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A QUEST FOR AN ALTERNATIVE TO THE USE OF SOIL MOISTURE REGIMES AT HIGH CATEGORIC LEVEL IN SOIL TAXONOMY

W.G. SOMBROEK

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W.G. Sombroek[1]

ABSTRACT

A tentative listing is given of associated features of soil moisture regimes at Suborder level of Soil Taxonomy. These may be used for the development of replacing definitions and naming at that level, relegating soil moisture regimes *per se*, and their subdivisions as proposed by Van Wambeke, to the management-oriented family level.

1. INTRODUCTION

In the ICOMMORT Circular Letter Nr. 2, Dr. Van Wambeke submits a proposal for subdivision of the present soil moisture regimes of the US "Soil Taxonomy" system of soil classification. The implied purpose of the proposal is to make the system more relevant for soil management and agrotechnology transfer. These application aspects of the system are supposed to be concentrated at the Family level. Therefore, any adaptation and subdivision of soil moisture regimes should be employed at that level, in a way comparable to the use of soil temperature classes. Such a use of soil moisture regime may have a repetition of the naming at Suborder level as a consequence; even a departure from Suborder naming may be required, viz. if one wants to put the main boundaries of the regimes somewhat different at family level to make them more meaningful for management purposes. Omitting soil moisture regimes at Suborder level would break up to whole structure of the classification system, which should be avoided. Implied in Soil Taxonomy is however that the criteria used at the higher categories are either the result of genesis or important for genesis.

[1]International Soil Museum, Wageningen, the Netherlands

The application of soil moisture (and temperature) regimes in this respect is meant to determine the conditions under which genetic processes take, or have taken place in soils. In fact, in a number of cases this relationship has already been "translated" into measurable characteristics ("the marks") other than moisture and temperature ("the causes"). Wherever such marks can be defined they should, in the rationale of Soil Taxonomy, have prevalence in the definition of the higher-category units over the soil moisture criteria themselves (cf. Guthrie's contribution at this Workshop). One may therefore try to do this systematically throughout the Suborder level, at the same time coining new prefixes to avoid overlap or a confusion with the detailed soil climate denominations at family level.

A tentative scheme for the associated features or marks of soil moisture regimes at high categoric level is given below, based on the example profiles in USDA Agricultural Handbook 436. To elaborate the scheme many more profiles would have to be checked. However, such a checking exercise can be restricted to the USA soil situation, because any proposed changes should fit with the soils pattern overthere in first instance to have any chance of becoming accepted. Elsewhere, and in the tropics and subtropics in particular, such changes can be accepted easier because the use of Soil Taxonomy in the countries concerned is often still in an experimental stage, or complementary to a national system.

The basic assumption is that a udic soil moisture regime (in mesic or warmer climate) implies a continuous downward movement of ions; an ustic moisture regime a seasonally interrupted downward movement; a xeric moisture regime a seasonally downward movement accompanied by a seasonally upward movement of ions; and an aridic moisture regime a nearly continuously upward movement. This should be reflected not only in the clay mineralogy (which unfortunately figures only way down in the system), but also in the pH-BS sequences in the pedon and the depth of appearance of free carbonates; the latter feature is sometimes already part of the definitions at Suborder level.

Notes:

a) pH stands for pH-H_2O; BS stands for base saturation by sum-of-cations method; Ca stands for free carbonates presence of more than weak effervescence (>1%).

b) All "decrease" or "increase" tendencies are taken to start *below* the plow-layer, since management practices may have modified the virgin condition in that layer substantially; a decrease may be regular or irregular, i.e. it may be interrupted by one or two minor increases.

c) Only profiles recorded in Soil Taxonomy are taken into consideration; any apparent trends should be tested on a substantial number of other profiles in the USA, and can only then be fully quantified and made mutually exclusive.

2. SOILS WITH UDIC MOISTURE REGIME

2.1 In the Orthox suborder a udic moisture regime is only *implied* in the definition: the soils should be non-aquic, non-torric, non-humic and non-ustic.

Trends: the pH sequence is often irregular but the BS is decreasing with depth till at least 200 cm (4 out of 6 profiles); the Ca is absent till beyond 300 cm (?).

2.2 At the Udults a udic moisture regime is *specified* in the definition. They should moreover be non-aquic and non-humic.

