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World Reference Base for Soil Resources

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A common language is vital to the functioning of any society. It is a matter of great concern that after a hundred years of modern soil science a generally accepted system of soil classification has not yet been universally adopted. The credibility of soil science is suffering from the lack of a generally accepted communication system. This situation arises partly from the fact that soils constitute a continuum, which, unlike easily identifiable plants and animals, needs to be broken into classes by convention.

Background. In the early days of pedology the classification of soils was mainly based on soil genesis. The various schemes that were generated differed according to the concepts of soil formation held by the authors. The first systems of soil classification were developed in environments, which were strongly influenced by glacial and periglacial phenomena (Russia, Central and Western Europe, North America) and where geologically young parent materials showed the mark of recent climatical conditions. As a result these classification systems were difficult to apply to soils formed on older landscapes and from strongly weathered materials in tropical and subtropical regions (Dudal, 1996).

The intensification of international communications and the expansion of soil surveys in the 1950s, both in temperate and in tropical areas, greatly enhanced the overall knowledge of the soil cover. Classification systems were developed which aimed at embracing the full spectrum of the soil continuum. Following consultations, which took place on the occasion of the 6th International Congress of Soil Science, in Paris in 1956, it was decided that special attention would be given to developing the classification and correlation of the soils of great regions of the world. As a follow-up, soil maps covering Africa, Australia, Asia, Europe and South America - at scales ranging from 1:5M to 1:10M - were presented at the 7th International Congress held at Madison, in the United States, in 1960. This Congress recommended that ways and means be found to publish these maps, as they reflected a vast amount of knowledge on the properties of soils and on their distribution in different parts of the world. It soon appeared that nomenclature, survey methods, legends and systems of classification varied so widely that inter-regional comparisons were difficult. Although a consensus had evolved as to the main soil bodies to be separated, major differences persisted with regard to the levels of generalization at which these soils were to be distinguished, the criteria to be used for their separation and the weight to be attached to different soil properties in a classification system. Differences in terminology and nomenclature were an additional constraint to international correlation. In response to a recommendation of the Madison Congress, and recognizing the need for an integrated knowledge of the soils of the world, FAO and Unesco, in association with the International Society of Soil Science (ISSS), agreed to jointly prepare a Soil Map of the World at scale 1:5M. The project started in 1961. Successive drafts of the soil map and of the legend were prepared - under the authority of an international advisory panel - from a compilation of existing soil survey material, combined with systematic field identification and correlation.

The internationally agreed legend was approved by the 9th International Congress of Soil Science, at Adelaide, in Australia, in 1968. The first map sheets were published in 1971. Publication of all 18 maps and of 10 explanatory texts was completed by 1981 (FAO, 1971-1981). It was the fruit of a worldwide collaboration between soil scientists from a great number of countries. The FAO/Unesco soil map differed from other overviews in that it reflected a consolidation of knowledge and experience of different schools of thought and of widely diverse sources of information. It provided a scientific basis for the transfer of research results between areas of similar environments and served as a useful instrument in planning agricultural and economic development (Dudal and Batisse, 1978). By the time the Soil Map of the World was published, twenty years had elapsed since the initiation of its preparation. During this period numerous soil surveys were carried out for development and investment purposes with the support of UN Agencies or bilateral assistance programmes. If the Soil Map of the World was to retain its value it was necessary to update it on the basis of the most recent information.

In the early 1980s countries became increasingly interdependent for their supplies of food and agricultural products. Problems of land degradation, disparity of production potentials and of population carrying capacities became international concerns. Against this background FAO felt that a framework should be created through which existing soil classification systems could be correlated and harmonized. Concurrently it would serve as an international means of

communication and of exchange of experience. The elaboration of such a framework required a more active involvement of the entire soils community.

At the initiative of FAO, in cooperation with Unesco, UNEP and the ISSS, a group soil scientists, representing a broad range of soil institutions, met at Sofia in 1980 in order to enhance international involvement in a follow-up to the Soil Map of the World. The Poushkarov Institute of Soil Science and Yield Programming hosted the meeting. The Bulgarian hosts effectively contributed to overcoming some geopolitical issues, which, at that time, were not entirely absent from scientific gatherings. The meeting decided to launch an International Reference Base for Soil Classification (IRB) with the aim of reaching international agreement on the major soil groupings to be recognized at a global scale as well as on the criteria to define and separate them. It was expected that such an agreement would facilitate the exchange of information and experience, provide a common scientific language, strengthen the applications of soil science, and enhance the communication with other disciplines. The group met a second time at Sofia, in 1981, and laid down the general principles of a joint programme toward the development of an International Reference Base (IRB).

