Time for a Universal Soil Classification System

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For thogh we slepe or wake, or rome, or ryde, Ay fleeth the tyme; it nil no man abyde.
[*c* 1390 Chaucer *Clerk's Tale* l. 118]
(Time and tide wait for no man)

Abstract
Soil science, unlike many other scientific disciplines, does not have a universally accepted classification system. Many countries have developed systems to classify their soils, but the results often do not translate well between taxonomic systems. Attempts have been made through efforts such as the *FAO Legend for the Soil Map of the World*, the *World Reference Base for Soil Resources*, and *Soil Taxonomy* to address the need for a globally accepted soil classification system. But so far, this goal has not been achieved. We believe the time is right to form a working group under the auspices of the International Union of Soil Sciences to explore the development of a universal soil classification system.

Background
Most natural sciences struggle for a common classification system such as botany, anthropology and astronomy. Natural classification systems should be accepted and used globally. Soil science and soil classification are viewed as National Systems yet none have received full international acceptance. Common reasons given for universal systems are pleas from a discipline to work together towards a common understanding and to provide a common language for communication.

Currently when we look at soil classification around the world we have what might be called an 'adobe tower of Babel' (see the variety of systems in Krasilnikov *et al*. 2009). The international politics that hampered global collaboration in soil science in the last Century has slowly mellowed towards a movement for more harmony and to develop an internationally acceptable nomenclature and methodology. This process was not merely to standardize terminology but required evaluation and changes in the whole process including methods of soil analysis and choice of criteria. The time is ripe for acceptance of standard soil terminology, concepts and rationale in elaborating the system and for linkages with current systems.

A group of international soil scientists while attending "Bridging the Centuries Conference in Gödöllő, Hungary, in 2009 agreed that we should submit the following declaration to the International Union of Soil Sciences:

The "Bridging the Centuries 1909–2009" events were organized to celebrate the 100th anniversary of the 1st International Conference of Agrogeology and to overview the last 100 years of advances in soil sciences:

The purpose of the 1st conference was to discuss the different approaches to field and laboratory methods, soil descriptions soil classification and soil mapping. An important objective was to gain a common understanding of methods and language, and to develop common soil classification and mapping schemes.

Although much has been achieved in the subsequent 100 years, the participants of the 2009 Centenary Conference concluded that soil science community is still lacking commonly accepted and used field and laboratory standards in soil characterization and classification, making communication and data exchange difficult within soil science and other disciplines.

Therefore the participants of the "Bridging the Centuries: 1909–2009" conference, declared that there is a need to develop a "Universal Soil Classification" (USC) system for the effective transfer of soil information.

It was recommended that a proposal for the development of such a system be addressed to the International Union of Soil Sciences (IUSS) Council at the 2010 World Soil Congress in Brisbane, Australia. The system would be developed under the scientific auspices of the IUSS in the form of a working group which would effectively be composed of representatives from countries from all continents, and representatives from key international and national agencies.

It was further recommend that the USC should be based on the experiences of existing broadly used national classification systems and to build on the experiences of the World Reference Base for Soil Resources (WRB), the correlation system of IUSS, as well as on accumulated soil information and state-of-the-art observation and data processing tools.

History

Many countries developed a national soil classification system, among others, Argentina, Australia, Brazil, Canada, China, France, Germany, Russia, Scotland, South Africa, and the United States and many of them have a long history.

A first international approach was the FAO Legend for the Soil Map of the World. This map had three levels, which was very apt for the scale of the map (1:5,000,000). Some countries have used the same legend for national mapping and encountered many difficulties. The scale of the potential use has to be reflected together with the detail of the categoric level that is selected. For classification purposes, the FAO Legend is meanwhile replaced by the World Reference Base for Soil Resources (WRB) that is maintained by a Working Group of the IUSS. WRB is a flexible system with a flat hierarchy and two categoric levels, the first level using a key, the second level using independent combinations of characteristics. The original purpose was to serve as a tool for correlation of national systems and help international communication. Some countries however adopted it also for mapping purposes. Lacking a common guideline however, the results were not satisfactory. In 2009, mapping guidelines have been established which allow using WRB for constructing small-scale map legends (1:250,000 and smaller) if the relevant soil data are available.

The Example of the United States

Standards are very important to have in all systems. There is need for a common and consistent way of describing, collecting and measuring soils. We should build upon existing systems. Moving away from an accepted system presents problems including psychological ones. The viable process that will enable change is to build upon existing systems and not to make dramatic changes that alarms users. For example, in the US we minimized the disruption to the Soil Survey Program when we replaced the 1938 system of soil classification with *Soil Taxonomy* by, in so far as was possible, accommodating the soil series that were established at that time as the lowest level of the new classification system.