Trends: the pH is decreasing or approximately equal with depth till at least 150 cm or till near (30 cm?) the parent rock (5 out of 6 profiles); the BS is decreasing or equal till at least 100 cm (6 out of 6 profiles); the Ca is absent till below 200 cm.

2.3 At the Udalfs a udic moisture regime is *specified* in the definition. They should moreover be non-aquic, non-boric, non-ustic, and non-xeric.

Trends: the pH is decreasing or approximately equal with depth till at least 120 cm or till near (30 cm?) the parent rock (7 out of 8 profiles); the BS is decreasing or equal till at least 80 cm (7 out of 8 profiles); the Ca occurs only below 150 cm; or at more than 50 cm below the base of the argillic horizon (see definition of Ustalf).

2.4 At the Udolls the udic moisture regime is only *implied* in the definition: they should be non-albic, non-aquic, non-rendic, non-xeric, non-boric, and non-ustic.

Trends: the pH is decreasing, equal or slightly increasing (less than 0.3 unit) till at least 65 cm (5 out of 5 profiles); the BS is decreasing or equal till 30 cm (4 out of 5 profiles); the Ca occurs only below 90 cm, or a calcic/gypsic/ca-horizon is found only below 150 cm or below 50 cm beyond the base of an argillic or cambic horizon (see definition Ustoll).

2.5 At the Uderts a udic moisture regime is only implied in the definition: their cracks should be less than 90 days open; they should be non-xeric and non-torric.
Trends: the pH and BS are not decreasing with depth or only over a short distance (40 cm?), but the Ca occurs only below 90 cm (2 out of 2 profiles).

3. SOILS WITH USTIC SOIL MOISTURE REGIME

3.1 At the Ustox an ustic moisture regime, combined with isothermic, thermic or warmer temperature, is *specified* in the definition. They should moreover be non-aquic, non-torric, and non-humic.
Trends: the pH is stable till more than 100 cm depth; the BS is stable or decreasing (?); the Ca is absent till below 200 cm (only one profile given in ST; Oxisol order moreover provisional).

3.2 At the Ustults an ustic moisture regime is *specified* in the definition. They should moreover be non-aquic, non-humic, and non-udic.
Trends: the pH is equal or only slightly increasing (less than 0.3 unit) with depth till at least 100 cm; the BS is equal or slightly decreasing (?) till at least 100 cm; the Ca is absent till ... cm (only one profile given in ST).

3.3 At the Ustalfs an ustic moisture regime is *specified*, but only as one of the possible requirements in the definition. The soils should be non-aquic and non-boric.
Trends: the pH is equal or only slightly increasing (less than 0.3 unit) till at least 50 cm depth; the BS is equal or slightly increasing till at least 50 cm depth; the Ca is found only below 60 cm, but within 150 cm c.q. 50 cm below the base of the argillic horizon (see definition).

3.4 At the Ustolls an ustic moisture regime (or ustic-aridic) is *specified*, but only as part of the definition; the soils should be non-albic, non-aquic, non-rendic, non-xeric, and non-boric.
Trends: the pH increases by more than 0.3 unit within 65 cm depth (4 out of 5 profiles); the BS increases with depth (?); the Ca occurs within 90 cm, or a gypsic/calcic/ca-horizon is found within 150 cm depth c.q. within 50 cm of the base of and argillic or cambic horizon (see definition).

3.5 At the Usterts an ustic moisture regime is only *implied* in the definition: they should be non-xeric, non-torric, and non-udic.
Trends: the pH and BS are increasing with depth; the Ca occurs only below ... cm but within 90 cm.

4. SOILS WITH A XERIC SOIL MOISTURE REGIME

4.1 No Xerox foreseen in ST.

4.2 At the Xerults a xeric moisture regime is *specified* in the definition. They should moreover be non-aquic, non-humic, non-udic, and non-ustic.
Trends: pH and BS decreasing (?) with depth; no Ca till ... cm (only one profile given in ST; representative?).

4.3 At the Xeralfs a xeric moisture regime is *specified* in the definition (or xeric-aridic with massive + hard). They should moreover be non-aquic, non-boric, and non-ustic.
Trends: pH and BS increasing with depth (3 out of 4 profiles); the Ca may occur throughout, but its maximum is found below 50 cm (?).

