The next steps in soil classification OR How to kill 3 birds with 1 stone: pedons, landscapes, functions

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Abstract
The next steps in soil classification are outlined starting from the present situation: Two worldwide-applicable systems exist, the US Soil Taxonomy (ST) and the World Reference Base for Soil Resources (WRB). ST has as a strong hierarchy with six categoric levels and WRB a flat hierarchy with two levels. For classification of an individual pedon, the flat hierarchy of WRB has two major advantages: All relevant characteristics of the pedon are reflected in the classification, and the technical key is thinner and easier to overlook. On the other hand, creating basic soil maps is nearly impossible in WRB except on very small scales. To make WRB suitable for mapping also at intermediate scales, Guidelines for constructing map legends were established recently and are now in a testing phase. A remodelled WRB system based on these Guidelines could be able to serve equally the needs of classification and mapping. The third task, to provide civil society's demand to predict the reaction of soils to human impacts is implicitly already fulfilled by both systems. The problem is that this information appears somewhat hidden for the non-soil science public, and we have the task to make it visible. A purely utilitarian classification system reflecting only soil functions, which is suggested by some soil scientists, would disregard soil dynamics and fail the objective to provide society with the relevant knowledge about soils behaviour. Recent discussions on developing a Universal Soil Classification are an interesting concept to overcome the lack of a single and worldwide-accepted soil classification system.

Key Words
Soil Taxonomy, World Reference Base for Soil Resources, hierarchy, flexibility, soil maps. soil dynamics.

Main text
Classification and Mapping
Two soil classification systems are applicable worldwide: The Soil Taxonomy (ST), edited by the United States Department of Agriculture (Soil Survey Staff 1999 and 2006), and the World Reference Base for Soil Resources (WRB), edited by a Working Group of the International Union of Soil Sciences (IUSS Working Group WRB 2007) and adopted by the IUSS as the officially recommended terminology to name and classify soils.

One purpose of both systems is to allocate an individual pedon within the system and give it the respective name. This procedure is (although not entirely correct) traditionally called the classification of a soil. ST has a strong hierarchy with six categoric levels. WRB has a flat hierarchy with only two categoric levels. The

In WRB, the upper level comprises 32 Reference Soil Groups (RSG). At the lower level, a soil name is constructed by adding qualifiers to the name of the RSG. All applying qualifiers have to be added, and the number of qualifiers, which a soil has, depends on the soil's properties. The qualifiers are defined in a common alphabetical list. For every RSG, the possible qualifiers are provided, and they are split up into two groups, prefix qualifiers and suffix qualifiers. The qualifiers of both groups are listed in a certain sequence, which must be followed when classifying a soil. But the position of a qualifier in the list is not related to its importance, i.e. the sequence is without any hierarchical order. The flat hierarchy of WRB has two major advantages: First, the open number of qualifiers for every pedon assures that all relevant characteristics of this pedon are reflected in its classification. Second, the definition of the qualifiers in a common list makes the technical key thinner and easier to overlook.

Besides classification of individual pedons, ST serves well for making soil maps at different scales. The strong hierarchy of ST helps to make that possible. In WRB, maps are only possible on the RSG level, which only makes sense at very small scales. For larger scales, qualifiers would have to be added, which is impeded by the fact that all qualifiers have the same rank, and up till now there is no rule, which ones have to be selected.

To make WRB suitable for mapping at intermediate scales (1 : 250 000 and smaller), the WRB Working Group developed Guidelines for constructing map legends (IUSS Working Group WRB 2010). Here, for every RSG, the qualifiers are subdivided into "main map unit qualifiers" and "optional map unit qualifiers". Whereas the optional ones are listed alphabetically, the main ones are ranked in an order of priority. With increasing scale, the first, the first two and the first three applying main qualifiers have to be added to the RSG name. They stand before the RSG name with the first qualifier closest to the name of the RSG, i.e. from right to left. At every scale, additional qualifiers of the main list or qualifiers of the optional list may be used in brackets behind the RSG name, according to the purpose of the map.

This creates a new problem: WRB will have different sequences of qualifiers for the classification of individual soils and for mapping. The suggestion is now to use the mapping sequence also for the classification of pedons, just with the difference that in this case all applying qualifiers have to be used.

Soil Functions

The family level of ST and the qualifiers of WRB provide exhausting information about soil functions. Civil society's demand on soil science is to receive exactly that kind of information: soil functions and the threats to soil functions. The problem is that for non-soil scientists this information is somewhat hidden. Our task is to make it obvious. For WRB this may include to redefine some qualifiers in a way that they can serve better the demands of civil society.

In some discussions it had been argued that the needs of society could be better satisfied by inventing a new and more utilitarian classification system to be used in addition to the more scientific ones. The scientific classification systems then, in turn, would have the purpose to reflect the state-of-the-art of soil science and to serve as a tool to bring forward its development. This approach bares a risk: The utilitarian system would be based on the current values of certain parameters. It would regard soils and soil functions as something static and neglect their dynamics and the processes going on in them. Such a system would fail the principle needs of society: to predict the behaviour of soils. Therefore, any information provided for the decision-makers has to be based on a profound understanding of soils. And the practical advantage is, that there is less to teach and to learn, if all the purposes can be served by one system.

Universal Soil Classification

During the year 2009, a discussion became more intensive that it would be desirable to have one single worldwide-accepted soil classification system. In September 2009, a group of soil scientists, came together in Budapest, Hungary, to celebrate the 100th anniversary of the first international soil science conference and approved a resolution on that topic. None of the two existing worldwide-applicable systems is used worldwide. The reasons seem to be different for ST and WRB. ST is regarded to be complicated and has some deficits in classification of individual soils due to its strong hierarchy. WRB is less well-known outside the pure scientific community and has (or with the Guidelines for constructing Map Legends: had) severe deficits in creating soil maps due to its flat hierarchy. Bringing together the knowledge of soil science and soil survey, learning from the experiences of existing soil classifications systems (worldwide and local systems) and serving the demands of society, under the umbrella of the IUSS a worldwide-accepted system could be designed.

Conclusion

1. The two worldwide-applicable soil classifications systems, the US Soil Taxonomy and the WRB, have different architectures and consequently different points of strength and weakness: WRB stronger in classification, ST in mapping. A reform of the second categoric level of WRB, based on the recently established Guidelines for constructing small-scale map legends, may overcome the weak point of WRB.
2. A good soil classification allows deriving sufficient information on soil functions and threats to soil functions. Both, ST and WRB have the potential for that. Contrary to that approach, a purely utilitarian system, based only on soil functional parameters, would disregard the dynamics of soils and would therefore be unable to predict soil behaviour.
3. Recent discussions focus on the elaboration of a soil classification system that has a better worldwide acceptance than ST and WRB.

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