One of the reasons for the success and acceptance of *Soil Taxonomy* was that there was ownership and an institutional guardian, the USDA Soil Conservation Service, and users were invited to contribute to developing the system. There are examples of individuals in countries who have tried to propose systems of their own; apart from being academic contributions, these quickly faded away in pedological history. A second important reason becomes evident and that is "for making and interpreting soil surveys". Just making an inventory of the soils with lines is not enough. By strongly linking the inventory with data to a system of making interpretations is the real strength of soil surveys. In the US soil interpretations became the important tool of soil survey and soil classification was only the vehicle. In countries where soil classification was a theoretical academic exercise, the

system fell into disuse very quickly. A third reason that *Soil Taxonom*y is successful is that because it uses the properties of the soil itself for defining taxa, and not theories of the soil's genesis, any competent soil scientist, whether a junior or senior member of the soil survey program, can classify the soil accurately and consistently. These are important considerations when considering a global system.

Soil Taxonomy was developed to accommodate all soils, not just those known in the United States. There have been eleven International Committees formed over the years to improve *Soil Taxonomy*. Six committees were devoted to improving the system at the Order level (Andisols Aridisols Gelisols Oxisols, Spodosols, and Vertisols.). Five other international committees were established to improve *Soil Taxonomy* with regard to specific characteristics including low activity clays, the aquic moisture regime, family-level classes, moisture and temperature regimes, and anthropogenic soils. The intent of these committees has been to continue to strive to achieve the eighth stated attribute of the system which is "*to provide for all known soils, wherever they may be*."

Towards a Universal Soil Classification System

We should consider adopting the most modern systems that have been inherited with a conceptual diagnostic approach, with established terminology, and existing structural elements.

We need to look for a starting point for a USC that is the most documented existing system. It should have the highest amount and most accurate data collected to support the science. We should share existing documents and documentation that represents the starting point for standards that will support our USC System. We also need an accepted approach by the IUSS in developing the new system, one that is fair and based on the best science of today one that is decided by a group of experts and political leaders and one that is accepted internationally.

We should however be cognizant of new developments. We see no reason why the numerical concepts that have been developed over the last 30 years cannot be investigated and if found fit for purpose, incorporated into the new system. These include the concepts of pedotaxonomic distance, numerical polythetic allocation and where appropriate, continuous classes. Existing taxa could be used as the starting point for such approaches.

Of crucial importance for the success of any global soil classification system is that there must be a solid and long-term support from an institution or group of institutions assuring the necessary resources for the development, maintenance and implementation of the USC worldwide. One of the main reasons for the failure of previous attempts was the lack of such an operational support. Any future global system will have to have behind its establishment one, or a group of, solid and committed institutions willing to mobilize the needed resources (staff and financial means) to maintain such a system on a long term.

The USC system must be dynamic and innovative. It must be continuously used and continuously tested and numerical approaches facilitate this. The classification should not be viewed as being just a name. The relevance and implications of the name and the kinds of accessory information incorporated in the name makes the system more powerful.

The detail in information required would depend on the kind of use and the scale of observations. During the processes of developing the system, an agreement on the number of categories is necessary. The system may use a Key that enables the selection of taxa, and the classification may consist of categories where the user can navigate with the aid of the Key. Standards for Terminology and Definitions (common data dictionary) are needed. Components of any system and users must adhere to the agreed terms and definitions to use the system accurately and reproducibly. This includes common methods of characterization of soil analysis and common methods for soil descriptions. Scale of mapping, 1:12,000 to 1:250,000 must be agreed upon also the way we make observations e.g., field morphology versus micromorphology.

Soil Scientists from around the world have expressed the desire and need to develop a common USC System. But, even more important, we need a global soil classification system that will be adopted by the major National

soil survey and mapping agencies currently actively engaged in operational soil survey activities. The future USC should not be solely an academic exercise, but should be developed together with the major agencies supporting soil survey and mapping in the world.

Finally, an important consideration is the practicality of the process. A core group will be responsible for binding decisions into the USC System but they must be supported by a number of specialized groups that provide inputs for the different components. An advantage of the proposed effort is that many classification systems exist, each have been tested and enhanced and deficiencies are known by the authors or users. Inputs by these experts can merge the different systems into a universally acceptable system.

A focus on use and management from the system should be the ultimate goal. Linkages to existing national soil survey programs are very important. It is important for us to achieve "Buy In" into a system that is active and established such as the US "National Cooperative Soil Survey" or the Mexican "Instituto Nacional de Estadística y Geografía", which are by far the most developed and extended operational soil survey programs in the world.

With the experience and enthusiasm that exists today, a USC System is feasible and will have international acceptance. The generation that developed the current systems is leaving the scene through retirement. Today the opportunity arises for the current generation to collaborate and realize the dream of one Universal Soil Classification System.

Thank you for your attention.

Reference

Krasilnikov P, Ibanez Marti J-J, Arnold R, Shoba S (2009). A Handbook of Soil Terminology, Correlation and Classification, Earthscan, London. 440pp.