4.4 At the Xerolls a xeric moisture regime is *specified* in the definition (or aridic-xeric). They should be moreover non-cryic, non-albic and non-rendic.
Trends: pH and BS are increasing with depth (7 out of 7 profiles); the Ca may occur throughout, but its maximum is found below 50 cm.

4.5 At the Xererts a xeric moisture regime is only *implied* in the definition: their cracks should be open for more than 60 days, and the temperature should be thermic or mesic.
Trends: pH and BS are increasing with depth; the Ca if present, has a (weak) top only below 50 cm.

5. SOILS WITH A TORRIC OR ARIDIC MOISTURE REGIME

5.1 In the Torrox the torric moisture regime is *specified* in the definition. They should be non-aquic.
Trends: pH and BS increasing with depth (?); the Ca is absent till ... cm? (only one profile given in ST).

5.2 In the Torrerts the torric moisture regime is only *implied* in the definition: their cracks should be open for more than 60 days, and the temperature should be hotter than thermic or mesic.

Trend: the Ca occurs throughout but has a weak bulge? (one profile only in ST).

5.3 In the Aridisols an aridic moisture regime is *specified* in the definition, in this case even at Order level, but again with some qualifications. The soils should be non-aquic, non-histic, non-spodic, non-oxic, non-mollic or -ustic, and non-vertic. When they have an argillic or natric horizon they should have an aridic moisture regime (and an epipedon that is not both massive and hard or very hard). If they do not have such an horizon then they should have either a salic, petrocalcic, calcic, petrogypsic, gypsic or cambic horizon or a duripan, combined with either an aridic moisture regime or an ustic or xeric moisture regime with presence of some free salts.

The above demonstrates that the aridic moisture regime *per se* is not the single criterion. On the other hand, the definition implies that normally no Ultisols, Alfisols and Inceptisols, including Andepts, can occur in zones with aridic climates. Examples however abound (Africa, Australia) of old, stable land surfaces in present-day aridic environment where the soils have well-developed low-activity-clay argillic or cambic horizon, dating from former, more humid periods. In other instances soils may occur in aridic environment where a special parent material, like an acid aeolean deposit, volcanic ash or sulfuric material, exerts a major influence on the soil characteristics. In both cases the resulting intrinsi properties of the soils are often not masked by an engulfing or encrusti calcic horizon or the like. In other words, the aridic environment has not, or not yet, imprinted itself on the soil in a predominating way. There is no overriding result of genesis in an aridic environment, hence their inclusion with Aridisols is unwarranted.

Trend c.q. *hypothesis:* Conceptually "developed" desert soils have high BS and Ca throughout the profile, expressing itself often in (petro)cal gypsic/salic horizons at depths affecting plant growth.

6. CONCLUSIONS

From this preliminar checking of trends per Order of the various soil moisture regimes it would appear that

- the soils with a udic regimes have a dominantly decreasing base saturation = alkalinity;
- the soils with an ustic regime have a downwardly approximately equal (iso) or slightly increasing alkalinity;
- the soils with a xeric regime have dominantly distinctly increasing alkalinity;
- the soils with a torric or aridic regime have dominantly a complete alkalinity throughout: per-alkalinity.

If one wants to apply management-oriented subdivisions of soil moisture regimes at Family level and therefore replace "udic", "ustic", and "xeric" at Suborder level (and at Great Group level for the Entisols) by some other formative element, then the use of dec(a), is(a), in(a) and per(a) may be considered. The following partial scheme illustrates the proposal:

Aqualf	→ same	Aquox	→ same	---	---
Udalf	→ Decalf	Orthox	→ Decox	Udipsamment	→ Decapsamment
Ustalf	→ Isalf	Ustox	→ Isox	Ustipsamment	→ Isapsamment
Xeralf	→ Inalf	---	---	Xeropsamment	→ Inapsamment
---	---	Torrox	→ Perox	Torripsamment	→ Perapsamment

The new definitions may comprise a combination of pH-BS sequence and depth of occurrence of free carbonates, specific per Order c.q. Suborder.

For the soils having obtained their features predominantly from the action of a torric or aridic moisture regime, an Order narrower than the present Aridisols may be defined, with the tentative name *Eremosols* (c.f. Appendix).

In all cases, the necessary mutually exclusive quantification of limits would require very ample testing, on US benchmark soils in first instance.