In 1982, at New Delhi, the 12th Congress of the International Society of Soil Science endorsed and adopted this programme and entrusted it to a Working Group at large. In 1986, at the 13th Congress of the ISSS at Hamburg, the IRB was taken in charge by a Working Group of Commission V itself (Soil genesis, classification and cartography). In 1990, the Commission devoted a Symposium to the IRB in the framework of the 14th Congress of the ISSS in Kyoto. The IRB scheme, which was presented on this occasion, comprised 20 major soil groups compared to the 28 first level units distinguished in the legend of the FAO/Unesco Soil Map of the World (Dudal, 1990). At the meeting of the IRB Working Group, at Montpellier, in 1992, it was decided that the revised FAO/Unesco legend would be used as the basis for the further development of the IRB and that efforts would be merged. It would be IRB s task to apply its general principles to the further revision of the FAO/Unesco units and to provide them with the necessary depth and validation. The consolidated approach was renamed World Reference Base for Soil Resources (WRB) reflecting the involvement of a wide range of soil scientists, rather than of representatives of national schools only, and the attention being paid to soils as a resource rather than as mere taxonomic units. Progress in the preparation of the WRB was reported to the 15th Congress of the ISSS at Acapulco in 1994 (Spaargaren, 1994). Numerous comments have been received from all over the world, discussed in WRB meetings at Leuven (1995), Kiel (1996), Moscow (1996), South Africa (1996), Argentina (1997) and Vienna (1997).

Objective. Given the great diversity of soils in different countries, national soil classification systems are justified at the lower categorical levels. It is indeed hardly possible that one overall system can simultaneously and adequately meets all global, regional and local objectives. The World Reference base for Soil Resources (WRB) is designed as an easy means of communication amongst scientists to identify, characterize and name major types of soils. It is not meant to replace national soil classification systems but will serve as a common denominator through which national systems can be compared and correlated. WRB also serves as a common ground between people with an interest in land- and natural resources. The system draws extensively on the legend of the FAO/Unesco Soil Map of the World. WRB is not a new international classification system, but a basis for better correlation between national systems. WRB is a tool for identification of pedological structures and their significance. It serves as a basic language in soil science and facilitates:

scientific communication;

implementation of soil inventories and transfer of pedological data, elaboration of different systems of classification having a common base, interpretation of maps;

acknowledgement of lateral links between soils and soil horizon distribution as characterized by topo- and chronosequences;

international use of pedological data, not only by soil scientists but also by other users of soil and land, such as geologists, botanists, agronomists, hydrologists, ecologists, farmers, foresters, civil engineers, architects, etc... with as particular objective to improve upon;

the use of soil data for the benefit of other sciences;

the evaluation of soil resources and the potential use of different types of soil cover;

the monitoring of soils, particularly soil development which is dependent on the way soils are used by the human community;

the validation of experimental methods of soil use for sustainable development, which maintain and, if possible improve the soil's potential;

transfer of soil use technologies from one region to another.

WRB aims to provide scientific depth and background to FAO's Revised legend of the Soil Map of the World (1990), incorporating the latest knowledge relating to the global soil resources and interrelationships. To include some of the most recent pedological studies and to expand use of the system from an agricultural base to a broader environment one, it was recognized that a limited number of important changes to the 1990 Legend were becoming necessary.

Principles. The general principles on which the WRB is based were laid down at the early Sofia meetings and further elaborated upon by the Working Groups entrusted with its development. These general principles can be summarized as follows:

the classification of soils is based on soil properties defined in terms of diagnostic horizons and characteristics, which to the greatest extent possible should be measurable and observable in the field.

the selection of diagnostic horizons and characteristics takes into account their relationship with soil forming processes. It is recognized that an understanding of soil forming processes contributes to a better characterization of soils but that they should not, as such, be used as differentiating criteria.

to the extent possible at a high level of generalization it is attempted to select diagnostic features, which are of significance for management purposes.

climatic parameters are not applied in the classification of soils. It is fully realized that they should be used for interpretation purposes, in dynamic combination with soil properties, but they should not be part of soil definitions.

