1978). The meeting, which drew participants from many countries, resulted in initiatives to create committees for other groups of "problem" soils as well, successively named ICOMOX on Oxisols, ICOMERT on Vertisols, ICOMAND on Andepts, ICOMID on Andisols, ICOMORT on soil moisture regimes in the tropics and ICOMAQ on soils with aquic moisture regimes.

All Committees held follow-up workshops. These were respectively on Oxisols and LACsoils in Malaysia and Thailand in 1978 (Beinroth and Paramanthan, 1979 and Beinroth and Panichapong, 1979) on Andisols and soil moisture regimes in Syria and Libanon, 1980 (Beinroth and Osman, 1981); on soils in tropical mountain areas in Rwanda in 1981 (proceedings in press and recent ones held in Chile and Ecuador on Andisols and in the Philippines on hydromorphic soils. (January and April 1984, respectively)

Together with initiatives of many individual soil scientists, the activities of the international committees resulted in a permanent stream of proposals for additional taxa, for new and better definitions and other changes.

It is unfortunate however, that the acceptance of proposed changes requires a long process. Although recently new procedures are proposed to remedy the shortcomings (Flach, 1984), some countries decided to continue to use national systems or to return to the development of such systems, while continuing to use Soil Taxonomy for international correlation (New Zealand, for example).

6. OTHER NATIONAL EFFORTS

Pre-occupation with principles of soil classification, concern to find adequate niches for nationally or locally important soils, as well as some national pride, led several countries to develop other, national soil classification systems. In all these efforts, emphasis is on well-defined diagnostic properties and strict class limits.

For tropical regions important examples are the Brazilian approach to soil classification - pragmatically, quantifying and subdividing the old genetic units on the basis of very many field data collected over many years. Their results are being worked out in a formalised system (3rd approximation) with detailed definitions of diagnostic properties. Also the approach of Northcote for Australian soils (Northcote, 1960), proposing a "natural objective classification", based on a bifurcating system with two classes per category deserves attention.

For temperate regions new systems are advanced in Canada, in England and Wales, the quantified Kubiena system for use in West Germany (1977) and also recent trends in the USSR. Interesting for conceptual purposes, is the scheme devised by Fitzpatrick (1972). Rather more ambitious, and conceived as an alternative to Soil Taxonomy are the proposals of a Working Group of the French ORSTOM organization (Segalen, P. 1977 and Fauch, R. et al, 1979).
The new approach intends to encompass all the soils of the world in a system that is based on soil constituents and soil mineralogy for subdivision at the highest categoric level, while (secondary) features like the presence of an argillic horizon are treated

at a much lower level. The system is conceptually very systematic and quantitative, though with less preoccupation for aspects related to the soil's agricultural production potential. As all other new national systems mentioned, it deletes (soil) climatic criteria, as these would have to be mapped separately.

7. UPDATING THE WORLD SOIL MAP

After completion of the FAO/UNESCO Soil Map of the World programme in 1974, it soon became apparent that the map cannot be left as a one-time exercise, but that regular updating is essential to maintain its usefulness. This updating would also imply some changes in the Legend and, in a number of cases, the elaboration of a third-level terminology. The International Soil Museum (ISM) for example, signalled a number of inconsistencies and incompletenesses in the legend when building-up a reference soil monolith collection of the major soils of the world.

In 1979, FAO consulted its field staff on the usefulness and need of additional efforts. The response was overwhelmingly positive. By that time also UNEP became interested in the matter. This new UN agency felt the need for a truly international system of soil classification- i.e. without geographical bias - as part of its World Soils Policy plan-of-action and to have a tool for its Global Environmental Monitoring System (GEMS). Joint efforts of ISSS, FAO, UNESCO and UNEP then resulted in three preparatory meetings on the elaboration of a so-called "International Reference Base for soil classification (IRB)", held all three in Sofia, Bulgaria. At the 12th ISSS Congress in New Delhi, India, its Commission V formally decided to create a Working Group for the project, under the chairmanship of Prof.Dr.E.Schlichting of West Germany.

The basic premise at IRB is that it would be virtually impossible to have a system with many categories adopted in all countries of the world, as there would be an obvious growing need for local systems geared towards the particular conditions and requirements of individual countries and regions. At international level one should try to have only a few - may be three to four - categories, to which all countries could conform and refer to, with only some guidelines for elaborating the details of national systems. It is noteworthy that representatives of all major national or regional systems - USA, France, USSR, Australia, Brazil, Canada etc.- have agreed to the principles of this approach and have promised their support for the undertaking. By now a Steering Committee for the IRB project has been formed under the Chairmanship of ISSS Commission V (Dr.R.Arnold), and a number of Working Committees are under formation for each identified major soil group (16 in total) under the direction of Dr. Schlichting.

The Sofia meetings already resulted in a degree of agreement on the principles and the rationale of the IRB system. Essential in the IRB rationale is the application of the expression of soil forming processes in the soil constituents at the highest categoric levels - taking the FAO/UNESCO Legend as starting point. The use of soil climatic parameters would be at the fourth level only - taking the FAO agro-ecological zones concept as a guide.

It is too early to judge whether the IRB efforts will be successful in presenting a satisfactory reference base that will be adopted worldwide. The undertaking should avoid, by all means, the impression that the IRB effort will be developed in competition to Soil Taxonomy or to any other detailed system of classification. It should combine the best elements of the existing systems, with special attention to the needs of developing countries, where improved knowledge of the soil resources is an urgent goal. Much will depend on the voluntary efforts of many national soil institutions and societies, as well as individual soil scientists.

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