WRB is meant to be a comprehensive classification system, which enables people to accommodate their own national classification system. It comprises two tiers of categorical detail: (1) the "Reference Base" which is limited to the first level only, having 30 Reference Soil Groups; (2) the "WRB Classification System" consisting of combinations of a set of prefixes as unique qualifiers (or modifiers) added to the Reference Soil Groups, allowing very precise characterization and classification of individual soil profiles.

the Reference soil units to be retained in WRB should be representative of major soil regions so as to provide a comprehensive overview of the world s soil cover.

the Reference Base is not meant to substitute for national soil classification systems but rather to serve as a common denominator for communication at an international level. This implies that lower level categories, possibly a third category of the WRB, could accommodate local diversity at country level. Concurrently the lower levels could emphasize soil features, which are important for land use and soil management.

the revised legend of FAO/Unesco Soil Map of the World was used as a basis for the development of the WRB in order to take advantage of the international soil correlation work, which has already been conducted through this project.

an attempt is made for definitions and descriptions of soil units to reflect variations in soil characteristics both vertically and laterally so as to account for spatial linkages within the landscape.

the term 'Reference Base is connotative of the common denominator function which the WRB will assume. Its units should have sufficient width to stimulate harmonization and correlation of existing national systems.

in addition to serving as a link between existing classification systems the WRB may also serve as a consistent communication tool for compiling global soil databases and for the inventory and monitoring of the world s soil resources.

the nomenclature used to distinguish soil groups will retain terms which have been traditionally used or which can easily be introduced in current language. These terms need to be precisely defined in order to avoid the confusion, which occurs when names are used with different connotations.

Elements of the World Reference Base for Soil Resources. For describing and defining the Reference Soil Groups and soil units of the WRB, use is made of soil characteristics, properties and horizons, which in combination will define soils and their interrelationships.

Soil characteristics are single parameters, which are observable or measurable in the field, in the laboratory, or can be analyzed by using microscope techniques. They include characteristics such as colour, texture and structure of the soil, features of biological activity, arrangement of voids and pedogenetic concentrations (mottles, cutans, nodules, ...) as well as analytical determinations (soil reaction, particle-size distribution, cation exchange capacity, exchangeable cations, amount and nature of soluble salts, ...).

Soil properties are combinations of soil characteristics which are known to occur in soils and which are considered to be indicative of present or past soil-forming processes (e.g. vertic properties are a combination of heavy texture, smectite mineralogy, gilgai, slickensides, hard consistence when dry, sticky consistence when wet, shrinking when dry and swelling when wet).

Soil horizons are three-dimensional bodies, which are more or less parallel to the earth's surface. Each horizon is characterized by one or more properties, occurring over a certain depth, with a certain degree of expression. The thickness varies from a few centimeters to several meters; most commonly it is about a few decimeters. The upper and lower limits ('boundaries') are diffuse, gradual, clear or abrupt. Laterally, the extension of a soil horizon varies greatly, from a meter to several kilometers. However, a soil horizon is never infinite, it disappears or grades into another horizon. Reference Soil Groups are defined by a vertical combination of horizons within a defined depth, and by the lateral organization of these horizons, or by the lack of them. Soil horizons and properties are intended to reflect the expression of genetic processes, which are widely recognized as occurring in soils. They can therefore be used to describe and define soil classes. They are considered to be "diagnostic" when they reach a minimum degree of expression, which is determined by visibility, prominence, measurability, importance and relevance for soil formation and soil use, and quantitative criteria. To be diagnostic, soil horizons also require a minimum thickness, which must be appraised in relation to bio-climatic factors (e.g. a spodic horizon in boreal regions is expected to be less thick than in the tropics).

The successive steps for defining the Reference Soil Groups are:

Determine the soil characteristics to be used in the definitions;

Identify soil characteristics through observation in the field, supported by laboratory analyses;

Determine the presence and kind of horizons;

Identify specific vertical successions of horizons on the basis of which the soil (pedon), considered to be the central concept of the major soil group defined;

Go through the technical key and define the Reference soil groups in terms of a specific combination of soil horizons.

When the information is available determine and describe lateral linkages, which occur in the landscape (composition of soil cover).

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INTERNET

http://www.isric.nl/WRB.htm

General information, photographs

http://www.fao.org/waicent/FaoInfo/Agricult/AGL/AGLL/WRB/Default.htm

Detailed information, maps

http://www.fao.org/docrep/W8594E/W8594E00.htm

Documents